U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

VEHICLE TECHNOLOGIES OFFICE

2014 Annual Merit Review, Vehicle Technologies Office

Results Report

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For the U.S. Department of Energy Vehicle Technologies Office

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Introduction

The 2014 U.S. Department of Energy (DOE) Fuel Cell Technologies Office (FCTO) and Vehicle Technologies Office (VTO) Annual Merit Review and Peer Evaluation Meeting (AMR) was held June 16-20, 2014, in Washington, DC. The review encompassed all of the work done by the FCTO and the VTO: a total of 295 individual activities were reviewed for VTO, by a total of 179 reviewers. A total of 1,354 individual review responses were received for the VTO technical reviews.

The objective of the meeting was to review the accomplishments and plans for VTO over the previous 12 months, and provide an opportunity for industry, government, and academia to give inputs to DOE on the Office with a structured and formal methodology. The meeting also provided attendees with a forum for interaction and technology information transfer.

The peer review process followed the guidelines of the *Peer Review Guide* developed by the Office of Energy Efficiency and Renewable Energy (EERE). Each activity is reviewed every three years, at a minimum. However, the Office strives to have every activity reviewed every other year. The reviewers for the technical sessions were drawn from a wide variety of backgrounds, including current and former vehicle industry members, academia, government, and other expertise areas. Each reviewer was screened for conflicts of interest as prescribed by the *Peer Review Guide*. A complete list of the meeting participants is presented as Appendix A.

Evaluation Criteria – Research & Development Subprogram Projects

In the technical research and development (R&D) subprogram sessions, these reviewers were asked to respond to a series of specific questions regarding the breadth, depth, and appropriateness of the VTO R&D activities. The technical questions are listed below, along with appropriate scoring metrics. These questions were used for all formal VTO project reviews, including any American Recovery and Reinvestment Act (ARRA) reviews.

Question 1: Approach to performing the work – the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts. (Scoring weight for overall average = 20%)

Scoring: 4.0=outstanding (sharply focused on critical barriers; difficult to improve approach significantly);3.5=excellent (effective; contributes to overcoming most barriers); 3.0=good (generally effective but could be improved; contributes to overcoming some barriers); 2.5=satisfactory (has some weaknesses; contributes to overcoming some barriers); 2.0=fair (has significant weaknesses; may have some impact on overcoming barriers); 1.5=poor (minimally responsive to project objectives; unlikely to contribute to overcoming the barriers; 1.0=unsatisfactory (not responsive to project objectives; unlikely to contribute to overcoming the barriers).

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals. (Scoring weight for overall average = 40%)

Scoring: 4.0=outstanding (sharply focused on critical barriers; difficult to improve significantly);3.5=excellent (effective; contributes to overcoming most barriers); 3.0=good (generally effective but could be improved; contributes to overcoming some barriers); 2.5=satisfactory (has some weaknesses; contributes to overcoming some barriers) 2.0=fair (has significant weaknesses; may have some impact on overcoming barriers); 1.5=poor (minimally responsive to project objectives; unlikely to contribute to overcoming the barriers); 1.0=unsatisfactory (not responsive to project objectives; unlikely to contribute to overcoming the barriers).

Question 3: Collaboration and coordination with other institutions. (Scoring weight for overall average = 10%)

Scoring: 4.0=outstanding (close, appropriate collaboration with other institutions; partners are full participants and well-coordinated) 3.5=excellent (good collaboration; partners participate and are well-coordinated); 3.0=good (collaboration exists; partners are fairly well-coordinated); 2.5=satisfactory (some collaboration exists; coordination between partners could be *significantly improved); 2.0=fair (a little collaboration exists; coordination between partners could be significantly improved); 1.5=poor (most work is done at the sponsoring organization with little outside collaboration; little or no apparent coordination with partners);1.0=unsatisfactory (no apparent coordination with partners).*

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways. (Scoring weight for overall average = 10%)

Scoring: 4.0=outstanding (sharply focused on critical barriers; difficult to improve significantly); 3.5=excellent (effective; contributes to overcoming most barriers); 3.0=good (generally effective but could be improved; contributes to overcoming some barriers) 2.5=satisfactory (has some weaknesses; contributes to overcoming some barriers); 2.0=fair (has significant weaknesses; may have some impact on overcoming barriers); 1.5=poor (minimally responsive to project objectives; unlikely to contribute to overcoming the barriers);1.0=unsatisfactory (not responsive to project objectives; unlikely to contribute to overcoming the barriers).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not? (Scoring weight, not included with overall average = 20%)

Responses: yes, no.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Responses: excessive, sufficient, insufficient.

Evaluation Criteria – Technology Integration Projects

Reviewers for the Technology Integration (TI) technical session answered questions tailored to TI's 2014 AMR focus on alternative fuels and alternative fuel vehicle deployment. These technical questions are listed below, along with appropriate scoring metrics.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts – the degree to which the project is well-designed, feasible, and integrated with other efforts. (Scoring weight for overall average = 20%)

Scoring: 4.0=outstanding (project approach is sharply focused on achieving project objectives; difficult to improve project significantly.); 3.5 = excellent (effective; project approach contributes to achieving the majority of project objectives); 3.0=good (generally effective but project approach could be improved; contributes to achieving some of the project objectives); 2.5= satisfactory (has some weaknesses; project approach contributes to achieving some project objectives); 2.0=fair (has significant weaknesses; project approach may have some impact on achieving project objectives); 1.5=poor (minimally responsive to project objectives; project approach is unlikely to contribute to achieving project objectives); 1.0=unsatisfactory (not responsive to project objectives; project approach is unlikely to contribute to achieving project objectives).

Question 2: Project accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated toward projects and DOE goals. (Scoring weight for overall average = 40%)

Scoring: 4.0=outstanding (sharply focused on achieving project objectives; difficult to improve progress significantly); 3.5= excellent (effective progress; strongly contributes to overall project objectives and DOE goals); 3.0=good (generally effective; progress is on schedule; contributes to some project objectives and DOE goals);2.5=satisfactory (has some weaknesses; progress could be improved; contributes to some project objectives and DOE goals); 2.0=fair (has significant weaknesses; rate of progress is slow); 1.5=poor (minimally responsive to project objectives and progress is significantly behind schedule; unlikely to contribute to project objectives or DOE goals); 1.0=poor (not responsive to project objectives; limited or no demonstrated progress).

Question 3: Collaboration and coordination with Project Partners – the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among the partners. (Scoring weight for overall average = 10%)

Scoring: 4.0=outstanding (sharply focused on collaboration with project partners; partners are well-suited to effectively carry out the work of the project and have very strong working relationships; no notable weaknesses); 3.5=excellent (effective; project partners meaningfully contribute to carrying out the work of the project; are well-suited to perform the work and have some excellent working relationships); 3.0=good (generally effective but could be improved; collaboration exists; partners are fairly well-suited to project work and have good working relationships); 2.5=satisfactory (has some weaknesses; collaboration among project partners is satisfactory for carrying out the work of the project; project partner team and working relationships are adequate); 2.0=fair (has significant weaknesses; little collaboration exists and partnerships need to be improved); 1.5= poor (minimally responsive; little collaboration exists and most work is done at sponsoring organization); 1.0=unsatisfactory (little or no apparent collaboration between partners; project partners are lacking critical expertise to effectively carry out the work of the project).

Question 4: Alternative fuel market expansion potential – the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas. (Scoring weight for overall average = 10%)

Scoring: 4.0=outstanding (sharply focused on critical barriers; clearly contributes to alternative fuel vehicle market expansion; difficult to improve significantly); 3.5=excellent (effective; contributes to overcoming most barriers; contributes to alternative fuel vehicle market expansion); 3.0=good (generally effective in overcoming barriers; has the potential to contribute to alternative fuel vehicle market expansion); 2.5=satisfactory (has some weaknesses; may contribute to market improvements but needs better focus on overcoming some barriers); 2.0=fair (has significant weaknesses; may have some impact on overcoming barriers); 1.5=poor (minimally responsive to project objectives; unlikely to advance an alternative fuel vehicle market); 1.0=unsatisfactory (not responsive to eliminating barriers or advancing an alternative fuel vehicle market).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not? (Scoring weight for overall average = 20%)

Responses: yes, no.

Question 6: Use of resources – are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Responses: yes, maybe, no.

Project Scoring

Reviewers were asked to provide numeric scores (on a scale of 1.0-4.0 in one-half point increments, as indicated above) for Question 1 through Question 4 of each formally reviewed activity. For each reviewed project, the individual reviewer scores for Question 1 through Question 4 were averaged to provide information on the project's question-by-question scoring. Scores for each of these four criteria were weighted using the formula below to create a weighted average for each project. This allows a project's question-by-question and final overall scores to be meaningfully compared against another project:

$$\boldsymbol{Weighted\ Average} = [\boldsymbol{Question\ 1\ Score\ x\ 0.20}] + [\boldsymbol{Question\ 2\ Score\ x\ 0.40}] + [\boldsymbol{Question\ 3\ Score\ x\ 0.10}] + [\boldsymbol{Question\ 4\ Score\ x\ 0.10}]$$

Each reviewed activity has a corresponding bar chart representing that project's average scores for each of the four designated criteria. As demonstrated in Figure 1, a bullet and red error line are included within the green bars representing the corresponding average and standard deviation of criteria scores for all of the reviewed projects in the same subprogram.

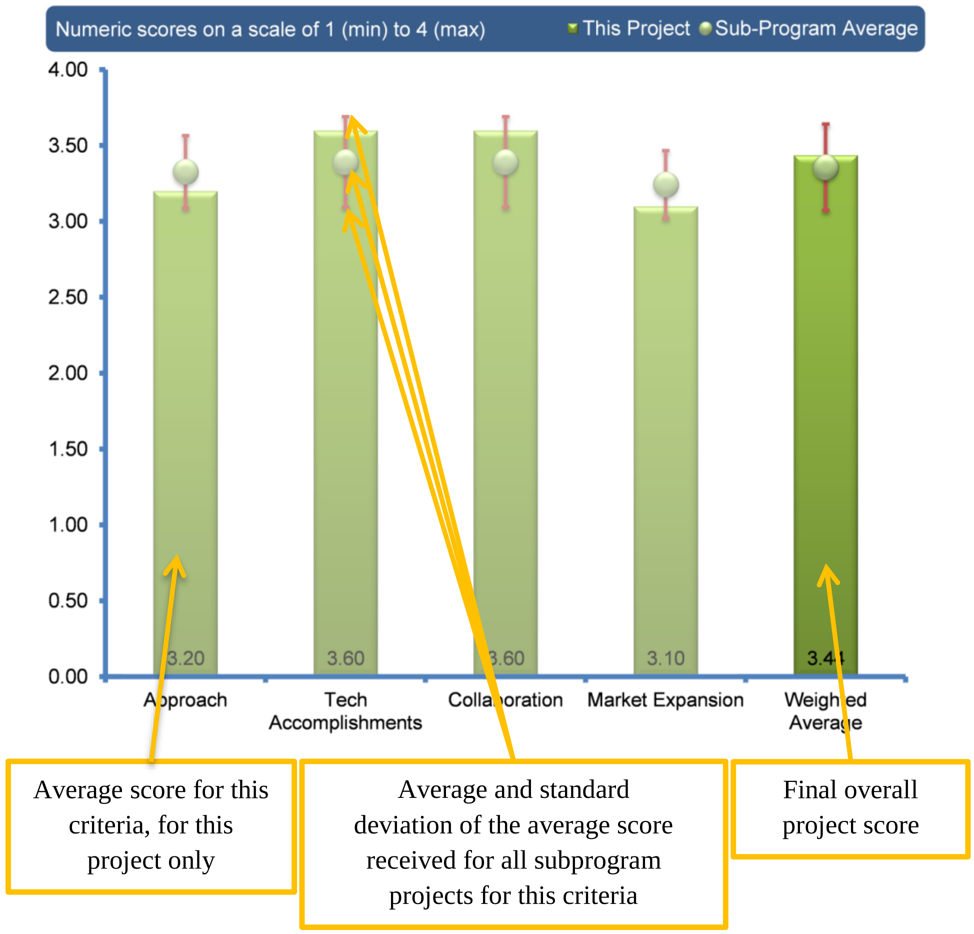


Figure 1. Sample Question 1 through Question 4 score averages, standard deviations, and overall Weighted Average for a TI project

Reviewers were also asked to evaluate a given project's relevance and funding through Question 5 and Question 6, which were each scored on a different scale than Question 1 through Question 4. Question 1 through Question 4 was rated on a 1.0 to 4.0 scale in one-half point increments, whereas Question 5 was rated on a yes or no scale, and Question 6 was rated on an excessive, sufficient, or insufficient scale for R&D subprograms, and a yes, no, or maybe scale for the Technology Integration subprogram. Consequently, Question 5 and Question 6 results were excluded from the Weighted Average calculation because the scoring scales are incompatible. Alternately, as demonstrated in Figure 2, each reviewed activity has pie charts representing that project's population distributions for each reviewer rating associated with Question 5 and Question 6:

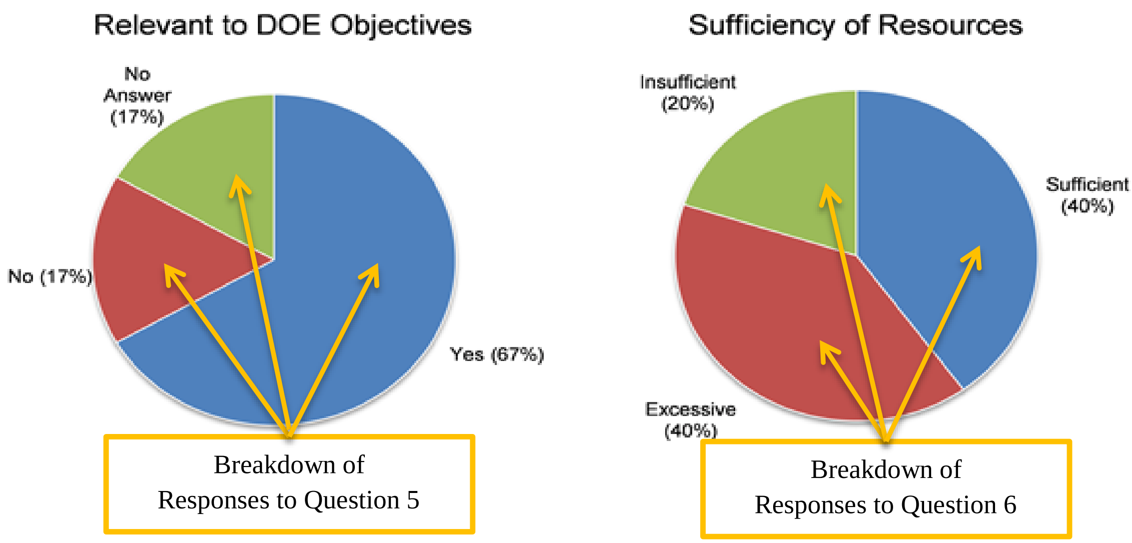


Figure 2. Sample Question 5 and Question 6 population distributions for R&D subprogram project

For TI projects, reviewers were asked to evaluate a given project's relevance and effective use of funds through Question 5 and Question 6, which were each scored on a different scale than Question 1 through Question 4. Question 1 through Question 4 was rated on a 1.0 to 4.0 scale in one-half point increments, whereas Question 5 was rated on a yes or no scale, and Question 6 was rated on a yes, maybe, no scale. Consequently, Question 5 and Question 6 results were excluded from the Weighted Average calculation because the scoring scales are incompatible.

Text responses and numeric scores to the questions were submitted electronically through a web-based software application, PeerNet, operated by Oak Ridge Associated Universities (ORAU). Database outputs from this software application were analyzed and summarized to collate the multiple-choice, text comment, and numeric scoring responses and produce the summary report.

Responses to the questions are summarized in this report, with summaries of numeric scores for each technical session, as well as text and graphical summaries of the responses for each individual technical activity. For each project, the reviewer sample size is identified. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that for each question the order of reviewer comments may be different; for example, for each specific project the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc. Not all reviewers provided a response to each question for a given project.

The report is organized by technical subprogram area. Each technical area section includes a summary of that subprogram, reviewer feedback received specific to the subprogram overview presentation(s) given by DOE, a subprogram activities score summary table (and page numbers), and project-specific reviewer evaluation comments with corresponding bar and pie charts.

1. Hybrid and Vehicle System Simulation

Hybrid and vehicle systems research provides an overarching vehicle systems perspective to the technology research and development (R&D) activities of the U.S. Department of Energy's (DOE's) vehicle research programs, and identifies major opportunities for improving vehicle efficiencies. The effort evaluates and validates the integration of technologies, provides component and vehicle benchmarking, develops and validates heavy hybrid propulsion technologies, and develops technologies to reduce the parasitic losses from heavy vehicle systems. Analytic and empirical tools are used to model and simulate potential vehicle systems, validate component performance in a systems context, benchmark emerging technology, and validate computer models. Extensive collaboration with the technology development activities is required for success. The results of hybrid and vehicle systems activities are used to estimate the national benefits and impacts of DOE-sponsored technology development, and successfully transfer developed technology to industry.

In August 2009, the DOE announced the selection of ten projects totaling $425 million for development, deployment, and validation of hybrid vehicles, and deployment of charging stations across the nation. American Reinvestment and Recovery Act (ARRA)-funded transportation electrification activities will aid in the deployment of technologies that help to reduce petroleum consumption. Activities include deployment of 18,000 public and private charging stations in major metropolitan areas across the country, and deployment of truck stop electrification infrastructure at 50 sites across interstate corridors. Additional deployment activities include development, validation, and deployment of light- and medium-duty electric drive vehicles.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram’s activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO’s needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: David Anderson (U.S. Department of Energy) – vss000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer said yes, definitely.

Reviewer 2:
The reviewer said that the presenter did a very good job in the beginning of the presentation to explain that Vehicle and System Simulation (VSS) was the last step in the process since all the Vehicle Technologies Office (VTO) work needs to be integrated into an overall vehicle and evaluated. In addition, the goals and objectives were explicitly addressed.

Reviewer 3:
The reviewer said yes, and clarified that the key points of the program were sufficiently covered in an orderly fashion so as to bring relevance and relationship to each.

Reviewer 4:
The reviewer said yes, and observed a systems approach to integrating work from engine, battery storage, transmission and driveline improvements.

Reviewer 5:
The reviewer said that work, goals, and value were adequately covered by area. This reviewer emphasized that the strategy was not so clear, unless the strategy was simply to attack challenges listed. The reviewer opined that this was not a real strategy.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer observed that the work in this program was mainly focused on near and mid-term evaluations. The projects will ultimately provide information towards meeting the long term goals of petroleum displacement.

Reviewer 3:
The reviewer believed so, and elaborated that the entire technology was being introduced on a greatly accelerated scale that was necessary to build business case, maturity, and acceptance; therefore, some things get "fuzzy" when trying to understand the time relationship.

Reviewer 4:
The reviewer believed that the program was probably a little current biased to mid-term biased. However, the reviewer observed a pretty good balance, overall.

Reviewer 5:
The reviewer said that there is a decent balance, although this reviewer thought there could be some more near-term focus (i.e., could focus on getting the technologies into commercialization). This reviewer believed especially, that more resources could be put on finding heavy-duty (HD) and medium-duty (MD) applications that have a payback for hybrid systems through more money going to the National Renewable Energy Laboratory’s (NREL) Fleet DNA database. The reviewer also suggested modeling of proposed hybrid systems using existing components where possible in applications that have data in the Fleet DNA would be helpful. Given recent interest, this reviewer indicated that natural gas could be another area for short-term research and development (R&D) and long-term R&D, especially more engine development (i.e., modeling) that optimizes the engine for natural gas.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer said yes, absolutely.

Reviewer 2:
The reviewer said yes, well done.

Reviewer 3:
The reviewer found that major challenges of extending electric vehicle (EV) range and improvement of EV charging as well as the need for grid integration were identified.

Reviewer 4:
The reviewer commented yes, and summarized issues and challenges as petroleum reduction goals, reduce greenhouse gas (GHG) emissions, and advance vehicle electrification.

Reviewer 5:
The reviewer said yes, and that one other challenge is likely the cost for hybrids. That could be system cost in addition to component costs covered by other groups. According to this reviewer, another challenge would be to include natural gas systems in the research given its surge in vehicle use.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer responded yes, and elaborated that for each of the challenges identified, there were associated strategies to be completed to address the challenges.

Reviewer 2:
The reviewer said yes. By definition, the programs are designed to address the significant issues. The reviewer found that the depth and quantity of programs underway have a significant range of scope to cover the various challenges.

Reviewer 3:
The reviewer responded that the tools available were being deployed to address the challenges that have been identified in the presentation and talk. This reviewer did not know if plans were in place for the challenges the reviewer previously mentioned. These challenges understandably were not identified in the presentation.

Reviewer 4:
The reviewer observed that several funding opportunity announcements (FOAs) were listed, and a series of tools and focus areas to address the challenges, but not so much in the way of plans. This reviewer expressed hope and trust that the program team has detailed plans, but it was unclear.

Reviewer 5:
The reviewer noted that the EV Everywhere Grand Challenge and a broad overview of topics were to be expanded upon during subsequent session presentations.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer commented that a large number of accomplishments and progress had been identified in each of the five focus areas this program addresses.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer said yes.

Reviewer 4:
The reviewer asserted that the measurables were quantified even greater through the individual program presentations.

Reviewer 5:
The reviewer commented that progress was compared to previous year plans.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:
The reviewer commented asserted that this was done well.

Reviewer 2:
The reviewer commented that the current portfolio including vehicle evaluation, modeling and simulation, component and systems, codes and standards, and systems optimization, provide an excellent mix of projects which help to address problems and barriers that VTO is working on.

Reviewer 3:
The reviewer said yes.

Reviewer 4:
The reviewer said yes, it is tying the other groups together.

Reviewer 5:
The reviewer said that regarding objectives, yes. The reviewer noted that results are general for this overview, but this reviewer expected specifics to be presented during the expanded reports in the sessions.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer said absolutely on all accounts. There has been a significant effort to this technology development and remarkable results from the DOE team.

Reviewer 2:
The reviewer said yes, the tool and focus areas interlink to cover all aspects of the area and build on the base level simulations to the highest level simulations. According to the reviewer, this is an area in which this program shines.

Reviewer 3:
The reviewer said yes, this program currently has 40 projects that are well managed and provide excellent information to help address VTO goals and objectives.

Reviewer 4:
The reviewer said yes.

Reviewer 5:
The reviewer responded yes, it supports the other VTO areas.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
The reviewer commented that the projects associated with evaluating the complete system and providing real in-use data were extremely important in determining the state-of-the-art of the technologies being evaluated.

Reviewer 2:
The reviewer noted that EV technologies were discussed, which could also offer improvement opportunities for other areas, like building efficiencies (heating, ventilation, and air conditioning (HVAC), etc.).

Reviewer 3:
The reviewer remarked that codes and standards work may be more important than anything else because this is one of the few places the industries can meet to work these out and then present a united view internationally. The reviewer observed that the work with industry to better model hardware is excellent (for example, Autonomie) and is another strong point. For this reviewer, a weakness was that some of the modeling systems of preference are still fairly speculative. The reviewer said that work where industry is not given a voice often has had some rather "political" assumptions.

Reviewer 4:
The reviewer remarked that many of the projects focus on batteries and hybrids, which can be a strength if there are ways to use that knowledge in products that eventually get to production. For passenger cars, batteries and hybrids have an outlet in production for the LEAF, Volt, and other vehicles. However, for MD and HD trucks, according to this reviewer, there are no large outlets to production because strong business cases (payback to the customer) for hybrid products have not emerged. The reviewer recommended that projects addressing this missing piece for MD and HD trucks would help get hybrids across the chasm in this market. The reviewer wondered if perhaps more focus on natural gas given its recent rise in use would be helpful.

Reviewer 5:
The reviewer said that the diversity of project scopes prohibits this reviewer from placement on such a spectrum.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer commented well thought out and innovative as opposed to novel perhaps.

Reviewer 2:
The reviewer commented probably not novel but certainly appropriate.

Reviewer 3:
The reviewer said yes, in general terms. The reviewer remarked that the presentation was light on specifics, but thought that presentations later in the day and week would provide specifics.

Reviewer 4:
The reviewer responded yes, with the exception of focus on system payback and development of hybrid systems for MD and HD trucks.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer found that this project collaborates extensively with industry, other government agencies, national laboratories, and academia, as well as within DOE and VTO itself.

Reviewer 2:
The reviewer commented yes, especially through the phenomenal efforts of the national laboratories.

Reviewer 3:
The reviewer said this was one of the better engagement programs, and that the program team works with many people.

Reviewer 4:
The reviewer commented yes, and specified both light- and heavy-duty. National laboratories and original equipment manufacturer (OEM) involvement was noted. The reviewer also noted that Autonomie was given as an example of effective utilization of models by industry and other partners.

Reviewer 5:
The reviewer said yes, and specified laboratories and industry.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer asserted that the collaboration is a very important and effective part of the success of this effort, as evidenced from the progress and accomplishments.

Reviewer 2:
The reviewer said yes, absolutely.

Reviewer 3:
The reviewer commented that it appeared to be a broad based collaboration with academia, industry and government partners.

Reviewer 4:
The reviewer said yes.

Reviewer 5:
The reviewer commented that it was hard to say. The reviewer elaborated that the program gets data from partners, but it was unclear how much the partners benefited, as they should in a true and effective partnership.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer said that the five focus areas being investigated provide an excellent portfolio. Therefore, according to the reviewer there does not seem to be any gaps.

Reviewer 2:
The reviewer was unable to identify any gaps.

Reviewer 3:
The reviewer said that no gaps were evident from this presentation.

Reviewer 4:
The reviewer remarked that as mentioned in previous answers for other questions, natural gas work is a gap, as is focus on system development and payback for MD and HD hybrid systems.

Reviewer 5:
The reviewer identified new calculation techniques for solving future problems or problems too complex to solve now. The reviewer elaborated that vehicles and society are very messy and complex problems, and new techniques might clarify a lot.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer commented that it appears the topics were being addressed adequately.

Reviewer 2:
The reviewer said no.

Reviewer 3:
The reviewer was unable to identify topics not being adequately addressed.

Reviewer 4:
The reviewer said none, other than advanced techniques.

Reviewer 5:
The reviewer suggested that a topic that could be better addressed is return on investment (ROI) studies and system development for HD hybrid systems that would encourage market adaption.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer said yes, and suggested safety specific performance standards – about $15 million in conjunction with the U.S. Department of Transportation (DOT).

Reviewer 3:
The reviewer referenced responses to Questions 12 and 13 related to advanced techniques.

Reviewer 4:
The reviewer noted that 10 FOA projects were listed and were relevant for further funding. Some of those include SuperTruck, autonomous vehicles, wireless charging, transmission efficiency improvement, and others.

Reviewer 5:
The reviewer suggested that this program should include even more work with industry partners for development and commercialization of MD and HD hybrid products. Much money went into components for HD hybrids (Remy and the battery manufacturers to name two). The reviewer suggested that more money could be spent on the modeling, development, and testing of those components in full hybrid systems. Without that help, even companies like Eaton and BAE were having a hard time getting hybrids across the chasm in the MD and HD markets. The reviewer noted that China and Europe end up doing the system development and getting the systems into production.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer said no.

Reviewer 3:
The reviewer said no. The reviewer elaborated that barriers were not discussed in detail at this overview session. This reviewer expected that the program reports will provide more insight into barriers that need resolution.

Reviewer 4:
This reviewer acknowledged hitting this topic pretty hard in some responses to questions prior to this one. The reviewer proposed possible systems for MD and HD hybrids using off the shelf components and testing them with major truck OEMs. The reviewer commented that natural gas engines for vehicles can be optimized. This department could also simulate proposed engines and test those engines in vehicles once they are built.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer said no.

Reviewer 3:
The reviewer’s only suggestion to help enhance the program would be to consider providing additional funding to this program area to allow for more vehicles to be evaluated.

Reviewer 4:
The reviewer said continued support of modeling and simulation, tools and tool development, lab and field evaluation, codes and standards, and vehicle systems optimization.

Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

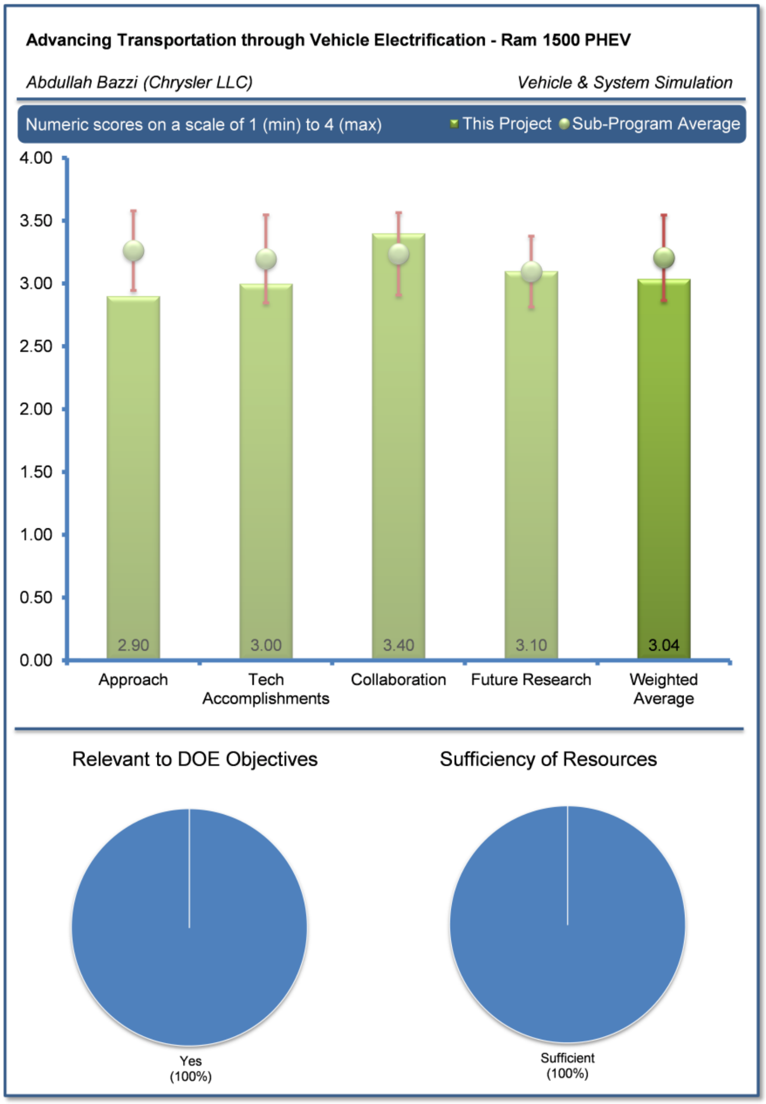
Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
††Advancing Transportation through Vehicle Electrification - Ram 1500 PHEV	Abdullah Bazzi (Chrysler LLC)	1-13	2.90	3.00	3.40	3.10	3.04
††Smith Electric Vehicles: Advanced Vehicle Electrification + Transportation Sector Electrification	Robin Mackie (Smith Electric Vehicles)	1-16	3.30	2.90	3.10	2.60	2.99
††Class 8 Truck Freight Efficiency Improvement Project	Derek Rotz (Daimler Trucks North America LLC)	1-20	3.70	3.80	3.90	3.50	3.75
††Technology and System Level Demonstration of Highly Efficient and Clean, Diesel Powered Class 8 Trucks	Ken Damon (Peterbilt)	1-23	3.50	3.67	3.83	3.17	3.58
††SCAQMD:Plug-In Hybrid Electric Medium-Duty Commercial Fleet Demonstration and Evaluation	Matt Myasato (SCAQMD)	1-26	3.17	3.00	3.17	3.00	3.06
Medium and Heavy-Duty Vehicle Field Evaluations	Kevin Walkowicz (National Renewable Energy Laboratory)	1-30	3.38	3.38	3.38	3.00	3.33
† DOE/DOD Parasitic Energy Loss Collaboration	George Fenske (Argonne National Laboratory)	1-33	3.20	3.00	2.90	3.00	3.04
Vehicle Integration & Aerodynamics for Next-Gen Heavy Trucks	Kambiz Salari (Lawrence Livermore National Laboratory)	1-37	3.40	3.40	3.20	3.20	3.35
Idaho National Laboratory Testing of Advanced Technology Vehicles	Matthew Shirk (Idaho National Laboratory)	1-41	3.33	3.33	3.17	3.17	3.29
Advanced Vehicle Testing & Evaluation	Tom Garetson (Intertek)	1-44	3.13	2.75	3.38	2.75	2.92
Advanced Technology Vehicle Lab Benchmarking - Level 1	Kevin Stutenberg (Argonne National Laboratory)	1-47	3.63	3.50	3.38	3.13	3.47
Advanced Technology Vehicle Lab Benchmarking - Level 2 (in-depth)	Eric Rask (Argonne National Laboratory)	1-51	3.50	3.50	3.25	3.25	3.44
Electric Drive and Advanced Battery and Components Testbed (EDAB)	Barney Carlson (Idaho National Laboratory)	1-55	2.63	2.88	2.50	2.88	2.77
Integrated Vehicle Thermal Management – Combining Fluid Loops in Electric Drive Vehicles	Daniel Leighton (National Renewable Energy Laboratory)	1-58	3.50	3.33	3.50	3.50	3.42
Advanced HD Engine Systems and Emissions Control Modeling and Analysis	Zhiming Gao (Oak Ridge National Laboratory)	1-61	3.25	3.38	3.13	3.00	3.27
† Codes and Standards to Support Vehicle Electrification	Ted Bohn (Argonne National Laboratory)	1-64	3.67	2.67	3.33	3.00	3.04
Development of High Power Density (HPD) Driveline for Vehicle Efficiency Improvement	Oyelayo Ajayi (Argonne National Laboratory)	1-67	3.10	3.30	2.80	2.90	3.14

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
CoolCab Test and Evaluation and CoolCalc HVAC Tool Development	Jason Lustbader (National Renewable Energy Laboratory)	1-70	3.75	3.38	3.50	3.38	3.48
Development and Demonstration of a Fuel-Efficient Class 8 Highway Vehicle	Pascal Amar (Volvo Trucks)	1-72	3.50	3.40	3.60	3.30	3.44
Improving Vehicle Fuel Efficiency Through Tire Design, Materials, and Reduced Weight	Timothy Donley (Cooper Tire)	1-75	3.38	3.50	3.25	3.50	3.44
A Materials Approach to Fuel-Efficient Tires	Peter Votruba-Drzal (PPG)	1-78	3.00	3.00	3.00	3.13	3.02
System for Automatically Maintaining Pressure in a Commercial Truck Tire	Robert Benedict (Goodyear)	1-81	3.50	3.88	3.25	3.50	3.66
Next Generation Environmentally Friendly Driving Feedback Systems Research and Development	Matthew Barth (University of California at Riverside)	1-84	3.00	2.88	3.75	3.13	3.05
Look-Ahead Driver Feedback and Powertrain Management	Rajeev Verma (Eaton Corporation)	1-87	3.00	2.75	3.25	2.75	2.88
EV - Smart Grid Research & Interoperability Activities	Keith Hardy (Argonne National Laboratory)	1-90	3.00	3.25	3.38	3.13	3.19
Wireless Charging Testing	Barney Carlson (Idaho National Laboratory)	1-93	3.50	3.40	3.20	3.20	3.38
Electric Drive Vehicle Climate Control Load Reduction	John Rugh (National Renewable Energy Laboratory)	1-96	3.25	3.25	3.38	3.25	3.27
High Efficiency, Low EMI and Positioning Tolerant Wireless Charging of EVs	Allan Lewis (Hyundai)	1-99	3.50	3.10	3.30	3.20	3.24
Wireless Power Transfer and Charging of Plug-In Electric Vehicles	Perry Jones (Oak Ridge National Laboratory)	1-103	3.40	3.20	3.60	3.00	3.28
† Dynamic Wireless Power Transfer Feasibility	Perry Jones (Oak Ridge National Laboratory)	1-107	3.25	3.00	3.25	2.75	3.06
Development of Nanofluids for Cooling Power Electronics for Hybrid Electric Vehicles	Dileep Singh (Argonne National Laboratory)	1-110	3.60	3.90	3.00	3.20	3.63
PEV Integration with Renewables	Anthony Markel (National Renewable Energy Laboratory)	1-114	3.38	3.63	3.13	3.38	3.47
Zero Emission Heavy Duty Drayage Truck Demonstration	Brian Choe (SCAQMD)	1-117	3.20	3.00	3.20	2.90	3.06
Houston Zero Emission Delivery Vehicle Deployment Project & Hydrogen Fuel-Cell Electric Hybrid Truck Project	Allison Carr (Houston-Galveston Area Council)	1-121	2.00	1.75	2.25	2.08	1.92
† Fleet DNA	Kevin Walkowicz (National Renewable Energy Laboratory)	1-125	3.30	3.20	3.60	3.10	3.26
APEEM Components Analysis and Evaluation	Paul Chambon (Oak Ridge National Laboratory)	1-129	2.88	3.00	3.25	3.00	3.00
Vehicle to Grid Communications Field Testing & Analysis	Richard Pratt (Pacific Northwest National Laboratory)	1-132	3.33	2.83	2.67	2.83	2.94
Motor Standards Support	Laura Marlino (Oak Ridge National Laboratory)	1-135	3.50	3.00	3.50	3.33	3.23
ARRA Data Reporting and Analysis	Kevin Walkowicz (National Renewable Energy Laboratory)	1-137	3.25	3.25	3.38	2.88	3.22

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Trip Prediction and Route-Based Vehicle Energy Management	Dominik Karbowski (Argonne National Laboratory)	1-141	3.50	3.30	2.90	2.90	3.25
Internal Combustion Engine Energy Retention (ICEER)	Jeff Gonder (National Renewable Energy Laboratory)	1-145	2.67	2.50	2.50	2.50	2.54
Vehicle Level Model and Control Under Various Thermal Conditions	Aymeric Rousseau (Argonne National Laboratory)	1-148	3.10	3.00	3.00	2.70	2.99
Impact of Advanced Technologies on Engine Targets	Neeraj Shidore (Argonne National Laboratory)	1-152	3.38	3.13	3.13	3.25	3.20
In-Vehicle LEESS Test Platform Evaluation of Lower-Energy Energy Storage System Devices	Jeff Gonder (National Renewable Energy Laboratory)	1-155	2.63	3.25	3.00	2.75	3.00
Dynamic Wireless Power Transfer Vehicle and Infrastructure Analysis	Jeff Gonder (National Renewable Energy Laboratory)	1-159	3.38	3.25	3.50	3.38	3.33
DC Fast Charging Effects on Battery Life and EVSE Efficiency and Security Testing	Jim Francfort (Idaho National Laboratory)	1-162	3.38	3.38	2.63	3.50	3.30
Thermal Control of Power Electronics of Electric Vehicles with Small Channel Coolant Boiling	Dileep Singh (Argonne National Laboratory)	1-166	3.25	3.50	3.50	3.38	3.42
Cummins MD & HD Accessory Hybridization CRADA	Dean Deter (Oak Ridge National Laboratory)	1-169	3.63	3.50	3.75	3.50	3.56
† Vehicle Thermal Systems Modeling in Simulink	Jason Lustbader (National Renewable Energy Laboratory)	1-172	3.63	3.38	3.50	3.25	3.44
Advanced Climate Systems for EV Extended Range	John Meyer (Halla Visteon)	1-175	2.88	3.00	3.25	3.13	3.02
Innovative Heating System for Cabin Heating in Electric Vehicles.	Timothy Craig (Delphi Automotive Systems)	1-178	3.25	3.13	3.13	3.25	3.17
EV Project Data & Analytic Results	Jim Francfort (Idaho National Laboratory)	1-181	3.63	3.50	3.63	3.25	3.52
† Autonomie Maintenance and Enhanced MBSE	Shane Halbach (Argonne National Laboratory)	1-183	3.25	3.25	3.25	3.13	3.23
† Impacts of Advanced Combustion Engines	Scott Curran (Oak Ridge National Laboratory)	1-186	3.33	3.50	3.33	3.50	3.44
† Powertrain Controls Optimization for HD Hybrid Line Haul Trucks	David Smith (Oak Ridge National Laboratory)	1-190	3.33	3.17	3.33	3.17	3.23
† Grid - Vehicle Communications and Charging Control	Richard Pratt (Pacific Northwest National Laboratory)	1-192	2.83	3.00	3.00	2.83	2.94
Overall Average			**3.26**	**3.20**	**3.24**	**3.10**	**3.21**

Note:
† denotes poster presentations.
†† denotes Recovery Act presentations.

Advancing Transportation through Vehicle Electrification - Ram 1500 PHEV: Abdullah Bazzi (Chrysler LLC) - arravt067



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts

Reviewer 1:

The reviewer commented that the project overcame issues associated with Phase I batteries voltage imbalances and generated additional route based adaptive controls with significant fuel consumption benefits for fully charged vehicles.

Reviewer 2:

The reviewer remarked that this project uses a direct approach. If the project team wants to know how these vehicles will work, put them into normal use and monitor all the relevant parameters. The reviewer suggested that the final results compare performance and fuel economy to conventional equivalent vehicles. The reviewer questioned whether fuel use could have been decreased if drivers charged more often.

Reviewer 3:

The reviewer affirmed that the project had a good approach on applying new technologies to plug-in hybrid electric vehicles (PHEVs), which can be used for other vehicle classes. However, the Phase II sample size is too small. The presenter did not explain the reasons for having smaller sample in Phase II. In addition, the presenter did not provide concise answers to the reviewers questions, which could have helped clear some of the issues raised in the questions.

Reviewer 4:

The reviewer stated that overall, this was a good demonstration project. There are lots of vehicles providing quite a bit of data. It was not made clear in the presentation why the second generation battery had less capacity that resulted in an expected all-electric range (AER) of half the first generation-equipped vehicle. The reviewer questioned why the problems with the first generation batteries were not found before. The reviewer asked if it was the chemistry or the integration into modules/pack that caused the degradation issues.

According to the reviewer, the real-world fuel economy results are not overly impressive. If these results are better than the conventional vehicle counterpart, it would be useful to see such a comparison for future presentations. The reviewer found the units to be confusing and questioned why the units were not either Wh/mile or miles per gallon equivalent (MPGe) for charge depleting (CD) mode.

The reviewer is disappointed in the plug-in electric vehicle (PEV) lineup for Chrysler and stated that it is unclear how much of an impact this project has had on Chrysler's plans for the future. If the U.S. Department of Energy (DOE) provides such a high level of funding, it should be expected to result in a serious effort on Chrysler's part to introduce more PEVs.

Reviewer 5:
The reviewer suggested reading comments for the next question. The reviewer commented that there was a lack of project detail in the presentation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
Apart from the problems associated with the first generation battery, the reviewer believed that the project progress appears on track. The design effort has been completed for Phase II, and the specified number of vehicles has been deployed for both phases.

Reviewer 2:
The reviewer noted that the project is on schedule.

Reviewer 3:
The reviewer was especially interested in two factors, namely the improvements achieved in battery balancing with the replacement batteries, and the active fuel economy optimization. The latter should be emphasized, and the reviewer would like to see more discussion of how this could be applied to other vehicles.

Reviewer 4:
The reviewer commented that the project has achieved progress in Phase II despite the small number of samples. It showed good results for the new tested technologies. However, the project needed to provide more information on the creation of green technology jobs, because it is one of the objectives.

Reviewer 5:
In the reviewer’s opinion, the learning experience of cell balance and thermal control were easily avoidable with institutional knowledge within the technology, though it was unclear who was ultimately responsible in this case (i.e., the OEM or the battery supplier), and the lessons learned are societal in nature that this can really happen. The reviewer commended DOE for stepping in and salvaging a bad situation, but the reduction in scope and lost field experience was costly.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that the competence and scope of collaboration was impressive.

Reviewer 2:
The reviewer acknowledged the project had broad collaboration with appropriate partners.

Reviewer 3:
The reviewer stated that the project has good collaboration with a diverse group of partners that include research institutes, and utility providers.

Reviewer 4:
The reviewer observed that the list of participants and demonstration partners is impressive. There appears to be a wide variety of demonstration locations.

Reviewer 5:
The reviewer remarked that perhaps a better initial core competence would have been better.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked that the technical aspects are very well covered. The reviewer is also interested in the people aspects. The reviewer hopes the project team will discuss whether the drivers bothered to plug in when appropriate. Also, the reviewer questioned if the vehicle characteristics were well matched to the uses that were tried. The reviewer also asked if a larger AER would have been useful, if charging time impacted vehicle utility, and what were the best fits, where the vehicle characteristics worked best with the functions performed.

Reviewer 2:

The reviewer observed that the future plan will continue in the same track for monitoring the functionalities that were identified in Phase II. Also, it appears that the lessons learned helped and will help in commercialization of technologies for future products.

Reviewer 3:

The reviewer noted that there are several interesting aspects on side project, such as the reverse power flow and map-based fuel economy optimization. There appears to be well-established plans to examine these issues and to complete the remaining milestones. The reviewer looks forward to seeing the end of project results.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer said that developing PHEV technologies has a great potential for improving fuel efficiency and thus supporting DOE objectives.

Reviewer 2:

The reviewer commented that obviously, any electric miles achieved are displacing petroleum miles. It would be good if the researchers actually quantify savings by comparing fuel use with fuel use for equivalent conventional vehicles.

Reviewer 3:

The reviewer stated that demonstration projects were useful for several reasons, including the design experience gained in addition to the potential to displace petroleum by furthering the knowledge of real-world PEV performance and helping to create economies of scale. As mentioned above, Chrysler's efforts to introduce PEVs into its lineup have been minimal. This reviewer hopes that this project will spur Chrysler to bring more PEVs to market that will be sold everywhere in the United States.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that $100 million was a lot of money, but the project had to design the vehicles and there are lots of testing and measurement and analysis. In addition, there are various technical advances, etc., about charging and vehicle to grid (V2G)–so it seemed reasonable, but without detailed budget information, the reviewer noted that it was hard to say much.

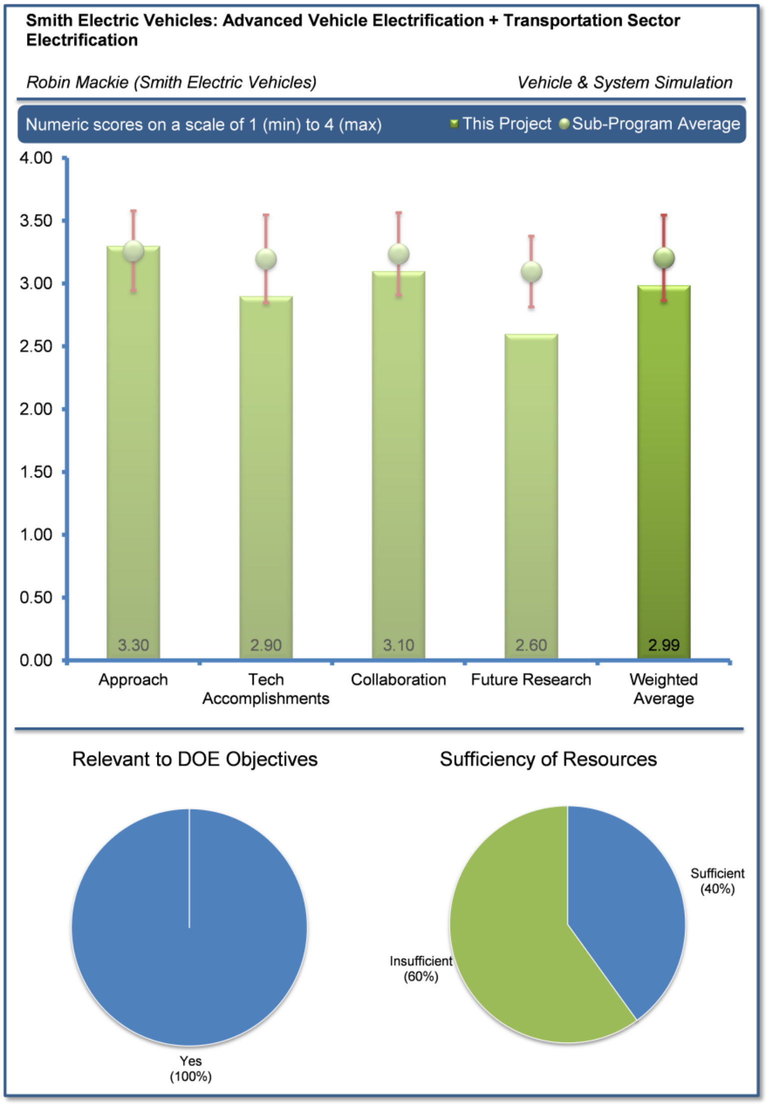
Reviewer 2:

The reviewer noted that it appeared that the project had no resources issues for the completion of the work despite the time extension.

Reviewer 3:

The reviewer commented that while the funding level was very high, the funding appeared necessary to complete all of the tasks for the number of vehicles deployed, along with the design effort and side projects.

Smith Electric Vehicles: Advanced Vehicle Electrification + Transportation Sector Electrification: Robin Mackie (Smith Electric Vehicles) - arravt072



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the deployment of electric commercial vehicles is a crucial part of the DOE's objectives. The SMITH electric vehicle project approach is completely in line with what is expected. It is unfortunate that the market conditions were not correct for this project to reach its final phase per the original project plan.

Reviewer 2:

The reviewer said that it was refreshing to hear honesty on real problems. The reviewer recounted that the project approach is simple and direct—put 500 vehicles on the road and see how the vehicles perform.

Reviewer 3:

The reviewer noted that establishing a new OEM is a monumental task that has only been accomplished in recent history by Elon Musk with Tesla Motors. While this reviewer appreciated the vision and was certain that the Smith Electric Vehicle team was completely dedicated to the success of this project, the project was up against a huge challenge on all fronts. Spending discipline, technological superiority and access to capital represent just a few of the areas that the team has to be leaders in the industry in, just to keep afloat.

Reviewer 4:

The reviewer stated that the project was essentially a demonstration of an all-electric vehicle (AEV) under the ARRA mechanism. The project set out to supply 500 medium-duty commercial AEVs, collect data on their field performance, and create 225 jobs in the United States.

Reviewer 5:

This reviewer acknowledged that Smith Electric Vehicles developed a fleet of all-electric MD commercial vehicles and the supporting technologies. The ideal use case is in a high density, urban environment for last-mile delivery/distribution of items such as soft drinks, potato chips, stationary, etc., with high stop-start duty cycle. The vehicle has a higher cost initially ($27,500 extra) compared with a conventional vehicle; however through incentives and improved efficiency, there is an approximately three-year payback on that initial investment followed by a cost savings to the customer, assuming an average use case. The reviewer recounted that the ARRA goals included the creation of 225 jobs within the United States. The present employment is lower (only 52 employees presently) due to poor business conditions and lack of capital investment and demand for the vehicle platform. Smith Electric Vehicles is further considering development of grid services (e.g., peak shaving, etc.) to provide additional cost savings to customers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that building and deploying 439 vehicles was pretty impressive. The data the project is collecting is interesting and will help future buyers decide whether to invest in such trucks. In addition, the proprietary components of the system appear to be significant steps forward, although it is hard to tell from the level of detail provided in this review. This reviewer preferred a day-long review for a project spending $70 million.

Reviewer 2:

The reviewer indicated that the technical accomplishments for this project were very good. To develop and deploy batteries of different sizes to support differing customer requirements is a feat in its self. Again, the reviewer added, that it is unfortunate that the final number could not be reached in time for this review. It is hoped that Smith Electric Vehicles can deploy the remaining units and still remain solvent.

Reviewer 3:

The reviewer observed that the Smith Electric Vehicles team had made a significant accomplishment with their efforts. Unfortunately, as the team has experienced, the team has to make never before seen achievements just to survive.

Reviewer 4:

The reviewer said that 439 vehicles were delivered to date (only 17 since the last Annual Merit Review [AMR]). The PI was open and honest about the financial problems of the company. The PI however promised that the rest of the vehicles would be delivered. Meanwhile, some valuable and very useful data were collected from the currently operating vehicles. Due to financial reasons again, the number of jobs created in the United States were far below the target.

Reviewer 5:

This reviewer observed that the vehicle deliveries and employment numbers presently did not meet the ARRA objectives, but that deliveries should be completed by the end of this year. 9 million miles achieved at 300,000 miles/month on the vehicle fleet. The data being delivered to the National Renewable energy Laboratory (NREL) has had a positive impact on the analysis of electric vehicle (EV) systems and their use, for example Smith Electric Vehicles has determined that most of its customers are using significantly less than the full range of the vehicle. The electric machine was stated to be 92-93% efficient. For a permanent magnet (PM) motor, this is lower than expected. The reviewer asked if this was the peak efficiency value and if the value includes inverter and/or gearbox losses. The reviewer continued it was further stated that the overall cost to operate this system was more important than its efficiency to its customer base. The battery remains the primary cost driver of the system. For new deliveries, Smith Electric Vehicles has developed a modular battery approach up to 120 kilowatt-hours (kWh), in 20kWh increments. Smith Electric Vehicles works with each prospective customer to right-size the battery pack based on their delivery route. This can significantly reduce the payback time of the EV investment.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

In spite of the company's financial problems, there was clear evidence of good collaborations with universities, a national laboratory and commercial organizations, including end users.

Reviewer 2:

The reviewer observed that there are numerous partnerships and customers that Smith Electric Vehicles closely works with, including the Kansas University Center for Research, Bristol University (UK), Leicester University (UK), QM Power, FedEx, NREL, Burns & McDonald, Schneider Electric, TARDEC, and Missouri University of Science and Technology. The reviewer asked if Smith Electric Vehicles also sold its developed subsystems to other OEMs.

Reviewer 3:
The reviewer noted that the project team had made efforts to maintain their commitments and would continue so if the working capital was available.

Reviewer 4:
The reviewer said that the collaboration is as expected. The work with NREL using the proprietary data recording system is as the reviewer would have expected. The analysis of the data does not surprise the reviewer. There are still some range fears out there even with the commercial operators and even with real data, it will take time to overcome these unnecessary concerns and ensure that deployed EVs are utilized to the best of their design abilities.

Reviewer 5:
The reviewer noted that several appropriate institutions were mentioned as collaborators on this or other projects, but it was unclear just what the partners did in relation to the project being reviewed.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer admired the project team's initiative in overcoming the financial setbacks that led to the interruption of production. The reviewer would have liked to see more information developed on the suitability of the vehicles for different types of use/duty cycle. The reviewer inquired about the following: which vocations fit best; which vocations required more miles than the vehicles could supply; what size batteries would be best and for what use if the batteries were oversized; and how the vehicles performed when compared to conventional ones.

Reviewer 2:
This reviewer stated that future plans in the project consisted of delivery of the balance of 500 vehicles as well as technology development and enhancement of the vehicle performance. The PI also talked about plans to address the financial problems.

Reviewer 3:
The reviewer noted that the future work included delivery of the remaining 61 vehicles under the effort, assuming additional capital investment could be secured. Such investment would allow production to restart and 95 new workers to be hired.

Reviewer 4:
This reviewer stated that the future work was not really relevant here. The only outstanding tasks are to complete the delivery of the remaining vehicles and then to track them for the remainder of the project.

Reviewer 5:
This reviewer commented that restarting production would be a difficult task given the expense and supplier support required.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This reviewer commented that these vehicles do not use petroleum – cannot do better than that.

Reviewer 2:
The reviewer said that electric commercial vehicles are a very relevant study and one that when finally proven successful, would contribute enormously to the DOE's objective of reduced petroleum usage.

Reviewer 3:
The reviewer stated that the use of AEVs would no doubt result in significant petroleum displacement, particularly when the electricity is generated from non-oil sources.

Reviewer 4:
This reviewer stated that the project aligns with DOE goals.

Reviewer 5:
This reviewer said that yes, Smith Electric Vehicles has determined that over 1 million gallons fuel have been saved across the Smith Electric Vehicles fleet compared to performing the same services using 8 miles per gallon MPGe vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer quoted that the total budget for 500 vehicles is about $ 67.5 million, which translates to about $135,000 per vehicle. This is certainly a sufficient level of funding for this demonstration project.

Reviewer 2:
From a resource perspective, the reviewer thought that Smith Electric Vehicles has had a hard time. The reviewer recognized the market conditions and coming from an eSTar background, the reviewer had every sympathy with the team on this project.

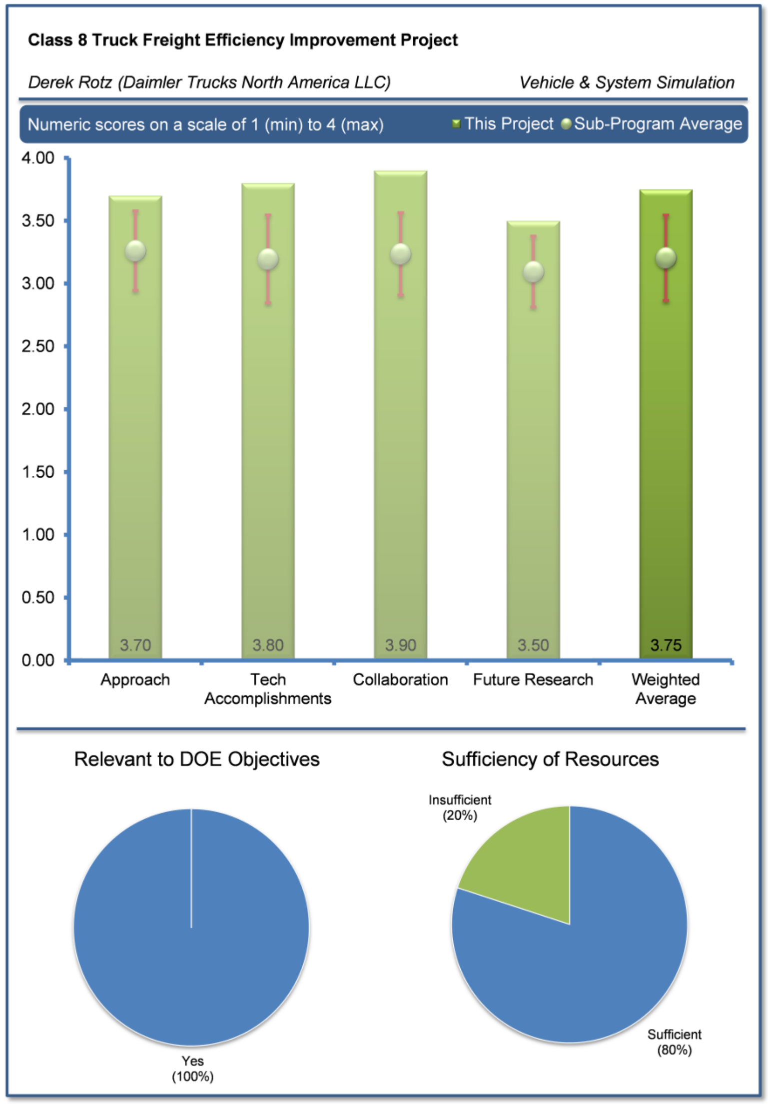
The reviewer believed that from a headcount perspective, Smith Electric Vehicles had sufficient resources to support the project. From an overall liquidity perspective, the reviewer believed, this is where the project failed.

Reviewer 3:
The reviewer commented that vehicle programs require hundreds of millions to launch, so the project amount was clearly insufficient.

Reviewer 4:
The reviewer commented that it was hard to evaluate. Any project that includes design of vehicles and creation of infrastructure to build them is going to cost a lot of money; but without detailed budgets, it was impossible to say much that is intelligent.

Reviewer 5:
The reviewer recounted that the Smith Kansas City EV production facility was shut down while working to secure additional private investment in the company ($70 million) and transition production of key components (batteries, battery management system [BMS], motors and controllers) to high volume suppliers to improve quality and reduce cost. Given the present level of project funds and supplementary private investment, the project will not complete its objectives. The reviewer concluded that assuming additional private investment can be secured, the remaining deliveries will be completed.

Class 8 Truck Freight Efficiency Improvement Project: Derek Rotz (Daimler Trucks North America LLC) - arravt080



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this project was very well managed, and the technical barriers were clearly managed with good engineering practices. There are no fundamental technical issues with the approach, the results, the analysis, and the future development.

Reviewer 2:

The reviewer commented that there was a broad approach to freight efficiency improvement. All types of losses seemed to have been investigated to maximize efficiency.

Reviewer 3:

The reviewer observed a well-structured program with strong participants. The reviewer would have liked to see additional truck manufacturers participating.

Reviewer 4:

The reviewer observed that the project was currently in Phase 4, the build phase. The reviewer noted the project was 80% complete and was impressed with Daimler's scenario analysis, rather than just picking what the team thought was best or believed from prior reviews. The reviewer continued to say that the data is from Society of Automotive Engineers' (SAE) fuel tests now, not just analytics. The reviewer stated that a sample (first prototype) then final demonstrator vehicle is being built now in Phase 4. The reviewer also noticed all kinds of integration challenges with a sample, which was then subjected to a series of tests-including durability and reliability. This reviewer was very pleased with the waste heat recovery (WHR) of 6kW with exhaust only.

Reviewer 5:

The reviewer pointed out that Slide 6 showed a comprehensive technology list to achieve the program goals, which was helpful to understanding the program. The reviewer was not so sure what the return of investment would be after investing so much on hybrid, and only to receive 1-3% benefits. The integration of the WHR package into vehicle seemed very complicated. The reviewer again was not sure how it would impact the cooling and aero.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
This reviewer observed strong achievements on milestones. The reviewer recounted testing of a truck – a big milestone with all the unique systems. The reviewer commented good work with various tests using emotor to eliminate 400 pounds of batteries, starter, etc. The reviewer commented that the over-the-road testing exceeded 50% fuel economy improvement - 52% and 61% on the two routes, Oregon and Texas. The reviewer exclaimed 1,500 lbs. weight savings!

Reviewer 2:
This reviewer said that given the funding level, the program has accomplished quite a bit. The objectives are high, and should be.

Reviewer 3:
This reviewer observed an extensive use of the testing facilities to develop and prove out individual components. The reviewer continued to say it seemed like the whole development process would generate a lot of know-how that could be applied to production programs much sooner than the actual technology used on SuperTruck will make it on the road.

Reviewer 4:
The reviewer commented that the technical accomplishments were more than what was expected from this project.

Reviewer 5:
The reviewer commented that the results shown in Slide 12 indicated that 50% freight efficiency was already achieved. It seemed it would be helpful to indicate how the 1,550 lbs. reduction was achieved.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed that there were a good mix of program partners, the technology investigated was important and the reviewer would have liked to see a broader participation from the truck chassis manufacturers.

Reviewer 2:
The reviewer stated that the comprehensive collaboration with suppliers leverages the expertise required to optimize the truck as a system – great job.

Reviewer 3:
The reviewer said that the project involves many partners, thus fully utilizing DOE funding to achieve the program goals.

Reviewer 4:
The reviewer said there was not much to mention in this review, but clearly there must have been strong coordination to get to such a strong conclusion. The reviewer noted that the fleets obviously contributed.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer stated that no more research was required at this time. The project just needed to assemble the vehicle and run the tests. It seemed to be on the way to achieve the program goal.

Reviewer 2:
This reviewer stated that not much detail was provided about future work but there seemed to be a rough timeline in place to proceed with the build and further testing.

Reviewer 3:
This reviewer observed that the project was now moving on to build the final prototype. However, the reviewer suggested going back and redoing some of the tests given. A sample testing is a good adjustment to the plan.

Reviewer 4:
This reviewer said that as the program matures, new avenues for research become apparent. The reviewer would have liked to see a review of the program coordinated with the next steps or future possibilities line-up for a follow-on program.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that line trucks represent a sizeable portion of the fuel consumption in the United States and are a foundational part of the goods transport. Programs like this have made a noticeable difference in the technology and more importantly the behavior of the truck operators. This program is loaded with new concepts that can continue the efficiency improvement of the line truck and only needs two things (i.e., keep getting the message out, and keep doing more of what it is doing). The reviewer further observed nice work.

Reviewer 2:
This reviewer noted that the project was at $120 billion of fuel burned by NA sleeper tractors, and exclaimed yes.

Reviewer 3:
The reviewer noted that early vehicle tests already showed over a 50% improvement in freight efficiency. This progress already demonstrated support of the overall DOE objectives of petroleum displacement.

Reviewer 4:
The reviewer commented that the project is on track to demonstrate over 50% improvement in freight efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

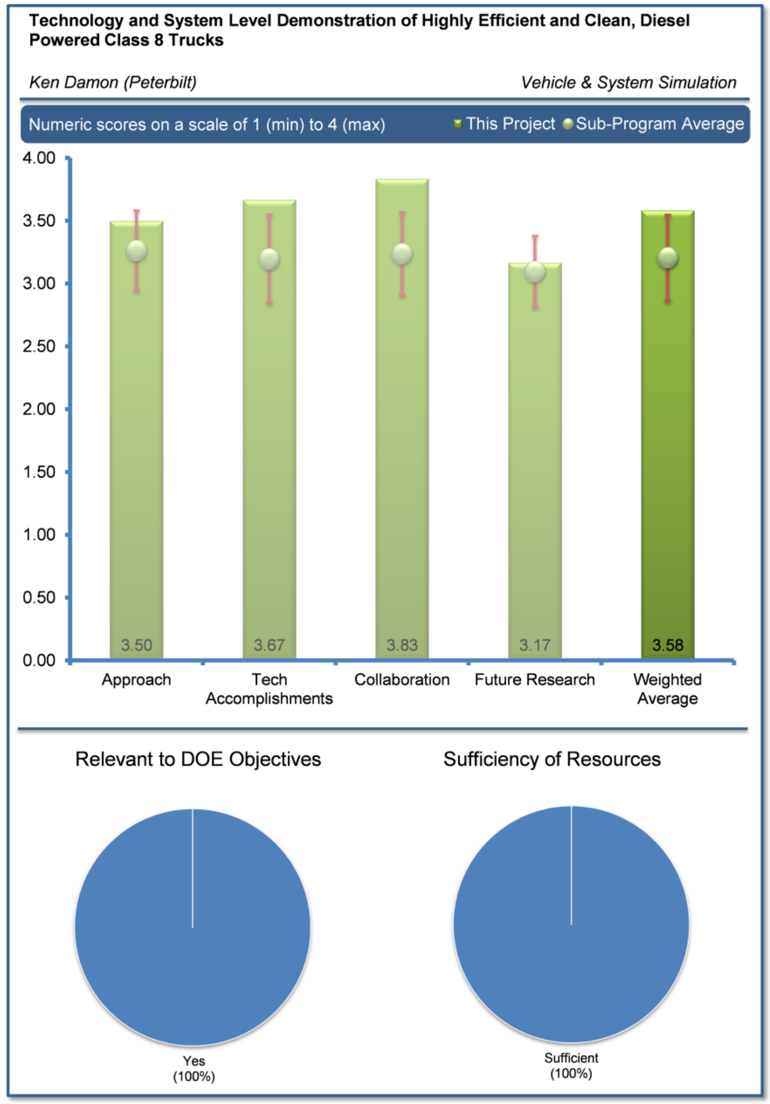
Reviewer 1:
This reviewer thought that Daimler was getting excellent use of their resources and were clearly dedicated to success.

Reviewer 2:
This reviewer stated that the project was on its way to achieve all program goals.

Reviewer 3:
This reviewer observed that the resources were not directly addressed within the presentation.

Reviewer 4:
This reviewer commented that the project needed additional resources to engage with a larger manufacturer set.

Technology and System Level Demonstration of Highly Efficient and Clean, Diesel Powered Class 8 Trucks: Ken Damon (Peterbilt) - arravt081



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that this project was very well managed, and that the technical barriers were clearly managed with good engineering practices. The reviewer found no fundamental technical issues with the approach, the results, the analysis, and the future development.

Reviewer 2:

This reviewer said there were very comprehensive approaches, covering most of the parts and corners of technologies.

Reviewer 3:

This reviewer stated that the presenter did not include specific Approach slides for the past year's work, but did show summary Gantt charts. Last year's approach appeared to have included switching from a fuel cell to a battery for the alternate power unit (APU), completing the Demo 2 vehicle, and the 24-hour test. The reviewer concluded that it would have been nice to see even more emphasis on overcoming deployment barriers to increase the near-term deployment likelihood for technologies demonstrated as part of the program.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer said that the results from the data shown were outstanding.

Reviewer 2:

According to this reviewer, the project's accomplishments included integrating a lithium-ion (Li-ion) battery to support idle engine off, which would be designed to recharge over a subsequent six-hour period of highway driving (though the presenter acknowledged that some customers may require a shorter recharge time). Other accomplishments included completing integration of the many additional energy saving features on the Demo 2 vehicle, and considering driver acceptance to incorporate feature enhancements such as an automatically retractable skirt at low speed and easy move-ability for service access. The presenter reported impressive results demonstrating fuel economy and freight efficiency improvements in excess of the established goals, though it would have been nice to see some test data with more repeatability/uncertainty quantification. This reviewer expected that a few repetitions could be performed for a very small percentage of the overall project budget, or at least this could be done over smaller test cycle sections to more precisely confirm the benefits over those sections that make the largest contribution toward the overall savings. It is good that for each result that both freight-ton-miles per gallon (FTMPG) and miles per gallon (MPG) are shown.

Reviewer 3:

While the reviewer acknowledged kudos for the significant achievement throughout the program, the reviewer felt the presentation was too sales/marketing focused rather than focusing on technical detail. It was unnecessary to show Slides 24 to 27, which were not relevant to the program goals. The reviewer continued to say that it was unclear how the APU worked. More specifically, the reviewer wanted to know if the battery was fully charged before the truck ran (Slide 14).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

While working with the key partners of the program, the reviewer noticed that Slide 12 demonstrated a successful story in working with all possible partners in achieving the program goals.

Reviewer 2:

This reviewer said that sufficient collaboration appeared to have occurred with subcontractors, suppliers, trailer manufacturers and end users.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This reviewer observed that the project was on its way to completing the program on vehicle side, and thus the future plan was mainly to write a report.

Reviewer 2:

This reviewer said that the project was concluding, so not much was stated regarding future work. The speaker mentioned that some technologies (such as weight saving enhancements) would be making it into near-term production vehicles, but no estimation was given as to the incremental level of production vehicle fuel savings that might be expected. It would have been nice to have more details in the presentation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer acknowledged that the project was very relevant to both DOE's petroleum displacement mission and to the ARRA program goals for job creation.

Reviewer 2:

According to this reviewer, many of technologies could be used in production in next few years, which significantly improved freight efficiency. This supports the overall DOE objectives of petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

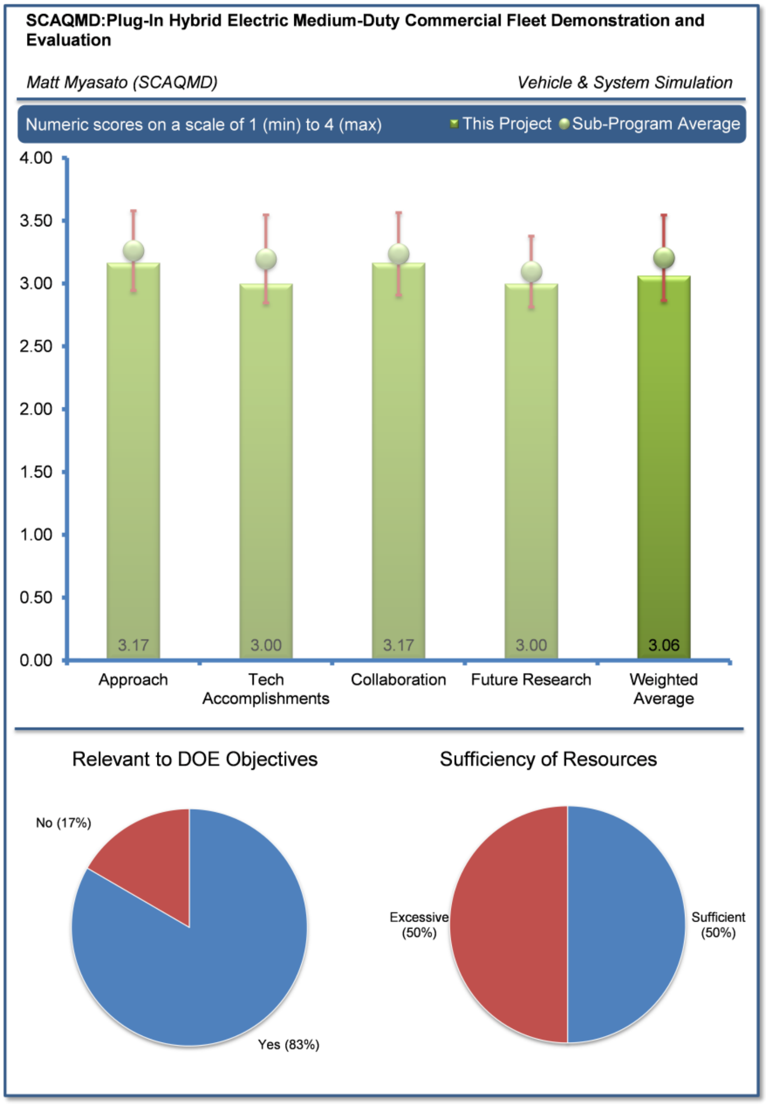
Reviewer 1:

This reviewer observed that the project was just on the way to accomplish the program goals.

Reviewer 2:

This reviewer said that this was a large, roughly $80 million research activity and given the short 20 minute presentation with limited technical details, it was difficult to make an informed judgment about the sufficiency of the resources.

SCAQMD: Plug-In Hybrid Electric Medium-Duty Commercial Fleet Demonstration and Evaluation: Matt Myasato (SCAQMD) - arravt083



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the design and development of the PHEV drive systems, fleet selection, deploying vehicles and performance assessment is excellent.

Reviewer 2:

This reviewer commented that the project is very good, and the weaknesses are beyond the control of the project leadership. The reviewer acknowledged that finding effective technology partners is not easy, and that the project faces many risks.

Reviewer 3:

This reviewer appreciated the PI's presentation style and delivery. It was easy for the reviewer to get an understanding of the project with the explanations. The reviewer noted that the approach relied heavily on commercial partners for design, development and deployment of both the Class 2 and Class 6/7 work trucks. In addition, the large demonstration fleet size and the vast deployment area really make this project scope unrealistic. It appears a re-scoping of the project may prove useful and allow the team to show more progress and results.

Reviewer 4:

This reviewer said that the presenter commented that specifically covering approach to the project may have been too aggressive, and that their deployment opportunities relied on the launch performance of start-ups. The California Air Resources Board (CARB) was shown as a barrier, but for this type of prototype deployment, DOE should be able to assist in obtaining waivers to help mature the technology. The early partnership plans did not come to fruition, and having new partner plans required additional modifications. The reviewer suggested that this needs to be understood in the preparation.

Reviewer 5:

This reviewer commented that the project had a fairly simple approach (i.e., build and deploy the vehicles and see how they work, which is enough of a challenge). Unfortunately, the material received by the reviewer was not very detailed, which made it hard to evaluate such a large project.

Reviewer 6:

The reviewer said that the approach should include a good plan to compare to baseline vehicles in order to assess effectiveness.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer noted that the project team got a vehicle out on the road in commercial operation, which was a major achievement. Some of the components represent important advances relative to conventional vehicle. The reviewer particularly admired the Odyne approach of hybridizing both the propulsion and the work functions of the truck.

Reviewer 2:

This reviewer observed that it was very good to see data from the Odyne field data and the fuel consumption and emissions testing. The data is encouraging because the PHEV technology shows improvements for both fuel economy and emissions. Finding 65 participants in 23 states to participate in the project showed very good progress, according to the reviewer.

Reviewer 3:

The reviewer commented that good progress has been made given the changes with OEMs, and added that the project is moving along well.

Reviewer 4:

According to this reviewer, the results from the Odyne test vehicles were very promising. There appeared to be a lot of areas of optimization remaining with regards to battery and electric machine sizing. Even the control system in place could provide a lot of unique benefits. The reviewer added that a more thorough understanding of just a few of these trucks would seem like valuable information that could be shared with industry to shape the next generation hybrid work truck.

Reviewer 5:

The reviewer commented that the efforts of Odyne appeared to be as much as the reviewers could hope to receive. The reviewer continued to say that the VIA Motors effort looked more like a science project that if successful would expand the industry understanding of the benefits and costs of this technology.

Reviewer 6:

This reviewer said that more information on fleet return on investment (ROI) needs to be developed to inform the government of opportunities to support the technology transformation to production levels through incentives, or to focus in other areas of advanced transportation for research.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer stated that this collaboration had a particularly varied and competent set of collaborators, chosen to be the best match for what was to be demonstrated.

Reviewer 2:

The reviewer noted that the fleets and OEMs had evolved, but it was evident that there would be a good mix of collaborative partners to complete the project.

Reviewer 3:

The reviewer noted that the project had a very good set of partners involved in the project. Also, there are 65 locations in 23 states where the trucks will be tested. The states are identified, but it would be good to have a list of the locations where the trucks will be used.

Reviewer 4:
To this reviewer, the project seemed to have stabilized with respect to the performance of the partners.

Reviewer 5:
This reviewer said there was a good presentation of the current project status, but again that the South Coast Air Quality Management District (SCAQMD) as a project lead needed to break down barriers for partners. The reviewer continued to say that the gathering of power take-off (PTO) duty cycle information was very valuable.

Reviewer 6:
The reviewer observed that significant barriers existed on the collaboration front given the lack of commercial partners. The project may need to re-scope the project once more substantial contracts are available. The reviewer concluded that VIA Motors may provide some insight, but that relationship is still in its infancy.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
According to the reviewer, the project has done a good job with re-planning future work based on evolving vehicle plans.

Reviewer 2:
To this reviewer, the project seemed effective even considering the delays. The reviewer hoped that the natural gas movement would not render this technology irrelevant with respect to lifecycle cost, but noted that this was beyond the control of the project.

Reviewer 3:
The reviewer commented that the plan for future work –was to complete the build of 54 VIA vans, 123 VIA trucks and 121 Odyne trucks and to get the trucks into service is very good. The trucks should all be in operation over the next several months followed by data collection. The reviewer was concerned that if there were any delays there would not be enough time before the projects end to collect and analyze the data.

Reviewer 4:
This reviewer said that the project had a good plan in place to recover, but based on past history the reviewer was apprehensive of the success of this project to continue to provide data. The reviewer continued to say that the creation of the field data beyond the current planned should be a requirement, as this may be the largest benefit of the project.

Reviewer 5:
This reviewer suggested that the team include comparison to conventional vehicle performance in their final results. The reviewer also wanted to know whether the operators remembered to plug in overnight, and whether the batteries needed to be recharged during the day. If not, the reviewer asked if a smaller battery would do for some uses. The reviewer commented that a matching design to use would be important.

Reviewer 6:
This reviewer noted that the future work included a lot of vehicles that were being built by the industry partners. The connection to VIA Motors does not appear that strong. VIA is currently in production, so those vehicles are likely to make it through production. The reviewer would like to see a sharper focus on the intended/expected results from future work. The reviewer said that these vehicles would make an interesting study as they enter the workforce, but it was just not clear how this project was going to capitalize on those vehicles.

The reviewer recommended to reduce the fleet size understudy as well as to focus on just a few unique regions of the country that provide interesting terrain, weather, duty cycles to fully capture the possibilities of these hybrid work vehicles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This reviewer commented that the Odyne vehicle results were quite impressive.

Reviewer 2:
To this reviewer, this project is very important both in field data collection for Class 2-7 vehicles and technology introduction into fleet environments.

Reviewer 3:
The reviewer said that any time the PTO is powered from the battery, oil is saved, and that the vehicles drive using less fuel as well.

Reviewer 4:
The reviewer stated that the project is relevant to the DOE petroleum displacement goals. The reviewer added that once the vehicles are on the road and data starts to be collected, the project would provide excellent information to DOE regarding PHEVs.

Reviewer 5:
This reviewer said yes, these trucks will help to develop advanced, efficient powertrains in niche applications, but the technology will be able to scale into other vocations and vehicles if successful.

Reviewer 6:
This reviewer noted that air emissions were significantly reduced from idling. This was not an obvious improvement in petroleum usage.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
To this reviewer, resources appeared sufficient but there was concern that since the project would complete in just over a year from now, and it has only spent on 40% of the funds.

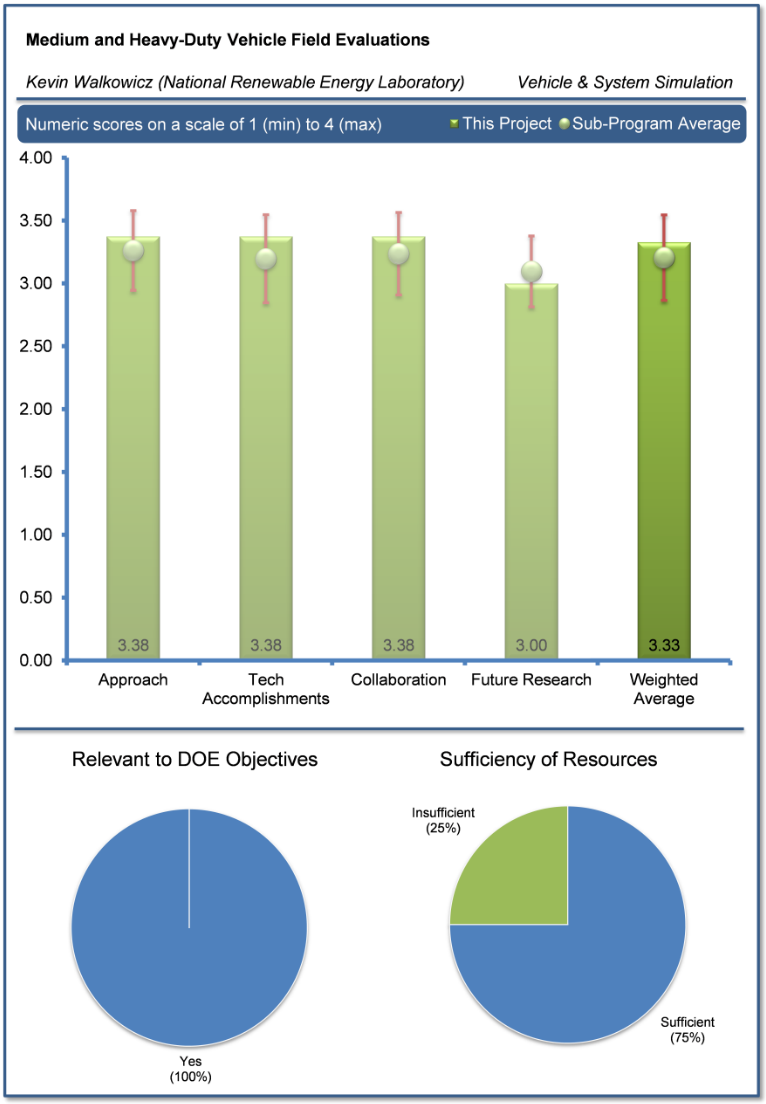
Reviewer 2:
According to this reviewer, the project seemed to indicate that pre-project simulation and other prototype work could have had a much better ROI.

Reviewer 3:
This reviewer stated that the scale of this project was too large considering the early system designs. A large deployment would be better if there was a third design iteration or higher of this technology. This would help launch the commercialization of these products (assuming there is strong interest).

Reviewer 4:
This reviewer asked again, how one could evaluate $90 million in expenditures in a 20-minute talk.

Reviewer 5:
This reviewer commented that given the lack of completion, the funds appeared to be underutilized.

Medium and Heavy-Duty Vehicle Field Evaluations: Kevin Walkowicz (National Renewable Energy Laboratory) - vss001



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer liked very much the grouping of fleet projects into a single project scope – EV and other technologies. The reviewer clearly recognized the barriers to adoption of technologies and said that NREL was well poised to help the industry in this way. The reviewer was not sure how projects were selected. The reviewer said that it was good to include maintenance data, as there generally is a cost plus or minus here that should be included in the fleet ROI.

Reviewer 2:

This reviewer liked the Consumer Reports-style evaluations of heavy-duty vehicles in the field. It can offer quite a bit of information to businesses wanting to invest but who do not have the supporting information. The reviewer added that there was good structure, investigations from a real world perspective.

Reviewer 3:

This reviewer noted that the program provided valuable feedback on in-service technology use and effectiveness based on how vehicles are used. Numerous benefits are derived from these efforts including gaining an understanding of technology benefits in use, degree of fit between vehicle and application, real-world benefits in terms of fuel economy, and also identifying technical barriers such as demand charge penalties for an EV fleet. Regarding project planning, the project start/end dates were not clear. The reviewer concluded that it was hard to judge what was accomplished this year and in the past.

Reviewer 4:

The reviewer said that the approach described on Slide 6 seemed reasonable and the reviewer appreciated the results made available through publications and DOE programs such as Clean Cities. Given the diversity between the Frito-Lay and Peloton truck platoon testing, the reviewer commented that the selection of the projects appeared to be too broad. The reviewer found the Frito-Lay study very interesting. It would really reinforce the importance of the data if the project would comment on how it has helped other fleet operators, given that is presented as one of the project objectives.

The reviewer continued to say that the transition to the Peloton truck platoon testing was odd. It was not obvious how this type of testing fit in with the Frito-Lay and UPS fleet projects. Given the projects were so different it diluted the focus from the reviewer’s perspective. The reviewer concluded that maybe it was just the structure of the program that allowed these to be binned together.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
This reviewer said it looked like a good start for the program with a good structure. The program success will be determined by the number and type of tests which should be determined by a constant survey/discussion with potential users of the information.

Reviewer 2:
This reviewer said that it seemed this set of projects really involved the partners to collect data that the team was interested in. These are the innovators for technology procurement and deeply understanding the use data is crucial to next adopters. The reviewer emphasized that this was exciting. The reviewer observed the project was going deeper than just fuel savings. Peloton platooning close following the distance issue with the cooling fan needing to come on significantly more often was highlighted by this reviewer as an excellent example of how this work helped find issues early. The reviewer added that linking field data to laboratory data was critical to accelerating adoption of these technologies. Fleets and truck builders want to be sure that they will really get the benefits. The reviewer remarked that this is so important!

Reviewer 3:
This reviewer commented that the technical accomplishments were clearly shown and well presented. According to the reviewer, Slide 8 showed that "EVs still save nearly 2/3 fuel costs" while the results were expressed in percentages of fuel economy improvement for the other two projects. The reviewer recommended that it would be more straightforward if it was all stated the same way; just a minor point the reviewer found while reading through the slides on their own. The results from the tests confirmed the impact of the technologies and the reviewer then suggested that it would be helpful to show how these results were being used because the objective was to provide the unbiased data to guide intelligent usage of new technology to fleet operators.

Reviewer 4:
This reviewer recounted that 3 main fleet projects collected data which generated useful insights, Frito Lay's EV fleet (10 vehicles), UPS hydraulic hybrid fleet (40 vehicles) and platooning fuel economy test (2 vehicles). This was a significant workload including data collection, analysis, and conclusion. These efforts also led to a reality check on standard drive cycles (e.g., NY Comp, charge sustaining [CS] hydraulic hybrid vehicle [HHV], heavy heavy-duty diesel truck [HHDDT]) by comparing and contrasting in-service use (e.g., Baltimore Custom) against those drive cycles. The reviewer then concluded that identifying a more appropriate drive cycle would minimize the risk of over/under-evaluating the technology potential.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
This reviewer applauded the collaboration with numerous partners (UPS, Frito Lay, and Peloton) to participate in the program. This strong collaboration leads to generating the most relevant results in terms of technology performance.

Reviewer 2:
This reviewer appreciated the fact that Frito-Lay and UPS were involved using actual trucks in service.

Reviewer 3:
The reviewer commented that the team seemed to work well with the partners. The reviewer suggested to maybe seek out others who could utilize the data and to be sure to make them aware of these results for a bigger overall impact.

Reviewer 4:
This reviewer observed good collaboration now, but the reviewer suggested that it needed to expand – almost like having a business development function attached.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer liked the alignment with SuperTruck moving forward – looking at how that project has helped bring more technologies into these innovator fleets.

Reviewer 2:
The reviewer said that the future work was well defined. The reviewer suggested including more in-depth review of the findings and how it is transferable to other fleets to solidify the findings.

Reviewer 3:
The reviewer said there was great potential here, but recommended to please use a potential user outreach activity to identify more and priorities.

Reviewer 4:
This reviewer observed that additional projects were indicated for the remainder of 2014 including Berks Area Regional Transport Authority (BARTA) and XL Hybrid. The reviewer recommended starting early to identify future collaboration as it takes time.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that this was crucial to increased and faster commercialization of technologies.

Reviewer 2:
To this reviewer, these data collection efforts provided valuable feedback to DOE to assess the impact of vehicle technologies on its petroleum displacement goals and provide input to inform areas of R&D that show the most promise.

Reviewer 3:
This reviewer acknowledged that moving new technologies past the early adopters is always difficult. This is a program that is positioned to assist in that role.

Reviewer 4:
The reviewer said that the project certainly identifies an important area of new technology deployment, and looked forward to hearing about the results at a much larger scale if they are adopted.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

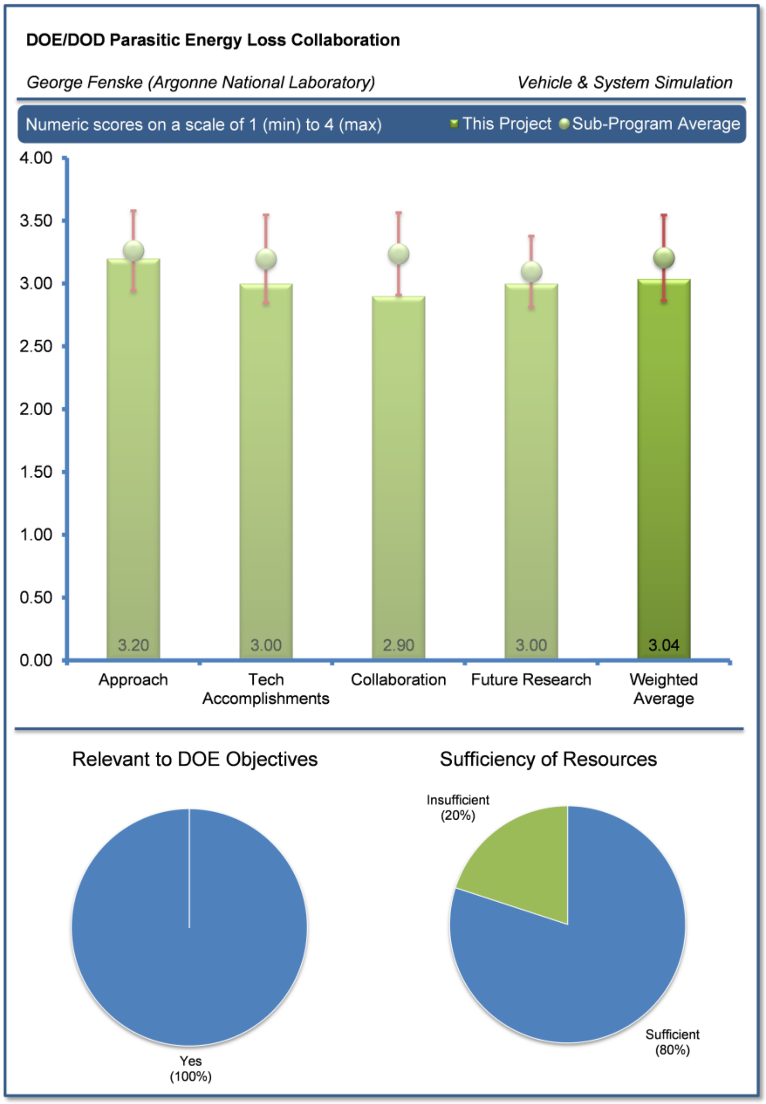
Reviewer 1:
To this reviewer, it looked like NREL was getting done a good deal for the resources available.

Reviewer 2:
This reviewer said that the project needed to expand in a deliberate fashion with stronger connections to the potential user community. The reviewer remarked good program!

Reviewer 3:
This reviewer commented that the funding appeared to be sufficient.

Reviewer 4:
This reviewer did not have the experience in this area to comment on funding.

DOE/DOD Parasitic Energy Loss Collaboration: George Fenske (Argonne National Laboratory) - vss005



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer said that the work was foundational in the continuing pursuit of energy efficiency improvements, and thought this was an excellent approach.

Reviewer 2:

The reviewer commented that the three phase approach of the project to develop modeling capability, perform experimental tests, and finally validate the results was very sound.

Reviewer 3:

The reviewer stated that the project is heavily leveraging prior work and models that were developed by Ricardo on engine losses. The commenter highlighted that gaining access to these models, and integrating them, is very powerful in understanding frictional engine losses and providing a value on the impact of surface finish changes and lubrication improvements.

Reviewer 4:

The reviewer recounted that the overall technical approach for the Argonne National Laboratory (ANL) DOE/U.S. Department of Defense (DOD) Parasitic Energy Loss Collaboration project was technically sound, having been refined over a number of years. It has three logically defined tasks with clearly identified activities therein which synergistically work to advance the knowledge base of cutting edge approaches to reducing friction in vehicular applications.

The reviewer observed that the project goals are to develop a public database to estimate impacts of viscosity, asperity function, and surface finish on friction losses at different engine speeds and loads; and to develop an experimental database on the impact of lubricant additives, advanced materials, temperature, and contact stress on asperity friction. It is important to note that these databases are really targeted to help small lubricant/additive manufacturers as larger ones likely already possess this capability.

While the technical approach to identifying new opportunities to reduce friction in engines is strong, the reviewer perceived that there were significant questions given the very conservative, risk adverse nature of the lubricants and additives industry, if the approach overall will ever really lead to significant commercial penetration of new friction reduction technologies. The reviewer suggested that it may be beneficial to consider re-scoping or at least augmenting the technical approach of this task with a possible industry visioning road-mapping component with the goal of altering the evolutionary paradigm of friction reduction technology development and subsequent implementation in vehicular applications. The reviewer concluded that the DOE and ANL are in an ideal position to fulfill this function in helping to bring together diverse elements of the industry in an attempt to achieve consensus on ways to dramatically accelerate the development of precompetitive technologies and subsequent implementation in vehicles.

Reviewer 5:

The reviewer stated that the area of parasitic and friction losses in an engine is a relevant area of focus for the improvement in engine efficiency. The design of the research has relied heavily on theory by means of modeling and simulation. The friction coefficients were measured using a reciprocating rig and used to revise the model. This approach is the first step to adding empirical data to the model, but it is not necessarily representative of friction occurring in an engine due to other environmental conditions. There has not been much actual engine validation against empirical test bench data completed to date. The reviewer added that this amounts to a weakness in the results generated by a non-validated model.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer saw impressive accomplishments adding to the sophistication of tribology evaluation.

Reviewer 2: .

This reviewer said that the technical accomplishments and progress during this project have been very good. The suite of codes was made operational working with Ricardo and studies were initiated for a small spark ignition (SI) engine. Scans of critical lubrication parameters were performed. In Task 2, the reviewer noted that the protocols were established to analyze data to isolate asperity friction from deferent conditions and the data showed asperity friction can vary by a factor of four or more.

Reviewer 3:

The reviewer observed that the project had demonstrated a steady stream of technical accomplishments under Task 1 including establishing a cooperative research and development agreement (CRADA) with Ricardo for use of their friction codes for various engine components, modeling of piston/ring friction in a small bore SI engine, modelling the impact of viscosity on power-cylinder losses, and application of codes to simulate the impact of surface finish and friction on power-cylinder friction forces and power losses. The trends related to viscosity, asperity friction, and surface finish observed by this reviewer, have been found to be consistent with automotive trends.

Under Task 2, the reviewer recounted that the accomplishments include development of test protocols to measure friction under boundary and mixed lubrications conditions; illustration of the range of boundary friction coefficients that can be expected for an unformulated oil, a fully formulated oil, and a fully-formulated oil with friction modifier; and the impact of temperature and coatings on asperity friction. Task 3 validation activities using an engine dyno are scheduled to commence in fiscal year (FY) 2015.

Reviewer 4:

The reviewer acknowledged the good progress made in integrating the models and developing understanding on the effects of lubrication improvements, surface finish, and other areas. However, the commenter indicated that a timeline/plan was not evident. The reviewer suggested that a timeline that shows project action officer tasks and tasks of collaborators would be helpful in understanding progress versus plan and contribution of collaborators in a real project sense.

Reviewer 5:

This reviewer observed that since project inception in FY 2010, progress has amounted to simulation results and some bench tests on a reciprocating rig. Technical progress has been made, albeit slower than expected. The reviewer continued to say that the simulation results could be obtained earlier in the program, leaving time for engine validation, which is scheduled for FY 2015. Arguably, the reviewer commented, that engine validation would require a larger effort than simulation, despite the plan allocating FY 2010-14 to simulation and FY 2015 only for validation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that the project was very well coordinated with engine and truck OEMs, the DOD, engine component manufacturers and lubricant suppliers. The reviewer said having these partners on the team makes for a strong project.

Reviewer 2:
This reviewer acknowledged that this project has steadily increased in recent years the extent of collaboration and coordination with other institutions and is now a strong suite. The diversity of partners includes engine and truck partners, DOD, an engine component manufacturer, and suppliers from the lubricant industry, as well as coordination with other DOE Vehicles Technology programs. The reviewer said that this was excellent. One suggestion the reviewer provided would be to try and pull in entities that represent the overall fuel/lubricants/additives industry (not a specific company) to gain insight, guidance, and support holistically. The reviewer concluded that the cost share for this project is very good at approximately 37% over its lifetime.

Reviewer 3:
The reviewer commented that Ricardo was named as a partner for their in-kind contribution of software. The reviewer would have liked to see collaboration with an engine manufacturer who would make use of the research results.

Reviewer 4:
The reviewer commented that most of the collaborators provided will be more heavily engaged during the engine/component testing.

Reviewer 5:
The reviewer's impression was that the project is largely internal. The subject and results are valuable to a broad industry set and should be shared. The reviewer recommended addressing a broader technology transfer to industry, or publication of results in appropriate journals, or discussing those activities in next year's report.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer saw a good concept for continuing research.

Reviewer 2:
The reviewer saw that the proposed future technical research for simulation, the friction database, and engine validation is reasonable following on logically to recently completed and currently ongoing activities. The reviewer commented that it was important to keep user friendliness in mind in the development of the friction database to encourage widespread understanding and utilization.

Reviewer 3:
The reviewer stated that simulation testing is the key to validating the models. The commenter noted that engine simulation testing is planned as well as integration of the validated models into Autonomie, which will yield usable knowledge for engine/lubrication developers. The reviewer reiterated earlier comments that a timeline would be helpful to understand when activity are planned to occur.

Reviewer 4:
The reviewer commented that the proposed future work of completing engine validation testing will be a key result.

Reviewer 5:
The reviewer expressed concern that the plan scheduled engine validation activities are too late in the overall program, since time and effort is expected to make up a significant portion of the research.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
To this reviewer, this project was extremely relevant to the goals of the VTO. By reducing friction losses in both new and legacy vehicles, the reviewer commented that there would be a reduction in the amount of fuel used in the transportation sector. In addition, reducing frictional losses in vehicles will help achieve the higher fuel economy standards in the future.

Reviewer 2:
This reviewer commented that this was a foundational element for energy efficiency of mechanical systems.

Reviewer 3:
The reviewer commented that attaching engine losses through enhanced lubrication can be applied across the entire national fleet of vehicles.

Reviewer 4:
This reviewer agreed that an improvement in tribology would lead to reduction in engine losses and therefore contribute to DOE's goal of petroleum displacement.

Reviewer 5:
This reviewer said that reducing friction has significant potential to improve fuel economy across a multitude of new and legacy vehicles. While the potential may only be as high as 5% for any one vehicle, spread over millions, the reviewer pointed out that the benefits become very large.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer observed good progress, and urged the project team to keep going!

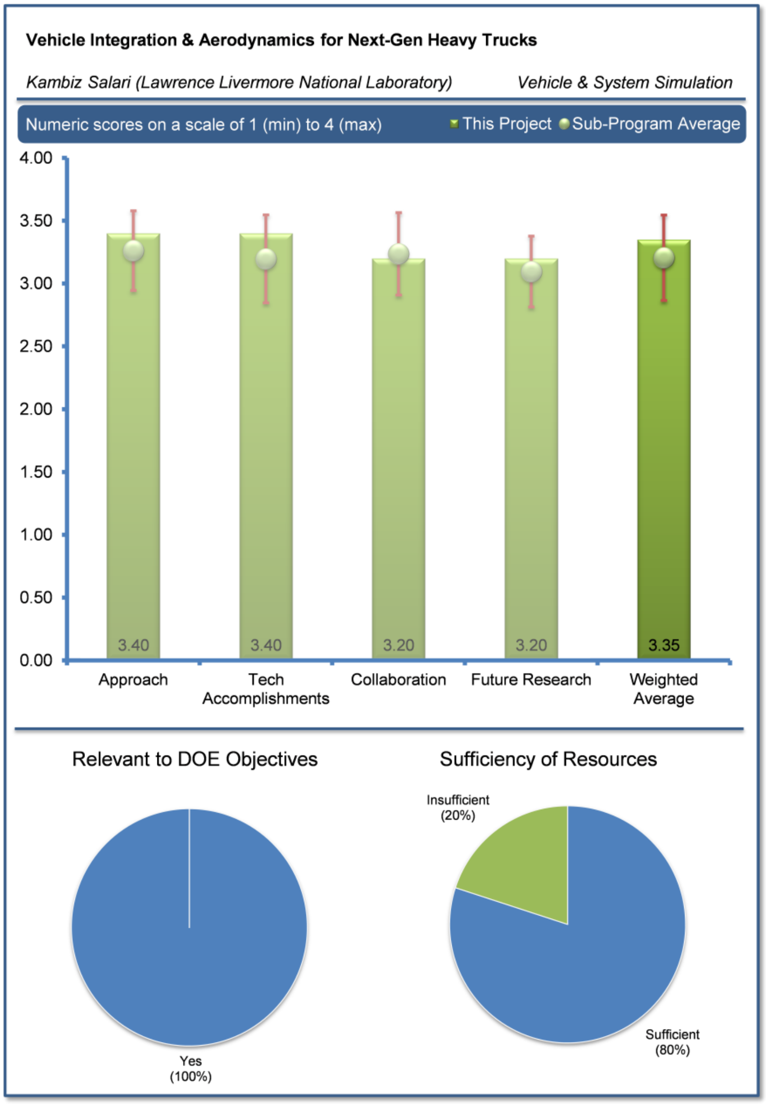
Reviewer 2:
To this reviewer, the resources were sufficient for the project and appeared to be on track to be used by the end of the project.

Reviewer 3:
This reviewer believed that the overall scope and budget of the program was sufficient to reach the target. However, the reviewer said that the plan should have scheduled engine validation earlier in the program, since that activity is expected to take a significant amount of time.

Reviewer 4:
This reviewer stated that the resources were adequate for the current scope of activities. According to the reviewer, should the project scope be expanded to include an industry coordination, visioning/roadmapping component, a modest increase in resources would likely be needed.

Reviewer 5:
The reviewer agreed that the project appears to be progressing; however, because a timeline for the tasks was not provided it was hard to tell.

Vehicle Integration & Aerodynamics for Next-Gen Heavy Trucks: Kambiz Salari (Lawrence Livermore National Laboratory) - vss006



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this was an important problem. The reviewer observed an excellent research plan and described the PI as impressive. The reviewer concluded by enthusiastically remarking that the approach was well done.

Reviewer 2:

The reviewer stated that the presenter rightly identified aerodynamics as a major area for improvement potential for commercial vehicles and has also targeted the trailer as an area of focus, given both its large contribution to overall drag and due to its current shape, which is not aerodynamics. The research splits both dry van box trailers as well as tankers. Given the relatively small population of tankers in the overall fleet and their infrequent use in long haul applications, tanker development should take less of a priority. Regarding dry van trailer work, the research strikes a good balance between evaluating conventional designs (exposed trailer door hinges and corrugated sidewalls) as well as more advanced design (tail devices). The reviewer believed gains are to be made on both fronts.

Reviewer 3:

The reviewer commented that much of private sector product development followed the approach presented in this project. Following this computer aided engineering (CAE), modeling, and full scale prototyping allows the work to support the OEMs that would take the concepts into production. As noted by the reviewer, close ties to industry are essential to keep the objectives as close to real world workable solutions that can be put to use.

Reviewer 4:

This reviewer said that the approach to work with industry, suppliers, truck and trailer builders and fleets was laudable and important if not crucial. The reviewer did not see sufficient evidence that this team was really working that deeply with these companies. The reviewer noticed the project could look deeper into other effects rather than just aero-improvement to make it easier for end-users to adopt. The reviewer added that it was very helpful using the full wind tunnel, but asked when the last time these trucks were in the tunnel.

Reviewer 5:
To this reviewer, it seemed that the method used was experimental base, and that there was no computational fluid dynamics (CFD) application. In Slide 6, the presentation mentioned virtual testing. The reviewer asked if this meant that the 1/8 scale was a test or CFD simulation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that this was a well-thought out research plan and strongly emphasized that this was also an excellent presentation.

Reviewer 2:
The reviewer noted that the accomplishments of the project focused on smaller well documented results that rolled-up to support the overall project objectives. This makes both the individual studies and overall impact useful to the end-users.

Reviewer 3:
This reviewer said it was nice to finally publish the full scale tunnel test data. The reviewer recounted that it seemed to have taken quite a while to get this out. The reviewer commented that the presenter was spending too much of the 20 minutes sharing general data on trucks rather than explaining what was accomplished in the project. The reviewer noted the recent 1/8 wind tunnel test and remarked that there was very good data on cargo container fuel efficiency/deficiency. The reviewer continued to say that that the new tractor design test is a good addition to the plan, and observed no real discussion of new design. The reviewer pointed out tankers. The reviewer suggested clarifying percent improvements with respect to speed, etc. The reviewer would very much like to see more evidence of accomplishments in these presentations and even in the industry press and information being shared in the general trucking media. The reviewer observed that the project would then get this data out there and open for others to build upon.

Reviewer 4:
The reviewer observed that the researcher developed some key insights which could shape the direction of future development, such as straight versus curved tails, tail hinges and corrugated trailer side walls. Furthermore, the development on the Generic Speed Form (GSF) 1 is a bold and ambitious approach for drastically reducing drag. The reviewer applauded this approach, while at the same time recommended to aggressively push towards maturing the basic shape into a functional truck. Normally any aerodynamic gains in basic aerodynamic work quickly erode as a design matures. The reviewer said that it would be important to closely monitor drag performance during this evolution to minimize aero performance degradation.

Reviewer 5:
This reviewer asked why the results with full wind tunnel and scale tunnel were quite different in Slide 13. The reviewer said it needed to be more specific to describe the difference between these two testing results. The reviewer concluded that it would be helpful to use the same scale to plot the results.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
This reviewer said it was the best collaboration seen in the session. The reviewer commended the project on the excellent job building collaborators.

Reviewer 2:
To this reviewer, the project showed exceptional integration with laboratories and industry partners.

Reviewer 3:
The reviewer saw that there was evidence of collaboration with fleets on testing and results evaluation. The reviewer would like to see collaboration expanded with trailer and aerodynamic device manufacturers (also cargo container manufacturers) expanded to make best use of the knowledge generated.

Reviewer 4:
According to this reviewer, there was not much evidence of collaboration and it seemed that the team may not be learning enough from this opportunity to understand more deeply how these trucks are operated and requirements needed.

Reviewer 5:
The reviewer suggested that there should have been one slide specifically to talk about partners for their involvement of this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer observed good future work.

Reviewer 2:
This reviewer recounted that the project mentioned platooning as a future piece of work and thought it was a good use of resources.

Reviewer 3:
This reviewer thought the future plans were both reasonable and showed great promise. The reviewer found the project interesting and very current to today's needs.

Reviewer 4:
The reviewer asked if the vehicle GSF1 would be fitted into the current powertrain system. The reviewer continued to say that the approach used for tank type of truck was interesting, and looked forward to seeing the results.

Reviewer 5:
The reviewer would have liked to see this research expanded, because aerodynamics is one of the largest contributors to fuel consumption and holds the largest areas for improvement potential.

That said, the plan moving forward should include specific milestones and go/no-go criteria, a defined scope and finite time plan – including project end. For new ideas (e.g., the GSF development,) new projects should be proposed and approved.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
According to the reviewer, right now the project generates good technical ideas and development results; however, the programmatic side would benefit from more structure (milestones, plan, budget, scope.)

Reviewer 2:
This reviewer noted that this was an excellent area that needed to be addressed by the long haul industry.

Reviewer 3:
This reviewer said that this was low hanging fruit. This was very important work and could solve an important problem. The reviewer said the project did excellent work.

Reviewer 4:

This reviewer said yes, absolutely. Aerodynamics is one of the largest levers for improving fuel economy for commercial vehicles where additional research can provide benefit.

Reviewer 5:

This reviewer indicated that the improvement of aerodynamics, and thus fuel economy supported the overall DOE objectives of petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

To this reviewer, the project had performed well and was structured in a way that additional funding could be put toward further progress.

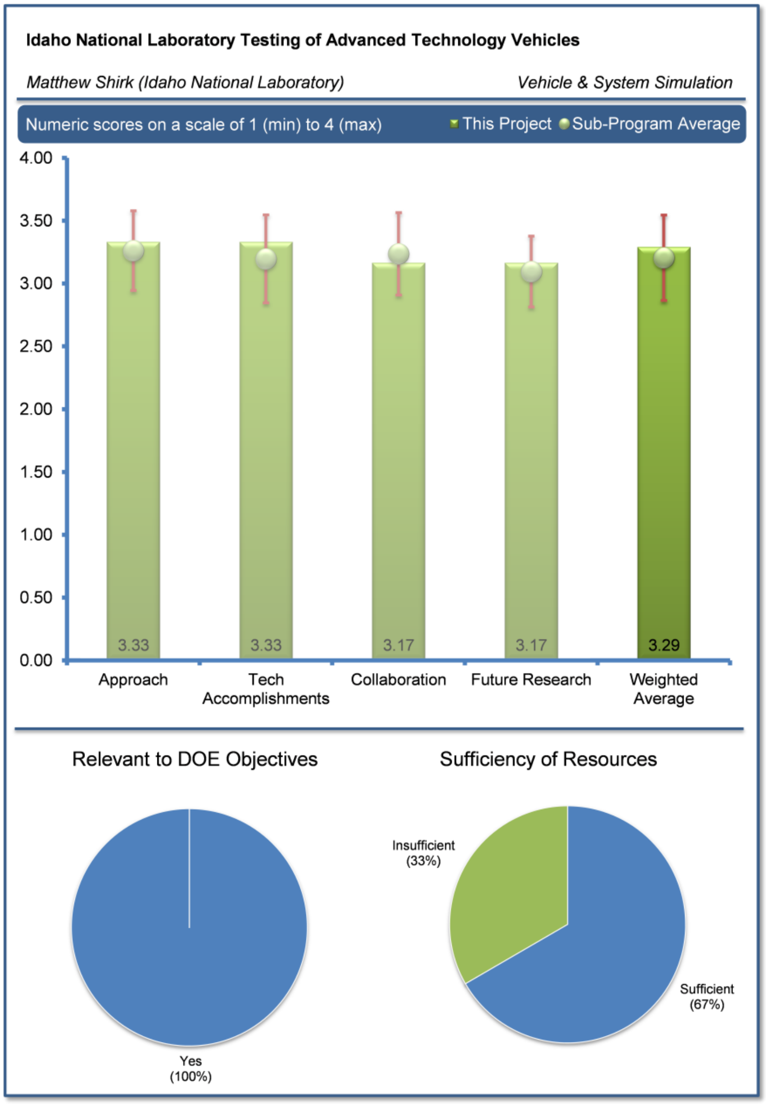
Reviewer 2:

This reviewer questioned the amount gained from this project. The reviewer stated this was a very important topic.

Reviewer 3:

The reviewer felt that the magnitude of importance needed in aerodynamic improvements was not matched to the scope and size of this project. Aero is a major topic and the efforts, though focused in the right area, are insufficient. According to the reviewer, it would be preferred to increase the budget, but also to increase output and deliverables to accelerate developments in this area.

Idaho National Laboratory Testing of Advanced Technology Vehicles: Matthew Shirk (Idaho National Laboratory) - vss021



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that this project was another in the collaborative set of national laboratory led programs. The reviewer added that this was an excellent example of a technology snapshot that is providing technical fleet data from an evolving market and technology.

Reviewer 2:

Overall, the reviewer stated that this kind of macroscopic testing of advanced technology vehicles is very valuable - especially when aspects such as charge efficiency, battery discharge, and dyno testing are included.

What is lacking is a standard set of metrics to evaluate and report in-use performance such as driving behavior. It is useful to have charge efficiency, battery capacity with fast charge, and standard consumption metrics; but there is so much more that can be done to show driving behavior (and as a result component response). For instance, the U.S. Environmental Protection Agency (EPA) came up with the 5-cycle ruling with mostly internal combustion engine (ICE) vehicles and only two hybrids. No PHEVs, no EVs. The EPA has done great analysis to evaluate vehicle specific power, speed-acceleration distribution, and resultant weights for standard drive cycles that represent this behavior. According to the reviewer, it is hard to know if these weights apply to EVs without conducting the same analysis on them. The reviewer suggested to please refer to the 5-cycle guidance document (pages 49-69) for this analysis and to repeat it with the fleet of EVs. Figure III-4 is especially informative if the team could include EVs on it. The reviewer thinks that the researcher and the organization have the right set of tools to do what was stated above; and that this would provide additional value to other laboratories, OEMs, and the general public for how advanced technology vehicles perform in the real world.

Reviewer 3:

The reviewer noted that the approach that had been outlined of using existing test procedures for each technology (to evaluate vehicles or other procedures developed based on fleet managers recommendations) provides for an excellent way to generate data from the advanced technology vehicles. The reviewer added that the testing performed on vehicles is very comprehensive and includes bench tests, closed test track, on road fleet testing or vehicle and infrastructure demonstration by private fleets, and allows for a wide variety of analysis and reporting of the state of the vehicles being evaluated.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer observed that the technical accomplishments and progress had been outstanding this year. The accomplishments listed for vehicle testing, battery testing, and vehicle and infrastructure demonstration projects show tremendous progress for the year and provided DOE with valuable information. The reviewer continued to say that the codes and standards support, and federal fleet outreach work this year had also been excellent and would help to eliminate barriers identified for this activity.

Reviewer 2:
This reviewer noted that it was a significant challenge to manage a fleet of vehicles through any test cycle and program. The selection of 4/model makes perfect sense for the fleet. The reviewer looked forward to end-of-project reports.

Reviewer 3:
According to this reviewer, it seemed like the technical approach was thorough and methodical. The team just needs to go a level deeper (as noted in the reviewer's previous comments) to have a standard set of takeaways for each vehicle/fleet added to the testing sequence.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
This reviewer observed that the collaboration in this project had been excellent. With the help of private testing firms, other national laboratories and OEM automotive companies and fleet users for the vehicle and infrastructure demonstration project, this overall activity continues to be a success. The reviewer added that the federal agencies for both codes and standard development and federal fleet outreach programs were well coordinated.

Reviewer 2:
This reviewer saw great cross-functional activity. The reviewer suggested collaborating with ANL more and comparing energy consumption and other loads from their dyno testing. The reviewer asked how the fleet consumption for driving, HVAC, etc., changed with average driving speed, driving distance, ambient temperature, etc.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that there were several remaining challenges and barriers identified that would provide for the opportunity for testing, evaluation and demonstration projects. The reviewer recounted the future work to include expansion of vehicle and infrastructure demonstrations and continuing to provide testing and data collection for future projects would continue to increase the data base and knowledge of these advanced technology vehicles.

Reviewer 2:
This reviewer stated that the future research seemed encouraging but mostly recommended staying on the course outlined. The reviewer suggested pushing the boundaries and going more in-depth. The reviewer asked to please contact other EV manufacturers like Tesla or Nissan for ideas on various things that can be done with the data that are especially interesting to OEMs. The reviewer would also like to provide some feedback to the PI regarding the direct current (DC) fast charging presentation for the LEAF.

This reviewer provided the following recommendations on things to investigate as the next phase of the project: mixed cycling (daily Level 2 charging and fast charging over the weekends, as the latter could be at a higher temperature); find a way to include the impact that depth of discharge (and charge) has on degradation in the design of experiments; and try rates higher than 50kW to push the envelope for fast charging. The reviewer further inquired about the power level at which degradation starts to significantly deviate from Level 2 charging, and remarked that 50kW is too low to enable transport electrification. The reviewer stated a need to keep pushing this boundary faster, and that the project had the resources to do this.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer stated that this activity was very relevant to the DOE goal of petroleum reduction by performing testing and demonstrations of vehicles and infrastructure to identify the potential petroleum displacement of the technology.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

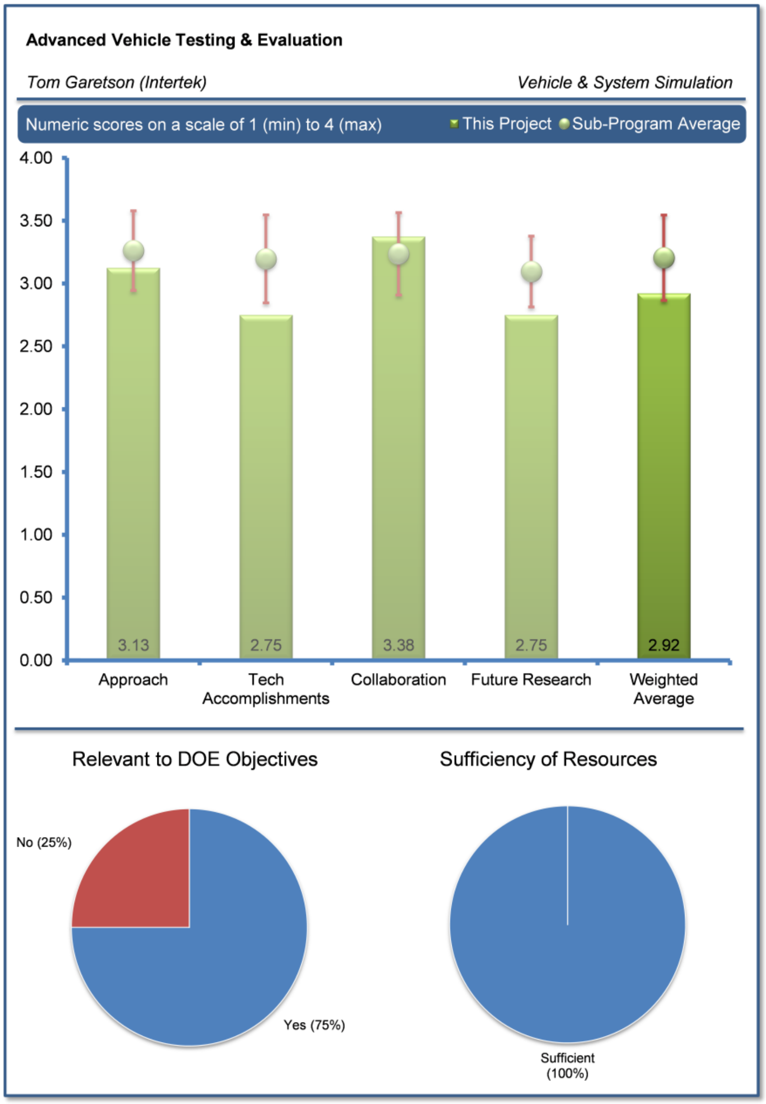
Reviewer 1:

According to this reviewer, there were large amounts of results and information from this project with the relatively small amount of resources provided.

Reviewer 2:

This reviewer imagined a need for more data analytics resources but that this needed to be verified with the PI. Also, the reviewer said that more cars and experiments were needed to push fast charging power levels higher.

Advanced Vehicle Testing & Evaluation: Tom Garetson (Intertek) - vss029



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer had reviewed this project in the past, and it seemed to this reviewer that process improvements were being implemented continuously to address the issues that have arisen in the past.

Reviewer 2:

The reviewer said that the approach outlined of procedure and documentation development followed by the data collection of baseline testing, fleet testing, accelerated testing and a variety of traction battery tests will provide DOE with an excellent set of data to evaluate these advanced technologies.

Reviewer 3:

The reviewer observed that the plan for this project covered all of the relevant technical aspects of performance of advanced vehicles in use. The reviewer would have liked to see a bit more about the people aspects. The reviewer asked if the drivers charged when needed, if the vehicles did the required functions well, and if there were any operational problems.

Reviewer 4:

The reviewer wished there was more information about the standards for the tests (test protocols), whether they were nationally accepted (or established by consensus-standards organizations), why and how they were chosen, and what the baseline is (how the baseline was established) rather than an emphasis on the numbers of vehicles and types of vehicles tested and miles driven.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer stated that progress on this project had been very good. A total of 54 vehicles had been tested in the field and 6 vehicles had baseline testing complete. There was no data presented in the presentation except for miles driven by the Toyota Prius. It would have been good to present the baseline testing and field testing that had been generated.

Reviewer 2:

The reviewer noted that this project was collecting key performance data for in-use vehicles. The reviewer was hoping that the project team would also provide clear insights into how the vehicles differ, and which types of users would be best suited by the different models.

Reviewer 3:

According to this reviewer, progress had been slow - more than halfway through the timeline, only 15% had been completed, though as the PI stated, there were issues beyond control that affected the level of progress, such as bankruptcy.

Reviewer 4:

The reviewer observed that the project is vastly behind schedule. It started October 2011 and ends September 2016 but is only 15% complete when it should be more than 60% complete. If the delay was not their fault, the reviewer pointed out that a revised schedule of milestones should have been worked out with DOE.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

According to this reviewer, the vehicle testing and analysis team was top-notch. The reviewer would have liked to see a more varied set of users, beyond taxis and messengers. The reviewer knew the team wanted high mileage, but normal consumers, like commuters, would have been useful as well.

Reviewer 2:

The reviewer noted that the collaboration with national laboratories and other industry partners was very good.

Reviewer 3:

This reviewer commented that the list of collaborators is wide and diverse, including private companies, other national laboratories, and a university.

Reviewer 4:

This reviewer observed that there was no problem here at all.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the future plan to evaluate over 50 models and 150 vehicles along with 12 infrastructure sites would provide a great deal of data for the evaluation of these advanced technologies.

Reviewer 2:

The reviewer had a couple of comments regarding the approach in general, which could perhaps be addressed to some extent as the project progresses. The largest number of samples of any vehicle in the tested fleet is four. This is not likely to yield statistically significant results. If the generated data are meant for the consumption of the general public, given the general lack of awareness of statistical methods (even among engineers), these results could be at a minimum, misleading. Recognizing that increasing the sample size comes at great expense, it may help to compare the results of the tests with data from dealerships (for instance), if such data were available. It may also make sense to include some form of confidence intervals. In general, the reviewer was not a fan of accelerated reliability testing – it takes the OEMs years to develop accelerated reliability tests, and these are usually developed based on accumulated customer data. Since the only customer data that are readily available are from the advanced vehicle testing activity (AVTA) itself, it may be helpful to show that the accelerated test in correlates in some form to the accumulated data from the other vehicles – for example, the reviewer suggested comparing the rotating moment histograms for the two cases.

Reviewer 3:
Again, the reviewer would have liked to see more attention paid to the less technical aspects. The technical aspects are covered well (the reviewer assumed end-of-test performance will be compared to initial performance). The reviewer asked if the drivers charged when they should have, if the drivers could have gotten more electric miles, or if that would have impinged on working hours.

Reviewer 4:
The reviewer saw that the future research was focused on catch-up with the schedule (running more tests).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that all of the vehicles being tested would reduce petroleum use compared to ICE. The results should tell just how much (e.g., less if driver uses CS mode).

Reviewer 2:
To this reviewer, the project is relevant to the DOE objectives of petroleum displacement. Evaluation and testing of battery electric vehicles (BEVs), PHEVs, hybrid electric vehicle (HEV), and ICE will provide the VTO with valuable information regarding advanced vehicle technologies life cycle cost data and how much petroleum consumption is reduced by using these advanced technologies.

Reviewer 3:
According to this reviewer, one of the barriers to increased usage of advanced technology, vehicles was the lack of reliable information on total ownership costs. It is a chicken and egg problem. Better estimates of total ownership costs will emerge as the sales of these vehicles increase, etc.

The reviewer added that this testing activity addresses this issue to some extent by providing independent testing results.

Reviewer 4:
The reviewer stated that the relevance was NOT direct. Insofar as providing test data to consumers or buyers of electric vehicles is influential in decision making, the choice of whether to displace vehicle with an ICE with an EV lies ultimately in the consumer or buyer.

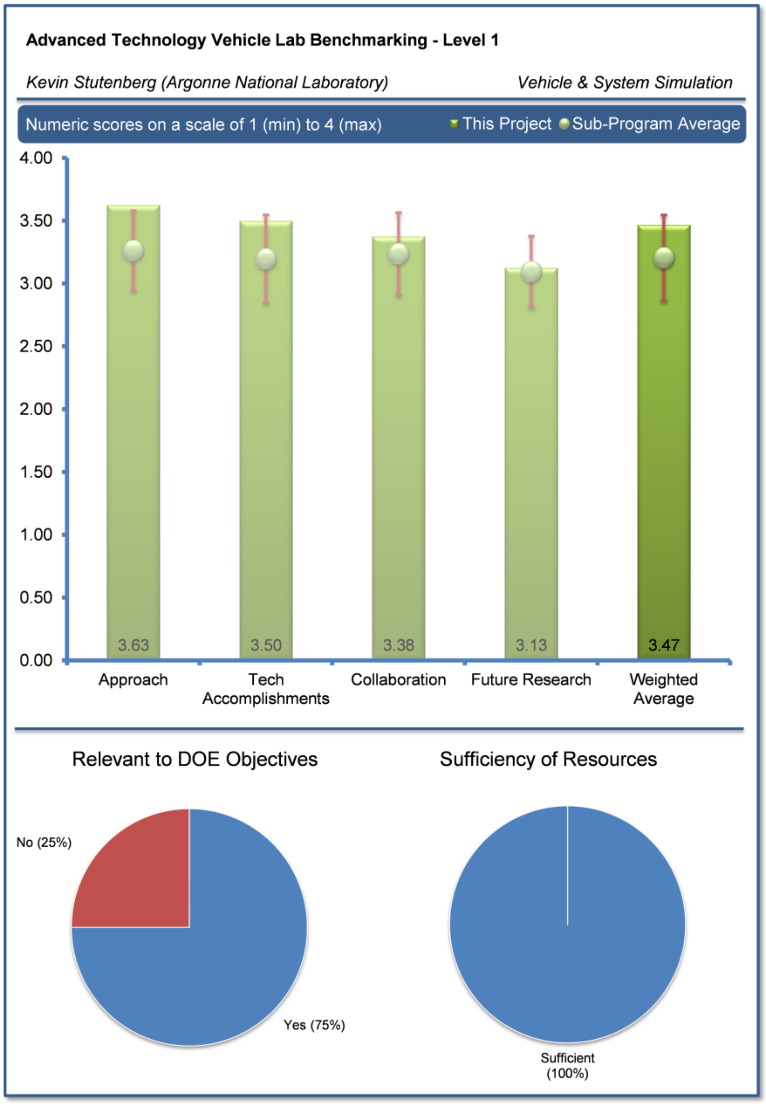
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that it would be nice if the sample size for each model vehicle could be increased, but given the cost associated with this activity, the funding is probably at an appropriate level.

Reviewer 2:
The amount of funds appeared to be sufficient according to this reviewer. However, since the project was only 15% complete and the project's timeline was about 50% complete, the reviewer wanted to know if the funds would be able to be spent by the end of the project.

Reviewer 3:
The reviewer stated lots of cars, lots of tests, and lots of analysis costs lots of money. The reviewer could not say much more without detailed budgets.

Advanced Technology Vehicle Lab Benchmarking - Level 1: Kevin Stutenberg (Argonne National Laboratory) - vss030



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

According to this reviewer, this is a well leveraged program which has great potential through solid empirical testing, which is challenging. The reviewer added seeing an excellent mix of database management, codes and standards support, model support, and U.S. DRIVE support. Although the reviewer had not been in the dynamometer downloadable database (D3) prior to the review, the reviewer planned to do so as time allowed. The reviewer said there was excellent analysis presented on temperature effects.

Reviewer 2:

The reviewer thought the approach was very thorough and could not make any suggestions for improvement. The reviewer was not sure about agreeing with the efforts expanding to include more extreme tests, such as Level 2 tests.

Reviewer 3:

The reviewer said that this benchmarking activity has developed very proficient testing methods that can be adjusted to individual activities. The overall approach is excellent and includes testing at INL for mileage accumulation and track testing, baseline testing at ANL and accelerated fleet testing at INL.

Reviewer 4:

This reviewer stated that ANL's Advanced Technology Vehicle Laboratory Benchmarking - Level I project is a long established (since 1998) activity that has had a strong history of accomplishment. A strong project approach and accompanying procedures have been refined and honed over the years. The reviewer noted that the approach involved utilizing a purpose-built research laboratory for automotive benchmark activities combined with well-established and proficient testing methods adjusted to individual technologies. Refinement over the years has resulted in advanced and unique facilities and instrumentation, continuous improvement of testing procedures, standardization of test plans including instrumentation and drive cycles that are adjusted for individual vehicles, and the development of a significant knowledge base of advanced vehicles and testing methods. This person reported that the Advanced Powertrain Research Facility (APRF) has expertise in testing a broad range of vehicular powertrains and alternative fuels. The basic APRF test process consists of incorporation of mileage accumulation, track testing, and coast down information from INL's Advanced Vehicle Testing Activity; baseline dyno testing consisting of test procedure preparation and vehicle instrumentation, dyno testing, and analysis; followed by data dissemination to national laboratory and United States Council for Automotive Research (USCAR) OEMs via the D3. This was all very sound to the reviewer and should be continued. The reviewer concluded that as time has gone on, it becomes harder to achieve significant further efficiencies in the project, but this task should always be keeping process/procedure efficiency and costs savings in the forefront of the mind to maintain the cost viability of the project in the future funding constrained scenarios.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

According to this reviewer, the technical accomplishments and progress had been very good and continue to address the barriers of lack of standard test protocols and providing information on advances in technology. The reviewer recounted that the specific accomplishments include the refined data management, analysis and reporting capabilities, vehicle testing, which is in-progress in collaboration with INL, and many test results and raw data that have been made publically available.

Reviewer 2:

This reviewer said this was redundant with prior comments, but that the solid data being generated by this project would provide valuable insight to technology growth and needed efforts.

Reviewer 3:

This reviewer noted that it appeared that all the milestones have been met.

Reviewer 4:

This reviewer stated that FY 2013/2014 project activities have a solid list of accomplishments, including Level 1 testing of 11 vehicles with very different powertrains; continued evaluation of thermal impact on energy consumption and powertrain operation of conventional, alternative fuel, and electrified vehicle technologies; further development/refinement of the D3; enhanced signal and testing lists available to OEMs and DOE partners; as well as continued codes and standards support. Compressed natural gas (CNG) versus gasoline engine efficiency has been compared, the temperature effects on BEV range examined, the effect of climate control setting energy consumption examined, and a study of blended PHEV fuel displacement is examined, which varies heavily on design and controls. ANL's APRF benchmarking tests are providing prototypes for power rating procedures for SAE J2908. Overall, the reviewer saw a solid list of accomplishments that can continue to be built upon.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

According to this reviewer, the Level 1 benchmarking activities had a strong and extensive list of collaboration and coordination partners which had been built up over the years. These partners span the OEMs, suppliers, other national laboratories, adjacent activities within ANL, international partners for testing and codes and standards related activities and universities. The reviewer concluded that it would be difficult to significantly further the level of collaborative partners.

Reviewer 2:

This reviewer saw that extensive coordination and collaboration existed between the APRF and U.S. DRIVE, international partners such as KATECH, Japan Automotive Research Institute (JARI) in Japan and the Joint Research Center in the European Union. In addition, the APRF helps with DOE technology evaluation and works closely with other national laboratories including NREL, ORNL and Idaho National Laboratory (INL). The reviewer verified that coordination also existed with the AVTA working with ANL and INL, and the Advanced Vehicle Technology Competition working with General Motors (GM) and universities.

Reviewer 3:

This reviewer would have liked to see EPA and CARB as a partner if emissions are being benchmarked.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that it was good that the PI was already thinking about benchmarking autonomous vehicle technologies, intelligent vehicle control systems, and active safety systems (such as adaptive cruise control in combination with forward collision warning system).

Reviewer 2:
This reviewer observed that the future work would continue to address the barriers and help to meet the DOE goal of petroleum displacement by continuing Level 1 benchmark work with emphasis on thermal testing. In the future, the reviewer recounted that there would be several potential vehicle models that will be added to the test matrix.

Reviewer 3:
This reviewer thought that the FY 2014 focus likely included Level 1 testing of a variety of vehicular powertrains including, EVs, PHEVs, diesels, range extender, bi-fuel vehicle, and a CNG conversion. Evaluation of the thermal effects on energy consumption and powertrain behavior will continue as will further development of data management and analysis tools for quicker data distribution. APRF also indicated that the project may begin greater involvement in analyzing and disseminating data. Presently, the APRF cannot handle extreme cycles like high altitude testing. Additionally, areas like adaptive cruise control may be something to consider. The reviewer suggested that it would be especially beneficial if ways to handle these types of testing could be accommodated, maybe through innovative duty cycle development, without having to incur the cost of significant new equipment installation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This reviewer said absolutely.

Reviewer 2:
This reviewer noted that the APRF was very relevant to the overall DOE objective of petroleum displacement. This project would provide DOE advanced vehicle test data and analysis, which will enable petroleum displacement through technology assessment and data dissemination.

Reviewer 3:
According to this reviewer, the Level 1 Benchmarking activities of the APRF are very important to continue the advancement of vehicular technologies through independent and unbiased technology evaluations including accurately establishing the current state-of-the-art, baselining technical targets and goal setting, providing input to and validation of vehicle and systems models, and providing data for procedures development and validation for codes and standards development. All these benefits, said the reviewer, help increase the rate at which advanced vehicular technologies are explored and more broadly understood and ultimately considered for implementation in the nation's vehicular fleet.

Reviewer 4:
The reviewer perceived that providing the consumer with data on alternative fuel vehicle performance only indirectly supported petroleum displacement. Notwithstanding, the reviewer felt that the real value of this effort was providing an independent, objective, impartial third-party verification and validation of data or source of vehicle performance data for use by the public and whoever needs it.

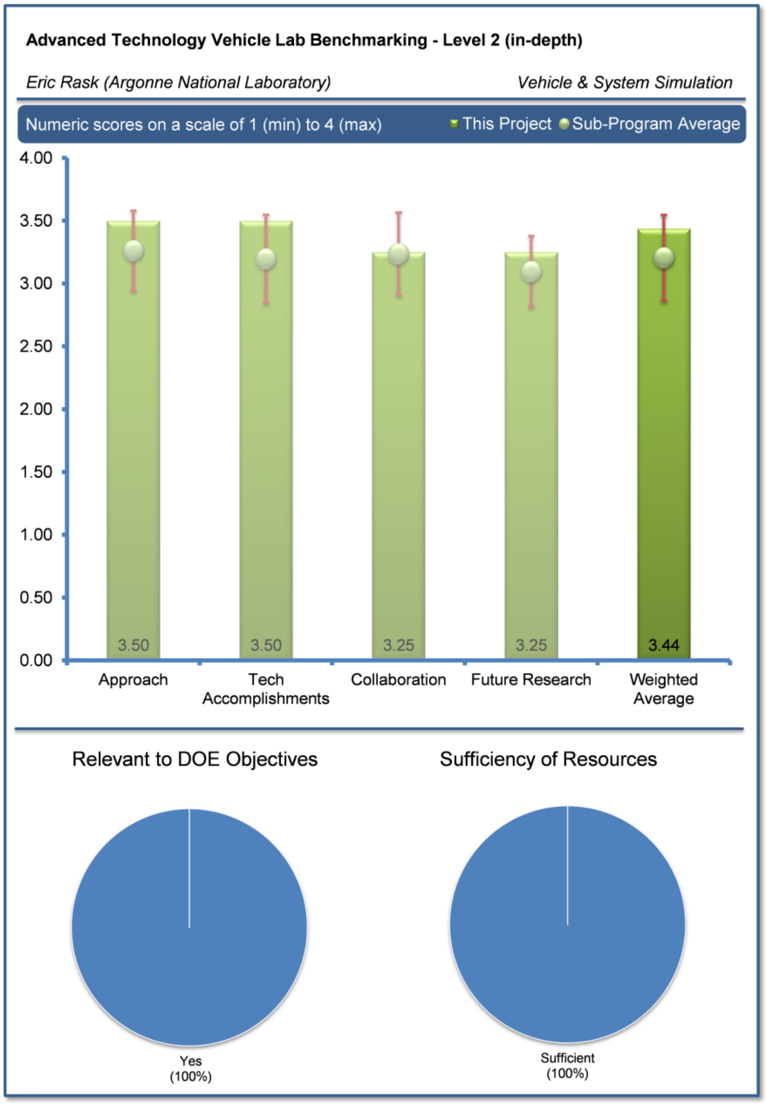
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer observed that there was a large amount of results and accomplishments for the amount of funding provided for this project.

Reviewer 2:

This reviewer noted that resources were sufficient for the current and projected task activities.

Advanced Technology Vehicle Lab Benchmarking - Level 2 (in-depth): Eric Rask (Argonne National Laboratory) - vss031



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer thought that the approach of selecting a vehicle for in-depth testing and providing extensive instrumentation to evaluate thermal and electrical loads was excellent.

Reviewer 2:

The reviewer perceived that, as this was the first full evaluation of a BEV at ANL, it was approached in a very comprehensive way. The system by system monitoring of draw from the energy storage device creates a proper understanding of the efficiencies of each sub-system and the overall contribution of each to the whole vehicle. The reviewer advised to keep an eye on how the sub-systems interact under various levels of state of charge (SOC).

Reviewer 3:

The reviewer reported that, while novel and difficult, this process attempted to compare what is in many circumstances incomparable at the detailed depth of the activity.

Reviewer 4:

The reviewer commented that after having been refined over a number of years, the approach to Level 2 benchmarking testing at ANL is sound. In short, it consists of determining the right vehicle to test given the uniqueness of a vehicle's technology and significant input and recommendation from stakeholders including DOE, industry, and national laboratories. A test plan is prepared of which a significant portion (approximately 70%) is relatively standard based on previous test plans and about 30% is customized to the specific vehicle and stakeholder requests. Extensive instrumentation is undertaken using a mix of direct instrumentation, off-line sensors, and controller automated network (CAN) bus information. Subsequently, the vehicle is tested across a wide range of regulatory, real-world, and specialized drive cycles. This reviewer further reported that a wide range of ambient temperatures and solar loads are evaluated to assess the impacts of HVAC on vehicle efficiency and range. Data is then assessed with full data sets downloaded to DOE and industry stakeholders and subsets made available to the public through the dynamometer downloadable database. The reviewer perceived that this was a solid approach having withstood the test of time. However, the reviewer believed some serious thought needs to be given to whether the Level 2 testing should always be completely comprehensive. The reviewer advised that it may be possible to get essentially all the information and results needed by conducting fewer tests, possibly running fewer drive cycles, instrumenting fewer components, or finding other viable shortcuts.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer reported that institutional knowledge in the vehicle systems and measurements was very apparent and well executed.

Reviewer 2:
The reviewer asserted that the project's technical accomplishments support the goal of increased battery capacity and lower mass or road loads for increased vehicle range. Testing showed 65-113 mile full depletion range depending on the type of test cycle operated. The reviewer observed that progress had been shown through the dissemination of data to industry and the public.

Reviewer 3:
The reviewer stated that so far the initial evaluation of the Ford vehicle has achieved most if not all of the intended understandings of the vehicle systems. The reviewer definitely recommended looking deeply at how the systems interact and are prioritized for draw at low SOC.

Reviewer 4:
The reviewer related that Level 2 testing has been completed for the Ford Focus BEV, with the final report and data outreach pending. Preliminary testing and break-in is complete for the 2015 Honda Accord PHEV, with in-depth testing ongoing. The reviewer further reported that full depletion cycle testing of the Ford Focus BEV is completed exhibiting a 65-113 mile full depletion range depending upon cycle aggressiveness and a roughly 85% SOC swing from full depletion to full charge. An in-depth look at the energy allocation has been conducted examining losses at high, low, and standard ambient temperatures across tractive energy, axle/tire losses, drive line losses, HVAC, and accessories. This person also indicated that some unique preliminary insights have been observed including that axle losses can interact with HVAC loading to over/under emphasize the penalty of heating/cooling at extreme temperatures, and that battery preconditioning may lead to secondary benefits such as reduced heating loads. Level 2 testing has also provided input to SAE J2908 hybrid powertrain ratings. The reviewer judged the overall level of technical accomplishments to be reasonable.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer reported that all correct partners appear to be identified and are utilized.

Reviewer 2:
The reviewer said it seemed that the U.S. DRIVE collaboration was the only true collaboration cited. SAE is stated as receipt of test procedures, so not sure what the collaboration is there. The reviewer was not sure about some of the others, but suggested that some suppliers of the sub-systems may be excellent collaborators to approach.

Reviewer 3:
The reviewer observed that the in-depth testing provided information to many groups including U.S. DRIVE, tech team and OEMs. Work is also coordinated with several national laboratories such as NREL, ORNL, and INL.

Reviewer 4:
The reviewer relayed that ANL's Level 2 laboratory benchmarking has a long history of collaboration and coordination with other entities including AVTA at INL, SAE for standards support, industry through U.S. DRIVE, tech teams, etc., other national laboratories, and internally with adjacent projects at ANL. The reviewer judged that these collaborations are sound, but advised that it is important to always be on the lookout for additional collaborations that may add value or new insights to advanced technology vehicle laboratory benchmarking.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer suggested that future efforts should include a mapping of the state of the art in the systems and subsystems in the vehicles; for example, how the Honda sub-systems compare to the Ford sub-systems in their respective full system roles. The reviewer believed that the data generation and analysis capability was clearly appropriate and that after more vehicles were tested, it was clear to the reviewer that a time based comparison of subsystems development efficiency was possible and highly desirable for industry and for future development planning.

Reviewer 2:

The reviewer observed that the future work to complete the testing of the Honda Accord PHEV will provide a second set of in-depth data for use by DOE.

Reviewer 3:

The reviewer reported that for FY 2014, the 2015 Honda Accord PHEV would continue to be tested, but pointed out that not much ancillary information was provided as to what specifically or potentially would be uniquely looked for in the testing of the Honda Accord PHEV.

The reviewer relayed that the cost of Level 2 advanced technology vehicle laboratory benchmarking has steadily increased over the years to where now it appears to cost approximately $350,000-$400,000, each time deep dive testing is conducted on a vehicle. This cost limits the number of vehicles which can be assessed to a maximum of one per year. Given the likelihood of constrained funding scenarios moving into the future, this can be somewhat problematic. The reviewer suggested that it may be beneficial to conduct an in-depth analysis of all the cost drivers of Level 2 testing from test procedure development, to the extent of instrumentation, drive cycle selection and bounding, testing, analysis, and subsequent data dissemination. The reviewer felt that there has to be some areas where the process can be further simplified. Cost/benefit decisions can be made such as restricting to a degree the number of components that are instrumented or drive cycles conducted, or more efficient data analysis/dissemination procedures could be implemented without significantly impacting the quality and extent of data made available. This is very important to the long term viability of Level 2 testing to show continued cost-effectiveness with ongoing efforts to achieve more value with the same or fewer resources.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer felt that the project is extremely relevant to the DOE goals of petroleum displacement. DOE has an emphasis on increased electric vehicle market penetration and technology development. The reviewer thought the work in this project will help provide in depth information on electric vehicles and will help to advance the state of technology.

Reviewer 2:

The reviewer found that understanding the performance envelope of these vehicles and understanding how the immature technology has moved forward shows the potential for increased displacement.

Reviewer 3:

The reviewer considered advanced vehicle testing necessary to benchmark start-of-the-art vehicular technologies to support technology goal setting; support hardware/model validation; support standards development through validation; and provide an unbiased, independent assessment of technologies.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the project seems to have the correct group of resources, but that suppliers of subsystems could be a good addition.

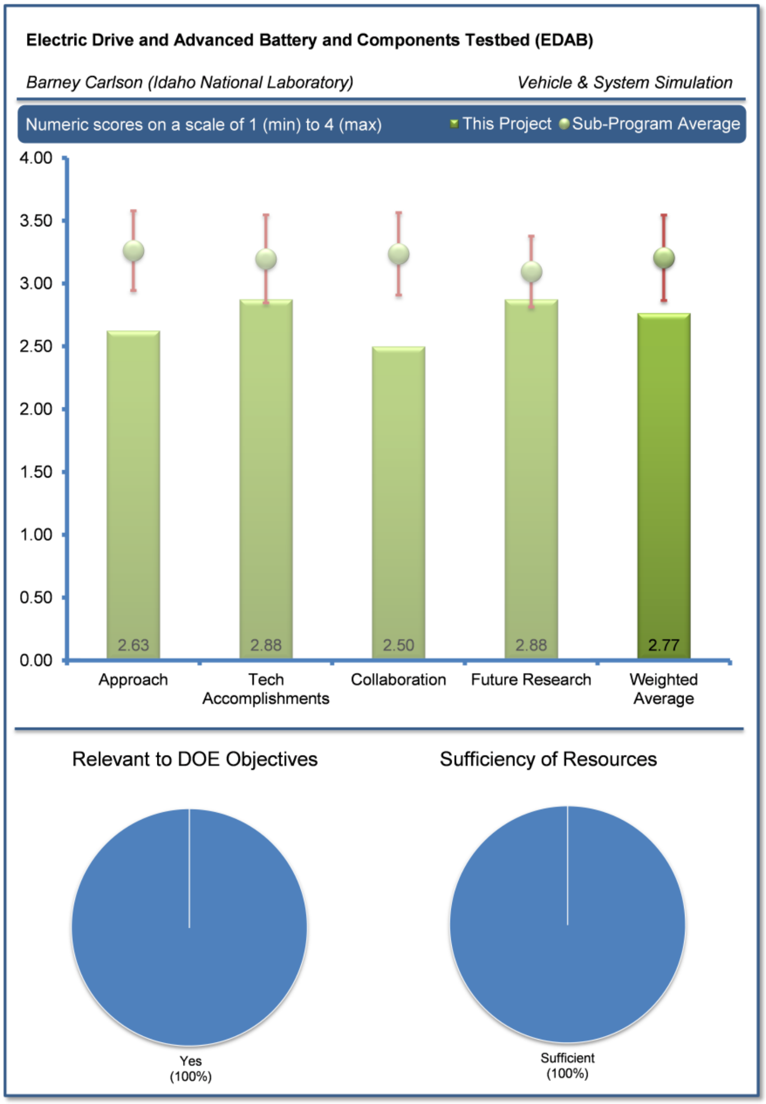
Reviewer 2:

The reviewer commented that available resources should be adequate to complete the project as planned.

Reviewer 3:

The reviewer opined that resources for the task outlined are sufficient.

Electric Drive and Advanced Battery and Components Testbed (EDAB): Barney Carlson (Idaho National Laboratory) - vss033



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer found that the idea of testing a battery to see how it performs after some service time is a good approach, and also liked the idea of comparing it to what the manufacturer claims. The reviewer thought it would be best if the cycle the battery is run through is very close to the cycle or vehicle the battery was designed for. The reviewer stated that for the EnerDel battery the vehicle it was designed for was little smaller than the LEAF, and asked if the Toshiba pack was designed for a vehicle/system that is similar to a Volt.

The reviewer saw that a lesson was learned with EnerDel and work for the second battery is being done with a company that wants to collaborate like Toshiba.

Reviewer 2:

The reviewer believed that independent testing like this gives a perspective, but without participation or even feedback from the manufacturer, the conclusions that can be drawn are somewhat limited.

Having said this, the reviewer found the approach to be appropriate, as the initial manufacturer EnerDel was contacted and chose not to respond. At least Toshiba has agreed to support the effort!

Reviewer 3:

The reviewer was not sure why the approach was chosen, as this kind of a build of a vehicle may have been more appropriate if it were to validate a hardware-in-the-loop (HIL) system using an environmental battery test chamber and to validate or correlate with system simulation software. The reviewer could not see the value of the output data other than the possibility to use it for validations or correlations.

The reviewer pointed out that the first test battery pack was not current technology so results may have little informational use. It was stated that it was chosen because it was available. Both the manufacturer and the vehicle producer would have tested for the same characteristic changes but in an actual real world vehicle application.

Reviewer 4:

The reviewer commented that based on the technical results there was a "big miss" in planning for this project with EnerDel ESS. As such, the reviewer thought that it was difficult to look at the rest of the project objectively. The reviewer recommended that clear due diligence be done before projects are done. The reviewer noted that this was a $250,000 project for FY 2014. As such, the rest of the reviewer's ratings for this project were rated accordingly low.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer believed that the test results on the EnerDel battery are good for reference and to understand how a battery can degrade. The reviewer said that having the test bed to test future batteries is also a good accomplishment.

Reviewer 2:

The reviewer viewed the technical accomplishments to be in line with the overall project objectives.

The reviewer mentioned that support from EnerDel would have added more meaning to the result achieved so far.

Reviewer 3:

The reviewer's specific observation was that the degradation started out at a much greater than published rate from the manufacturer, and then shifted slope after about 175 cycles to be more in line with manufacturer degradation slope. The reviewer believed that this needed to be understood or the time spent testing will not yield much. The reviewer wondered if it was due to average daily temperature changes, charge pattern changes, or something else. The reviewer stated again that to do this with no collaboration with the pack maker is a bit futile.

The reviewer considered that what was learned was that in this application the level of available charge capacity dropped, but not in accordance with manufacturer published information, but not why it happened.

The reviewer concluded that the project could also provide value if it could result in an understanding of how the Energy storage system will interact with the many sub-systems on the vehicle.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer perceived that collaboration with other national laboratories has kept the project on track and is critical to the success of the matching the battery packs to the duty-cycle.

Reviewer 2:

The reviewer recognized the effort to contact EnerDel and they did not reply back. The reviewer was glad that the researchers are involving Toshiba for the second round, and felt that, outside that first battery pack maker, the collaboration is very good.

Reviewer 3:

The reviewer stated that making data generally available is not an example of collaboration. The reviewer observed no real collaborations cited in the presentation, unless the reviewer does not understand what is meant by collaboration. The reviewer believed that in general some of these projects seemed to be "stove piped," with little development of a collaboration strategy. The reviewer cautioned against showing collaborations if none exist.

The reviewer perceived that setting up a series of tests of varying energy storage systems (ESS) systems with individual manufacturers collaborating on the testing of their products would make a lot more sense. By doing this, the ESS industry could see how their products stack up when benchmarked against others for certain characteristics. The reviewer believed that this could move the bar upward in the competitive marketplace.

The reviewer finally concluded that the lack of battery manufacturer involvement makes this a marginally effective project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that moving to a new battery pack from Toshiba is completely appropriate and the logical next step.

Reviewer 2:
The reviewer hoped that the next test cycle/application will use a pack very close to the cycle or application that the pack/cell was designed for. The reviewer believed the idea of tying in modeling of the Cell (with CellSage) to the actual performance of the pack in the test bed is a very good one.

Reviewer 3:
The reviewer recommended that if the project is to be continued, it should be done with a clear eye on working closely with the battery manufacturer, and only test some current or near-future storage packs. The reviewer also stated that it should also be an opportunity to create a benchmarking program for certain important ESS characteristics.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer perceived that either debunking or reinforcing manufactures claims is very relevant.

Reviewer 2:
The reviewer said that, yes, we do need to know how batteries degrade or hold steady in energy and power over use as hybrids and electric vehicles are adopted more by the public.

Reviewer 3:
The reviewer perceived that it probably does conceptually, but the output is marginal for the reasons stated in the other sections. The reviewer suggested that it should be structured for creation of new information pertinent to future ESS development.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

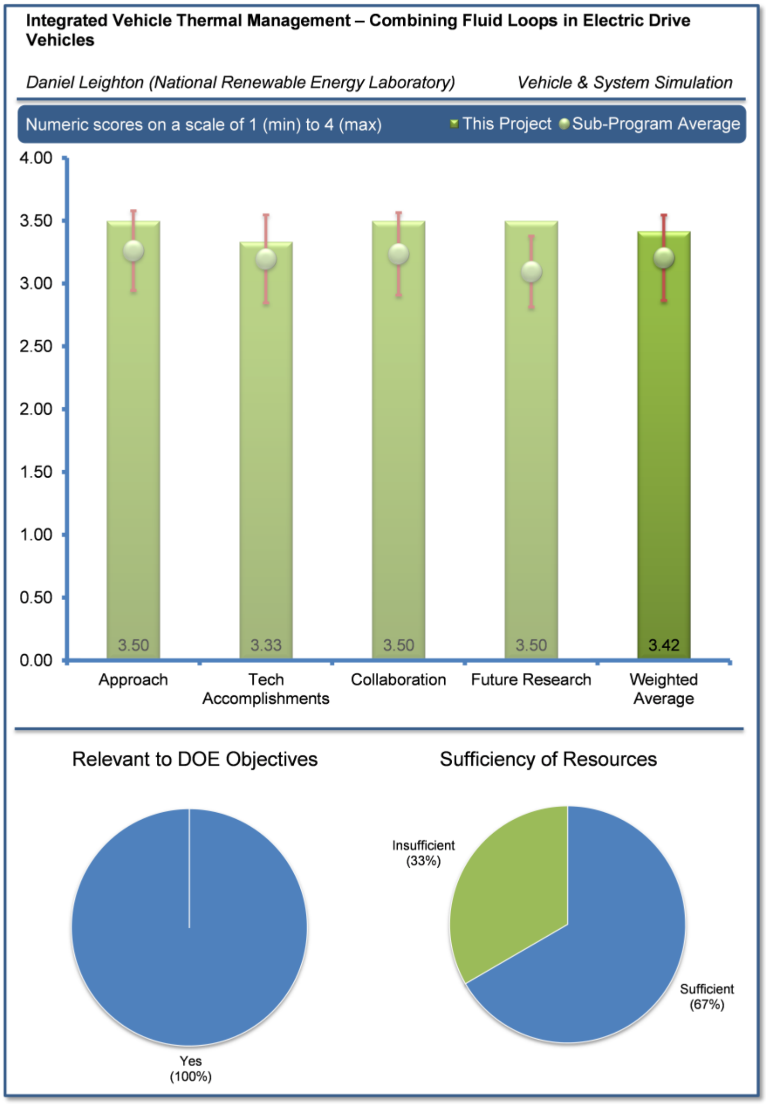
Reviewer 1:
The reviewer concluded that if further battery packs are to be evaluated and the test bed continues to be used (after the Toshiba pack work is done) then more funding will be required.

Reviewer 2:
The reviewer did not see any indications where additional resources would benefit the program and equally there are no indications that insufficient resources are causing program delays.

Reviewer 3:
The reviewer found that resources are sufficient for what is actually being done, but may be insufficient if the approach were changed.

Reviewer 4:
The reviewer emphatically said up front fail bike.

Integrated Vehicle Thermal Management - Combining Fluid Loops in Electric Drive Vehicles: Daniel Leighton (National Renewable Energy Laboratory) - vss046



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer thought the multi-year approach to the project was well thought out with reasonable deliverables.

Reviewer 2:

The reviewer found that the technical approach was well defined and the approach was a logical progression based on the availability of hardware for evaluation. Each step (i.e., modeling, test fixture, and vehicle testing) improved results, and therefore forwarded the study.

Reviewer 3:

The reviewer said that this project interestingly makes an already simpler vehicular configuration even simpler, and cited creative solutions for low temperature operation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Through working with Tesla, the reviewer got the impression that the project team was employing a similar system on the Model S, and wondered if there were any production EVs that were combining fluid loops currently.

The reviewer found that this was an excellent area of study and that the presenter was very knowledgeable about the project and technical details surrounding it.

In this reviewer's past experience with an EV OEM, the reviewer observed a huge gap in understanding of the cooling/heating options available for the power electronics, battery, and passenger compartment across the industry. The reviewer thought that this area deserved a lot more attention and that this project was just the beginning, and honestly believed the scope and support could be increased due to the value of the information improving the range and efficiency of EVs.

Reviewer 2:

The reviewer asserted that there was a good use of mixed tools - analytics, modeling, bench, and vehicle.

Reviewer 3:
The reviewer reported that progress did not appear to be behind schedule, but it was insufficiently clear as to the results of the analysis method employed to date. The main accomplishment was identified as the testing rig, which appeared to meet the needs of the project, but the reviewer believed a brief explanation of the features would be useful. The reviewer expected that results reported next year should be interesting.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer recognized that collaborators and their roles were identified in the presentation and clarified in the question and answer session, and indicated that they seemed to be sufficient for work to date and planned work.

Reviewer 2:
The reviewer commented that private industry and automotive suppliers were appropriately engaged to support the project. A larger program could certainly support it.

Reviewer 3:
The reviewer stated that there was excellent collaboration and coordination for the fuel related entities that are involved, but that it seemed there could have been earlier coordination with a car builder.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that Part 3 of the project is integrating this system onto an on-road vehicle, which will be an excellent validation test for the concept.

Reviewer 2:
The reviewer was glad to see the plans to get this on a car inside this budget/project.

Reviewer 3:
The reviewer concluded that the future work proposed was logical and clear. The reviewer reported that no decision points were identified, but did not seem necessary as the purpose was to see to what degree the combined fluid system met thermal management requirements.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer asserted that this is a key enabler to increasing the range of EVs to a customer acceptable amount.

Reviewer 2:
The reviewer stated that efficiency improvement will reduce fuel consumption and that weight reduction will reduce fuel consumption. Further, this person pointed out that this technology applies to EVs, a technology that already reduces petroleum consumption.

Reviewer 3:
The reviewer believed that simplifying new technologies can really help adoption by lowering costs and decreasing complexity for maintenance, etc.

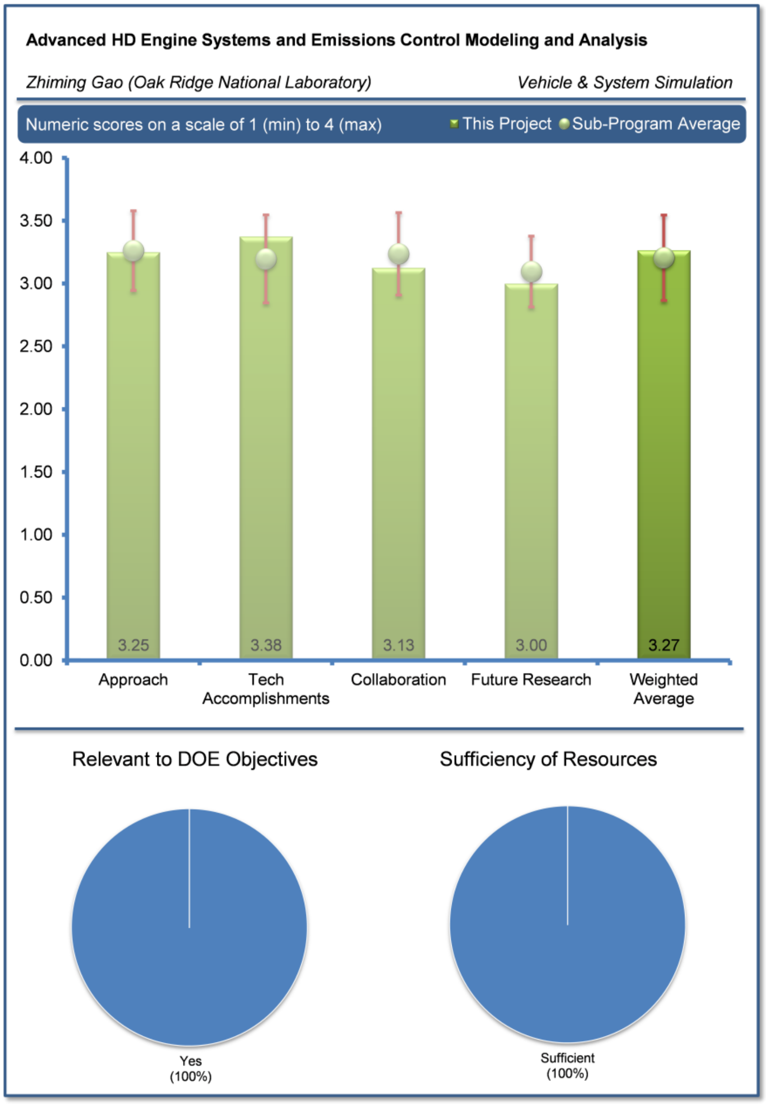
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that no deficiency in resources could be identified as all work to date and planned activities seemed manageable with resources identified.

Reviewer 2:
The reviewer commented that resources seemed sufficient, but was a little unsure.

Reviewer 3:
The reviewer could not comment on the appropriateness of the funding, but from the reviewer's perspective this subject could use additional attention because it is useful to EV deployment.

Advanced HD Engine Systems and Emissions Control Modeling and Analysis: Zhiming Gao (Oak Ridge National Laboratory) - vss048



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer found the integration of exhaust emission and hybrid system performance to be an excellent tool. Developers struggle with this analysis and the tool will be very helpful. The reviewer concluded that leveraging of the data and developed models of the various DOE programs into the modeling tool is an excellent use of resources to accomplish the project.

Reviewer 2:

The reviewer reported that the project is combining DOE databases that already exist – and concluded integration is important to solve MD/HD system hybridization. The reviewer believed this project had a very good research plan.

Reviewer 3:

The reviewer said there was a very good engineering approach to the problem statement. There was an organized process and appeared to be an adequate selection of test equipment and references. The reviewer perceived that the project needed a broader inclusion of user/operators beyond the local transit operator, and suggested using New York City transit, which has in-depth knowledge of their vehicles over a long period.

Reviewer 4:

The reviewer recommended that the work should include economic feasibility when models and materials cause more expense to the systems that are under evaluation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported good technical progress and good data on vehicles and driving cycles.

Reviewer 2:

The reviewer believed the project was on track, and the work plan seemed reasonable.

Reviewer 3:
The reviewer left some general comments on all projects. There was no Gantt chart that showed planned progress versus actual progress. It was hard for the reviewer to assess progress against the original plan.

The reviewer concluded that the improved Autonomie model showed that the research was being integrated into tools that improve the performance of industry development design teams. The energy loss distribution provided a good focal point on where to focus to yield the greatest result for the effort. The bar chart clearly showed this reviewer that addressing engine idle was a very big deal.

The reviewer stated that product cost of the hybrid system is a deterrent to adoption, and that the ability to optimize the parallel hybrid motor/inverter and battery for greatest impact/cost was very important. The reviewer said that many systems oversize the drive or battery system which in turn limits market adoption.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer asserted there was a good choice of partners.

Reviewer 2:
The reviewer indicated that OEM collaborators should be added. The reviewer saw the need for bus agencies and bus manufacturers to be working with the project. In this reviewer's opinion the buses need to be hybrids.

Reviewer 3:
The reviewer recognized that the project has leveraged much work completed to integrate capabilities into the model. However, the degree of collaboration with the stated partners was not clear to the reviewer. The rating provided is higher than what the briefing can justify primarily because of the information that was leveraged to provide greater modeling capabilities for others.

Reviewer 4:
The reviewer commented that this project needs the collaboration of outside agencies especially builders and operators. The reviewer though that this will be a difficult request, but will be very worthwhile in converting this valuable tool into a productive service for the taxpayer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported good progress; the project appeared to be on track and planned future work is reasonable.

Reviewer 2:
The reviewer stated that the project is scheduled to end at the end of FY 2014, and concluded that planned work to finish the project is good.

Reviewer 3:
The reviewer considered the proposed research to be good, judged in a micro-environment of the involved technologists. The reviewer believed the project should be evaluated against the larger operational world of heavy hybrids with field operators and addressing their business and operational issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer found the modeling tool capabilities to be excellent and thought it will assist system designers in developing more cost effective and impactful systems that will lead to greater market adoption.

Reviewer 2:
The reviewer said that, yes, we need hybrid MD and HD vehicles. The project raises important questions. The reviewer said that more than building models, the project will need to have collaborators so that it will be used.

Reviewer 3:
The reviewer concluded that programs testing transitional technologies is a good function of the national laboratories, but the effort should be put forth to insure a relevant test regime addressing field operational issues if possible.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

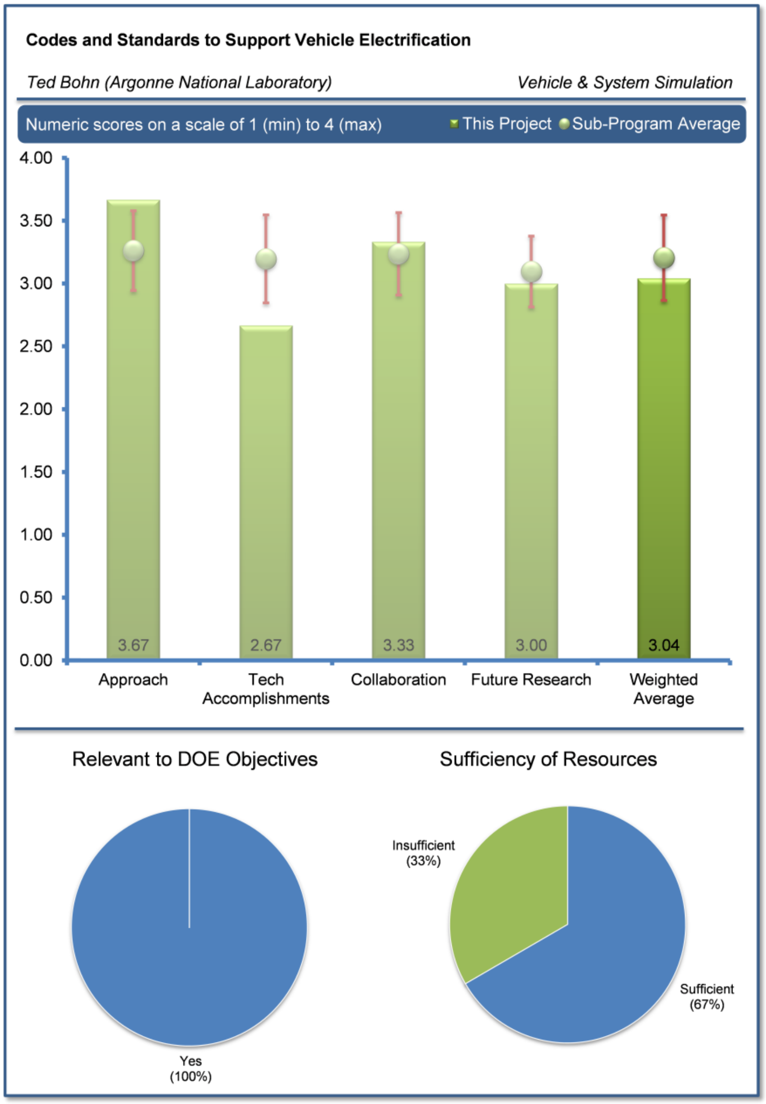
Reviewer 1:
The reviewer recognized there was a good validation of modelling, and that bus modelling is important.

Reviewer 2:
The reviewer found funding sufficient for the current approach, but thought it could be expanded if a larger consortium was built.

Reviewer 3:
The reviewer concluded that economics must be considered in all projects, but that accomplishments should have deployment feasibility points as well.

Reviewer 4:
The reviewer reported that FY 2014 funding shows as current expected funding, and that it looked like the chart had not been updated, or that the funding was questionable.

Codes and Standards to Support Vehicle Electrification: Ted Bohn (Argonne National Laboratory) - vss053



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer thought the idea of making up components to test out proposed standards is a good one, when off the shelf components are not appropriate or not available.

The reviewer concluded that providing leadership on the standards is important, especially if industry is taking a wait and see approach or are in disagreement.

Reviewer 2:

The reviewer applauded that this poster session was the highlight, and inquired about whether Ted can be cloned. The reviewer highlighted that the researcher has the most enthusiasm that they have seen for a DOE project. The commenter liked what they saw from a Test Procedure and Tools and Charging Communication Controls, albeit this was a poster session and not a full-on demonstration with vehicles. The reviewer stated that this presentation had all the right timing charts that are desired, including timing, dollars, and timing for future work. The commenter noted having brainstormed potential future work with the researcher, and hopefully the researcher captured the ideas.

Reviewer 3:

It appeared to the reviewer that there was significant concurrent activity and collaboration with most of the right partners; however, DOT should be involved from the roadway infrastructure and vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) connectivity perspective. The reviewer suggested considering the DOT Intelligent Transportation Systems Joint Program Office (ITSJPO)

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that input has been given on several standards, and leadership was provided on several others. A laboratory was set up to provide test grounds for what is being proposed for the standards.

The reviewer was not clear on how much actual research was done on the grid beyond current charging methods and communication.

Reviewer 2:

The reviewer found that, based on the level of detail provided, it was very difficult to tell how much was accomplished and what was involved to do so and what is the significance. There is one slide dedicated to this. The reviewer related that no performance indicators were provided to assess progress toward DOE goals. There were no responses to reviewer comments or discussions about anticipated barriers to achieving FY 2015 objectives.

The reviewer left the final remark that a key slide for all the acronyms would be very helpful for reviewers.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer saw that there was good collaboration to get the standards to progress.

Reviewer 2:

The reviewer noted that there appeared to be significant and appropriate collaboration with many entities involved, which was a long and tedious process. As this reviewer mentioned before, the DOT/ Federal Highway Administration (FHWA)/National Highway Traffic Safety Administration (NHTSA) should be consulted to ensure that their perspective, input and challenges are considered.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer recognized that the grid research part of the work would likely need to be emphasized with any remaining time and budget. This first part of the work looked to have focused on facilities (test site) and standards.

Reviewer 2:

The reviewer believed that areas of attention, milestones, and goals were clearly presented, but suggested that some strategy should be included to overcome anticipated barriers from lessons learned in FY 2014.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer applauded that the project was spot on.

Reviewer 2:

The reviewer indicated that standardization for charging and hybrids in general to lower costs would be needed.

Reviewer 3:

The reviewer thought that interoperability is key to increasing market penetration for EVs and reducing reliance on fossil fuels for transportation energy. This also aligns with EPA and DOT objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer asked if more resources were given to the researcher if they could achieve more.

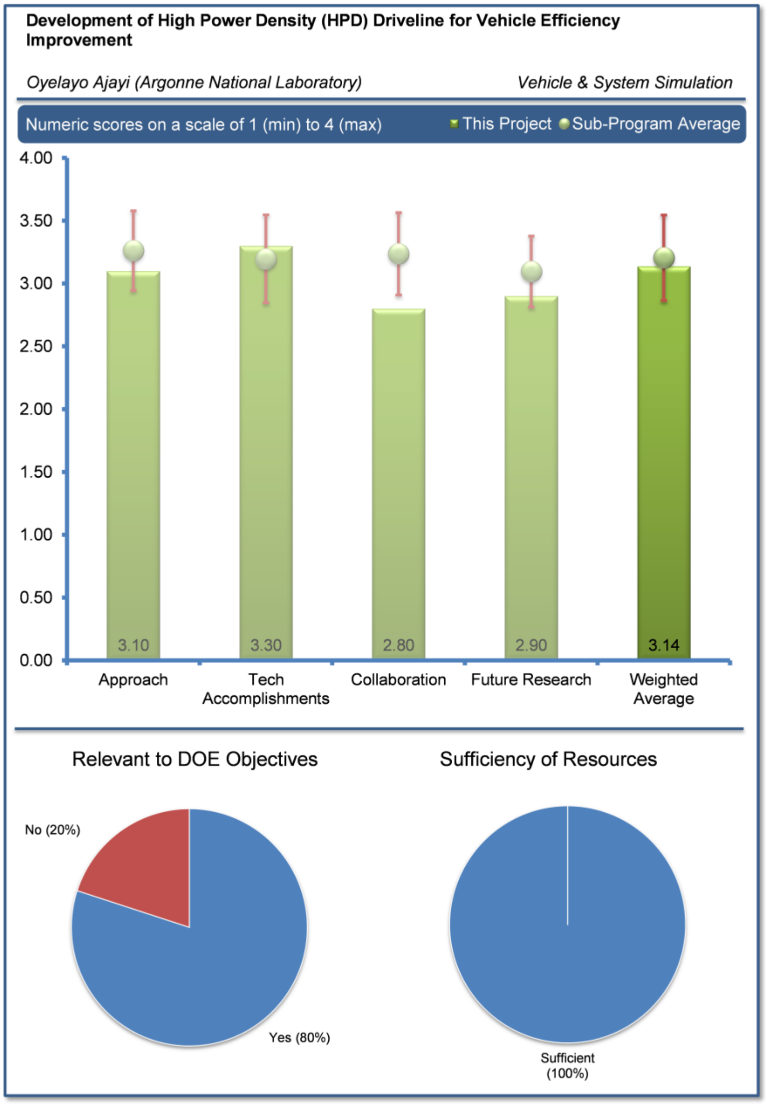
Reviewer 2:

The reviewer got the impression from talking with the presenter that, except for the laboratory, this project is somewhat of a one-man-show. The reviewer suggested that perhaps that is why grid research appears to have not been given as much emphasis as the standards.

Reviewer 3:

The reviewer thought that, provided that similar funding levels are maintained, significant progress should be made.

Development of High Power Density (HPD) Driveline for Vehicle Efficiency Improvement: Oyelayo Ajayi (Argonne National Laboratory) - vss058



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer perceived that this is an important problem; reducing vehicle weight is a key problem that needs a solution.

Reviewer 2:

The reviewer found the approach to be sound, with results to date for support. The reviewer would have liked to see more background material on the 2X and 3X life increase criteria and determination. Contact fatigue seems to be the largest hurdle (3X life increase), yet was left to be tested last.

Reviewer 3:

The reviewer relayed that the program seeks to achieve weight reduction by removing tribological barriers by applying novel materials, coatings and lubricants to driveline gears. Estimated savings to achieve 3-4% vehicle weight reduction and 2-3% fuel consumption reduction are large enough to warrant the program. The reviewer also reported that the program also rightly focuses on a systems approach in finding an optimal mix of coatings and lubricant. The research activities focus on tribological theory which is rightly the focus. That said, this reviewer believed the program would benefit from including an application component to the theory by showing how they would apply to transmissions and axles.

Reviewer 4:

The reviewer reported that the approach was to look at scuff and wear, and is appropriate. However, the reviewer sensed that, because the transmission is a collection of gears, claims on reduction of weight should be balanced on the basic fact that transmissions are sized based on first and reverse gears.

Reviewer 5:

The reviewer said the approach seemed too far separated from the objective of achieving a significant vehicle weight reduction. The reviewer would rather see the objectives and approach stated in a way that the surface treatments and lubricant development are stated more prominently. The reviewer would imagine that there are some very notable goals well short of making a lightweight gear box. As a viewer in the audience noted, this study is ignoring the bending moment and noise requirements that are likely to arise during the lightweighting efforts.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed an impressive PI, and remarked good research plan. The reviewer quoted the PI as saying that the "easy part is done -- the hard work is to come." According to the reviewer, this demonstrates the fact the PI does understand problem. The reviewer concluded excellent progress of this team.

Reviewer 2:

The reviewer noted the rapid development of a novel lubricant formulation which shows promise to meeting the project objectives is outstanding.

While the initial results are encouraging to the reviewer, the often contradictory nature of wear life versus scuffing life versus contract fatigue life lends to some concern over the final contact fatigue results.

Reviewer 3:

The reviewer stated that there appeared to be good progress made in lubricant development, which led to a patent pending formulation that improved scuff resistance.

Reviewer 4:

The reviewer reported the ANL P.F. lubricant showed amazing improvements in scuffing life, which is impressive. It was not clear if there is some other trade-off not presented that the commercially available lubricants address that the ANL P.F. does not. The reviewer said it seemed as if only half of the story is available.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer reported that the collaboration that existed appears to be well-coordinated and a large contributor to the overall project success. The reviewer was a bit unclear regarding the level of involvement each of the collaborators provided. Ideally, the reviewer would have liked to see more collaboration with gearbox manufacturers.

Reviewer 2:

The reviewer asserted that the project does identify a lubrication additive partner; however, there could be a stronger collaboration with automotive component manufacturers to get input on the coating & materials portion of the project.

Reviewer 3:

The reviewer asked where the big lubrication suppliers were (e.g., Exxon-Mobil). The reviewer emphatically stated that gear manufacturers should be interested in the great research.

Reviewer 4:

There are only three HD transmission manufacturers in the United States (i.e., Caterpillar, Allison, and Eaton). The reviewer would like to have seen at least one of these companies as a partner in this investigation.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer was very excited that a 60% reduction in friction was achieved, and thought it was excellent work. The reviewer went on to exhort that the future work plan is impressive, but needs cost data and materials research, as new alloys are coming.

Reviewer 2:
The reviewer believed that the remaining barriers are well laid-out and the proposed future work indicates the overall goals. The reviewer would have liked a better understanding of the methodology that will be used to evaluate contact fatigue and how the other failure modes will be avoided during evaluation.

Reviewer 3:
Moving forward, the reviewer would have liked to see the PI actively work to push the formulation into production via the formulation partner. Also, the reviewer recommended acquiring driveline components for in situ testing purposes.

Reviewer 4:
The reviewer found the future work plan and the path forward to meet the project objectives to be unclear.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said this work is very important – reduced weight and improved fuel economy is the promise of this research. The only negative this reviewer pointed out was the need for more collaborators.

Reviewer 2:
The reviewer concluded that improvements in scuff and wear factors will lead directly to transmission and axle efficiency increases and ultimately lead to fuel economy improvements.

Reviewer 3:
The reviewer stated the project is a supporting weight reduction which in turn results in petroleum displacement. The authors did a good job of outlining why increased lubrication is necessary for increased power density.

The reviewer asserted that, while the project outcome itself does not directly result in weight reduction of the vehicle power train, it is a necessary catalyst in the overall process.

Reviewer 4:
The reviewer said that, yes, improving tribological properties in axles and transmissions have the potential to displace petroleum. This project takes a different approach by looking at technologies which enable the design of smaller, more lightweight components, which is novel. The reviewer remarked that other similar programs in tribology tend to focus on friction reduction.

Reviewer 5:
The reviewer indicated the project is not currently demonstrating any petroleum displacement results.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

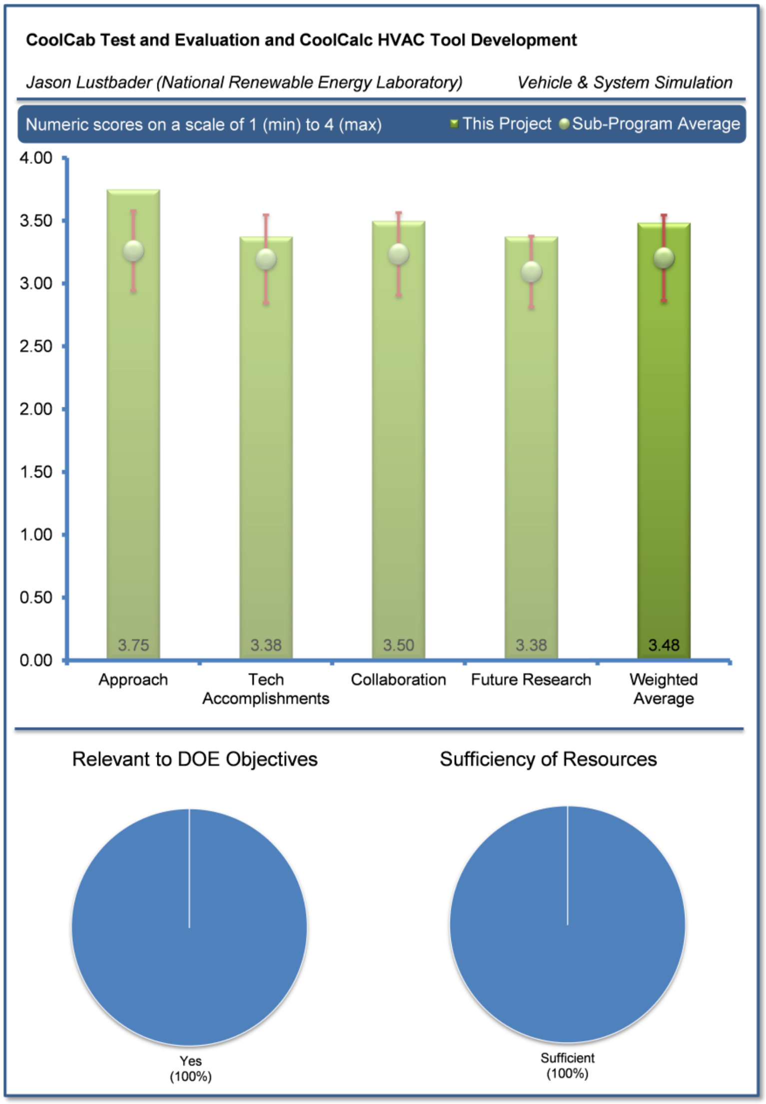
Reviewer 1:
The reviewer noted good progress, and believed resources appeared to be sufficient.

Reviewer 2:
The reviewer said resources appeared sufficient.

Reviewer 3:
The reviewer concluded that the resources were well defined, necessary, and properly utilized.

Reviewer 4:
The reviewer concluded that the resources appeared to be sufficient.

CoolCab Test and Evaluation and CoolCalc HVAC Tool Development: Jason Lustbader (National Renewable Energy Laboratory) - vss075



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer stated this was an excellent research plan and that there was a highly qualified PI. The reviewer had been following this project for a number of years, and had been impressed with the progress so far. The reviewer cited new regulation requirements for idle reduction.

Reviewer 2:

The reviewer commended the excellent bottom-up approach, focusing on reducing the HVAC need rather than simply taking the current requirements as a given.

Reviewer 3:

The reviewer thought that quantifying benefits and risks with fleets in mind was excellent. A 30% goal for system level approach means the project is methodical and understands how to keep the drivers comfortable. The reviewer thought the developed CoolCalc tool would be good for the future

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer recognized great accomplishments with clear contributions to addressing the project objectives.

Reviewer 2:

The reviewer stated that there were impressive accomplishments.

Reviewer 3:

The reviewer observed many strong accomplishments tied very closely to end-user needs. The reviewer thought this program was well matched to industry needs, even though the end users were not yet responding to the opportunities available here.

Reviewer 4:

The reviewer found that good progress appears to have been made in evaluating efficacy of various advanced technologies.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted excellent partners.

Reviewer 2:
The reviewer observed good links with OEMs that can use the research results.

Reviewer 3:
The reviewer said that, in general, there is no problem. However, it would be very helpful to use the knowledge base of the partner organizations to get a good estimate on fuel savings potential (refer to the last of the critical assumptions and issues).

The reviewer believed that quantifying the benefit and impact of the various advanced treatments and technologies is clearly very important, and with all the great progress that has been made in this project, it can be done easily and effectively over some assumed drive cycle. The reviewer suggested that what is perhaps needed more is to relate this to real world driving cycles, and the relationship with the partners should be leveraged here to quantify this better. It may even be beneficial to bring in some trucking companies as partners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer thought that the project had a well thought out research plan.

Reviewer 2:
The reviewer thought that the most important aspect of the project going into the future was to have very reliable fuel use and payback period analysis. In this reviewer's mind, this if anything would be the biggest carrot to persuade customers - trucking companies, which would then ask the truck manufacturers - to go for the upfront investment. The reviewer recommended that, in order to achieve this, the project probably needs to include trucking companies as partners.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that, yes, any design improvements to the cab that would result in heating load reductions would result in a reduction of fuel consumption.

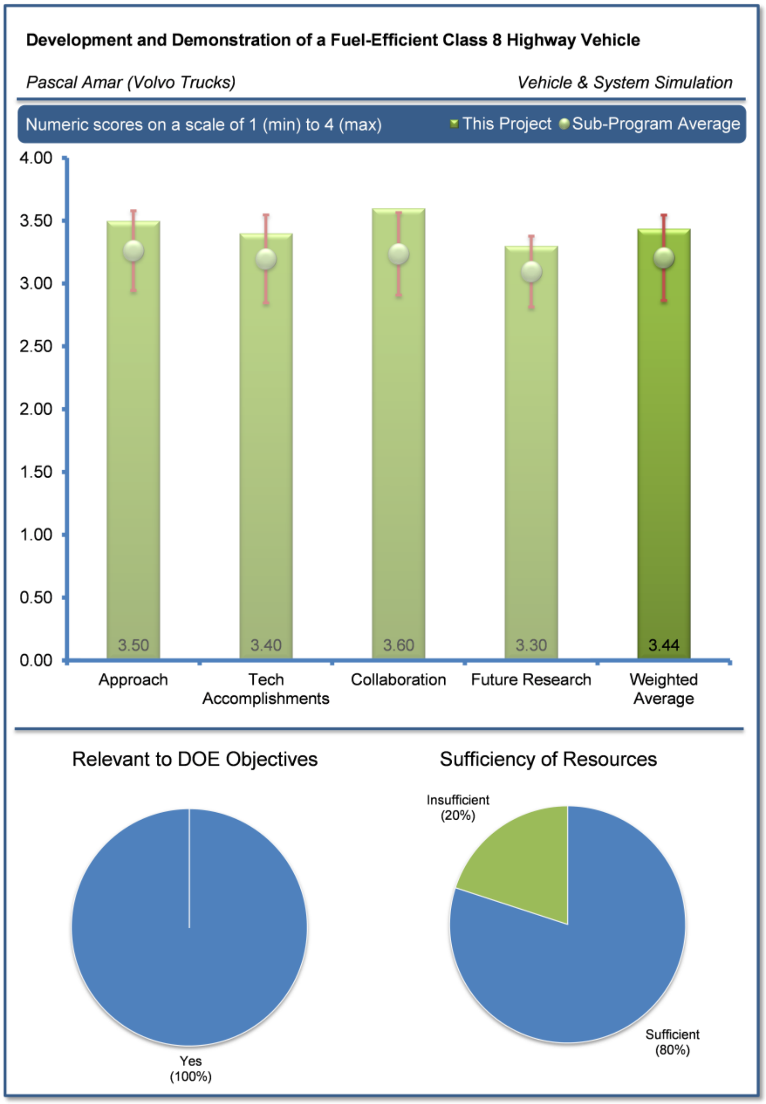
Reviewer 2:
The reviewer concluded that thermal management of the cab will reduce oversize units and will save energy. Knowing the load will improve sizing the battery.

Reviewer 3:
The reviewer emphasized really needing this help as movement progresses toward less idling for so many reasons.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer concluded that the project was definitely meeting expectations for accomplishments versus budget.

Development and Demonstration of a Fuel-Efficient Class 8 Highway Vehicle: Pascal Amar (Volvo Trucks) - vss081



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer cited great use of simulation techniques to refine the design before proceeding with hardware prototyping, and thought that the emphasis on integration efforts to make sure that the pieces of the puzzle fit nicely together was also great.

Reviewer 2:

The reviewer found this project to be very well managed, and the technical barriers were clearly managed with good engineering science. There are no fundamental technical issues with the approach, the results, the analysis, and the future development.

Reviewer 3:

The reviewer reported the overall project approach was presented as starting with a 2+ year period of concept selection (baseline testing, modeling and evaluation) followed by development, integration and eventually testing in a demo truck. The previous year spanned the conclusion of the concept selection phase and into the initial stages of the development and refinement phase. The reviewer related that the presenter emphasized the importance of an integrated design approach--factoring together the interactions between effects such as driving demand, heat rejection, packaging and cooling needs. While no details were presented, the presenter also mentioned soliciting driver acceptance feedback for some of the more dramatic feature changes relative to a traditional truck, which to the presenter seemed like a good idea.

Reviewer 4:

The reviewer commented that technology selection was wrapping up in this phase and starting to be integrated into a full vehicle design, and that the project had finished a first workable prototype and tested it. The reviewer questioned if it was designed for real operating conditions, and how those were changing. The reviewer thought Slide 5 to be a very good simple view of how the energy is used in baseline versus SuperTruck; need less power for instance. The reviewer further relayed that Volvo continues to have a strong end customer buying into their designs, which optimized as well as limited the challenges for fleets to buy, and also ran dynamometer and field testing.

Reviewer 5:

The reviewer said that it seemed that the tractor front shape and hood must be raised in order to accommodate the device associated with WHR, which is a major change on the truck. It is shown that WHR may not be in an optimal design. The reviewer recommended that a technology list slide or table should be used to describe what are being used in the program. Without this list, it was not clear how the program goal is to be achieved.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented on the excellent path to first prototype, and how the project made selections quickly, tested 16 configurations, exceeded first target of 41% by 2%, and is going now to downsize to 11L from 13L. The reviewer wondered what material will be used for ultra-light frame assembly - 45% lighter aluminum for now!

Reviewer 2:

The reviewer thought that a 43% improvement in a vehicle was excellent considering that the program got started late compared to its competitor. The reviewer also suggested that it would be helpful to show the route used for this program, since without this, it could be misleading.

Reviewer 3:

The reviewer reported that the work seemed to be proceeding and progress was being made, but presentation lacked details on all aspects. For instance, testing does not specify the nature of those tests or their duration, therefore it is difficult to assess whether results are meaningful.

Reviewer 4:

The reviewer reported that accomplishments included chassis dyno and on-road testing of the Phase I concept configuration(s), and achieving both fuel economy and freight efficiency improvements that approached the eventual 50% goal. As a result, the project team is expecting to significantly surpass this goal by the end of the project. The reviewer relayed that considerable progress has been made on the individual factor goals as well--such as achieving a 30% aerodynamic drag reduction (relative to the eventual target reduction of at least 40%), an improvement in engine brake thermal efficiency to 48% (relative to the eventual 50% target), and achieving over 40% weight reduction with a custom aluminum frame rail assembly.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that good collaboration is obvious and cited frame rail collaboration with Metalsa as a good example.

Reviewer 2:

The reviewer reported that a number of collaboration partners appear to be actively involved in the project.

Reviewer 3:

The reviewer concluded that the project utilizes many other companies to work on the program.

Reviewer 4:

The reviewer said that there seem to be fewer partners and suppliers than other SuperTruck projects, and wondered if more partnerships (and therefore freight efficiency improvements) could be leveraged from Volvo suppliers

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer believed that although future work is not very detailed, it seems to have the right components.

Reviewer 2:
The reviewer noted that the emphasis for the future work in the next year of the project is on building the demonstrator truck. The future work discussion did not go into detail on the testing plan, but hopefully the team will be able to achieve the high efficiency improvement levels anticipated (and will be able to place some uncertainty bounds around the numbers). The reviewer is hopeful the team will also be able to show that technologies which have been developed and advanced through the project will be making their way into a production program.

Reviewer 3:
The reviewer indicated a future final demonstrator.

Reviewer 4:
The reviewer stated the future work shown in Slide 14 displayed the road map of how the final vehicle was assembled.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer hoped this would be a huge opportunity for major U.S. fuel and emissions savings.

Reviewer 2:
The reviewer concluded that improvement of freight efficiency is a clear indication of supporting the overall DOE objectives of petroleum displacement.

Reviewer 3:
The reviewer believed the project certainly supported DOE's petroleum displacement objectives.

Reviewer 4:
The reviewer pointed out that this project currently achieves a 43% freight efficiency improvement with more improvements yet to be made. All those new technologies developed on SuperTruck projects are the way to go to displace petroleum.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

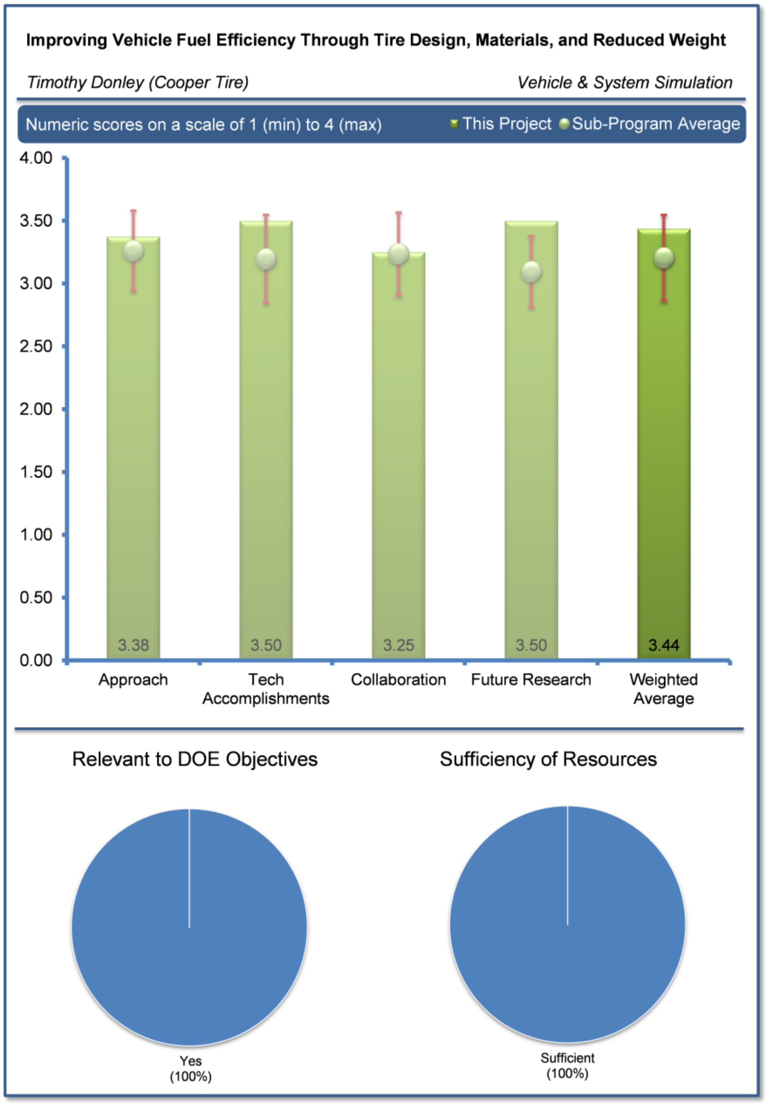
Reviewer 1:
The reviewer concluded that with only a 20 minute presentation and limited details it is difficult to make an informed statement about the sufficiency of the project resources. However, it did seem noteworthy to the reviewer that the Volvo team is expecting to surpass the SuperTruck program targets with a budget roughly half the size of some of the other teams.

Reviewer 2:
The reviewer stated that this project is getting a lot done for half the money of the other teams.

Reviewer 3:
The reviewer pointed out that the funding level is much less that its competitor.

Reviewer 4:
The reviewer observed that the resources involved on this project were not detailed in the presentation.

Improving Vehicle Fuel Efficiency Through Tire Design, Materials, and Reduced Weight: Timothy Donley (Cooper Tire) - vss083



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewer 1:

The reviewer believed that the project approach to investigate several technologies at one time is ambitious but reasonable. However, the reviewer cautioned that at this phase of the project the project should concentrate on developing and combing the successful technologies to have a product that can be commercialized. The reviewer pointed out that the approach for reducing the tread depth should be considered because it can effect on road safety.

Reviewer 2:

The reviewer believed this project effectively addresses the barriers to this topic.

Reviewer 3:

The reviewer observed that the project has pursued several paths for developing tires with reduced rolling resistance and tire mass, both of which impact fuel consumption during use. Reducing the mass of the tire also has the potential to reduce manufacturing costs and energy use. The reviewer reported that several technologies were evaluated individually to quantify the effects on rolling resistance in addition to wear and traction, and appropriate considerations have been made to ensure that overall performance will be satisfactory in key areas of consumer expectations. Plans to combine the technologies are appropriate and it is reasonable to expect that the technology combinations will provide very good results. The reviewer recognized that appropriate go/no-go decisions were included in the project plan and the path forward used relevant performance metrics to assess the viability of each technology. Some of the technologies did not meet all performance targets and were eliminated from consideration, which indicates that challenging targets were set and higher risk approaches were included in the project plan. The reviewer stated that, nonetheless, other options have proven to be successful, and the project approach has included a good balance of stretch objectives and more moderate technology approaches. The reviewer believed the costs of the technologies were not clearly discussed in the presentation, however, and it is not clear that the set of technologies pursued can be manufactured at a cost that is commercially acceptable.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer found that progress has been clearly defined, and noted that it was useful to identify the design/material features which contributed to the weight reduction/fuel savings and those that were not pursued due to high technical risk.

Reviewer 2:

The reviewer said the project has achieved progress in 50% of the proposed technologies. In addition, it showed that successful technologies when combined can achieve the DOE goals.

Reviewer 3:

The reviewer observed that multiple material evaluations and tire builds have been completed. The technologies evaluated show very high potential for providing significant rolling resistance reductions. The reviewer reported that tire testing using industry-accepted test procedures have demonstrated the rolling resistance and mass benefits of the constructed tires. The magnitude of fuel savings expected from a change in rolling resistance was stated verbally during the presentation and is believed to be reasonable, and a realistic target was established for the rolling resistance improvement needed to achieve at least 3% fuel savings. The reviewer stated that test results were presented relative to the performance of a reference tire, but its rolling resistance was not compared to that of the overall Cooper Tire product line. Therefore, it is not clear if the approximately 30% reduction in rolling resistance that is targeted represents an improvement that will yield 3% better fuel economy than the average tire. The reviewer found that more clarification of the benefits relative to an average tire from Cooper Tire's product offerings would be helpful.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer found the collaborations presented indicate a positive relationship with suppliers, and some research was conducted with the national laboratory, although it seems that the collaboration with NREL did not result in significant benefits to the project. Details of a "project team" environment among the partners were not provided, so it is not possible to assess the degree of coordination among the partners on the project.

Reviewer 2:

The reviewer concluded that the project could benefit from more collaboration with companies, research institutes, or labs specializing in advanced materials development.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer believed that the Phase 2 Tire Program proposed which combines the technologies was a good approach.

Reviewer 2:

The reviewer observed the proposed future approach for combining the successful technologies and also further perform a limited testing of the unsuccessful technologies is most logical.

Reviewer 3:

The reviewer commented that future research addresses strengths and challenges from prior work. This reviewer believes that the selection of research to continue is very relevant and will advance the project goals. The planned tire builds seem to have a very high probability of yielding a tire design that fully satisfies the targets for the project, and additional research activities will address other potential improvements in material hysteresis.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reported that the results thus far indicated that the DOE objectives were being met.

Reviewer 2:

The reviewer indicated that project goals for tire rolling resistance reduction can be achieved, and assuming that the tires can be produced and are commercially successful, it can be expected to result in fuel savings of several percent.

Reviewer 3:

The reviewer said the program showed that tire rolling resistance reduction can be achieved by combing the developed technologies that showed positive results.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

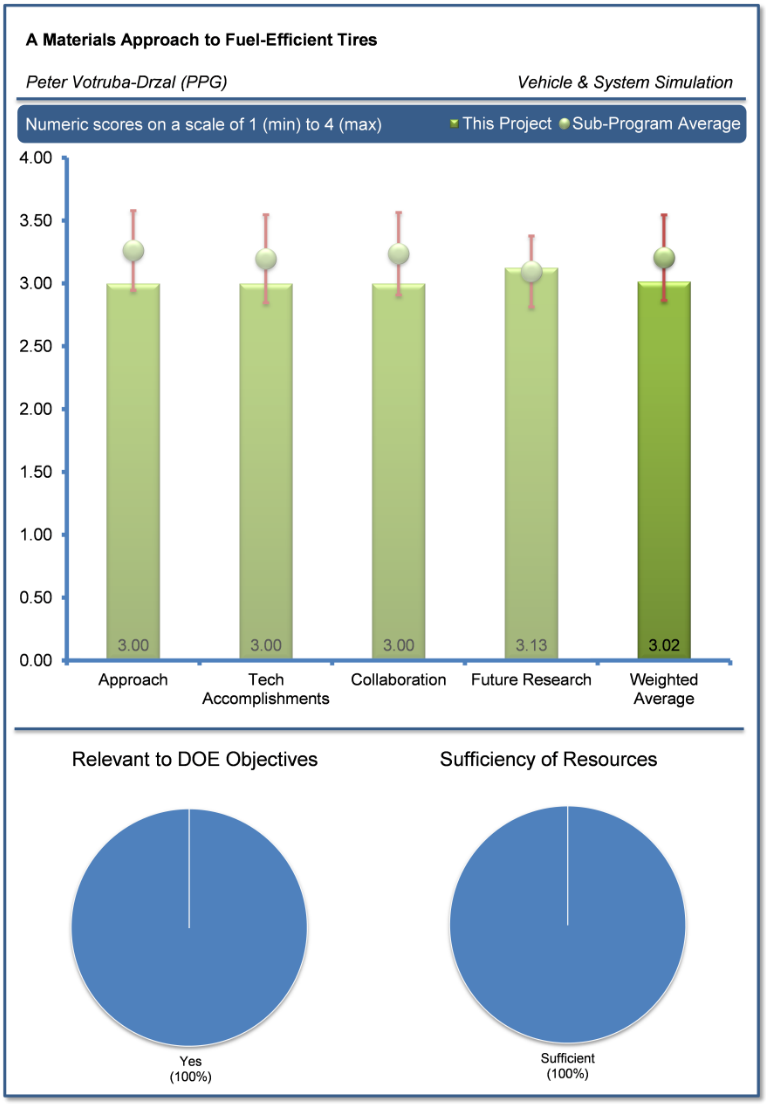
Reviewer 1:

The reviewer believed the resources budgeted for the project, including those provided by the company, to be appropriate for the materials development, tire builds and testing that have been conducted and are planned.

Reviewer 2:

The reviewer judged that the project has sufficient funding resources to achieve the needed results.

A Materials Approach to Fuel-Efficient Tires: Peter Votruba-Drzal (PPG Industries) - vss084



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that this project has two material approaches (tire barrier coating and tire filler) that address reducing fuel consumption.

Reviewer 2:

The reviewer said of the filler approach that it is the most promising technology for tire rolling resistance improvement but needs to accelerate development by performing tire tests soon. The reviewer indicated that the coating approach needs to address manufacturing issues in this stage of the project.

Reviewer 3:

The reviewer reported that the technical tasks for material development appear to have been successfully executed, but activities to demonstrate an improvement in the rolling resistance in the tire have been rather limited and plans to evaluate tires occur only very late in the project. The reviewer thought that earlier and better integration with the project partner Goodyear would have been prudent to prove out positive results using tire road wheel and on-road testing as opposed to exclusive laboratory-based material evaluations and assessment of barrier coating adhesion.

The reviewer pointed out that potential processing issues for modified silica with Goodyear formulations were identified as a risk, yet this has not been evaluated with the project over 80% completed. Similarly, the strategy outlined for filler development indicates a goal of "improved tread wear with equal (or better) rolling resistance." The reviewer presumed that the rolling resistance improvement is the primary objective of the project and will be achieved by using a reduced tread depth tire design, and with improved wear of the material and constant hysteresis, a reduction in tire rolling resistance could be expected with similar tire wear performance. The tradeoffs between rolling resistance and wear performance in a tire are rather complex, and an evaluation with actual tires is necessary to evaluate the overall performance. As the reviewer stated above, not performing these evaluations with actual tire testing earlier in the project leaves little room for follow-up development if the results are not as expected.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed significant progress in the fillers and coatings technologies. However, manufacturing issues may not result in the commercialization of a product.

Reviewer 2:
The reviewer said that it would be useful to have the milestones for the two technology approaches (tire filler and tire barrier) separated into two charts or more clearly defined for clarity of the project. The reviewer said that it seemed that the testing of the barrier technology is further along versus the testing of the filler material, but the milestone charts does not separate testing between the two approaches.

Reviewer 3:
The reviewer found that slides for Technical Accomplishments and Progress made on fillers do not highlight specific improvements made for tire rolling resistance. The data presented appears very similar to that shown in 2013, and advancement in overcoming technical barriers is not clear. Again, there is no evidence of collaboration with tire manufacturer to quantify the benefits in actual tires. The reviewer commented that evaluations of the inner layer show reasonable results for adhesion and oxygen (O_2) retention performance in the laboratory. A comparison with 2013 results does not clearly show improvements made in O_2 transmission rate performance, however.

The reviewer observed that items listed under Proposed Future Work from the 2013 AMR presentation were not addressed systematically, and it was unclear for several aspects of those tasks as to what specific barriers had been resolved with research conducted during the past year. Some results from research were shown, but the reviewer found that a clear presentation of specific advancements made addressing the barriers of the project is lacking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed good collaboration with a tire manufacturer and a research institute that specialize in advanced materials research.

Reviewer 2:
The reviewer concluded that collaboration with Goodyear and North Dakota State University were well defined.

Reviewer 3:
The information presented indicated that Goodyear, acting as a subcontractor for the project, had very little activity for the work completed to date other than providing some tires for evaluation and some limited information. The tire manufacturer participation was critical for building tires and evaluating their performance at multiple stages of material development, but this had been left out until the very end of the project. Goodyear's participation "Working in an advisory role" is not sufficient to ensure project success, and there is no evidence that this role had influenced the project direction significantly. This is a very significant weakness in the project.

The reviewer remarked that the collaboration with North Dakota State University for synthesis of soybean oil-based materials was mentioned nowhere else in the presentation. It is apparent that there were no active collaboration and coordination of activities during the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer pointed out that key metrics for filler technology does not list rolling resistance. The reviewer was unclear if rolling resistance testing will be conducted for filler technology evaluation or if only being evaluated for material properties at the compound level.

Reviewer 2:
The reviewer commented that the basis for decisions and future directions to be pursued using go/no-go evaluations is not evident in the proposed future work, and a complete set of individual tasks to be completed is not clearly provided. Instead, rather general descriptions are given. The reviewer identified evaluation of the materials in a tire build as a clear need, and there are plans to do so at least for the coatings. The reviewer said that stated plans for fillers list key metrics for materials processing and further material property evaluations,

but tire testing is not clearly indicated. It was unclear to the reviewer that there will be a final measurement to characterize the rolling resistance improvement achieved as a result of the research performed.

Reviewer 3:

The reviewer suggested that the filler future approach needs to provide more details on testing tires. This reviewer further commented that the future coatings approach has identified future risk areas and how to manage them.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer remarked that the project's material approach is most promising for improving tire fuel efficiency and should support the DOE objectives.

Reviewer 2:

The reviewer commented that both technologies would contribute to the objective of reduction in fuel consumption.

Reviewer 3:

The reviewer said that the research addresses DOE objectives of petroleum displacement through improvements in tire rolling resistance, which has a direct impact on the fuel consumed by vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

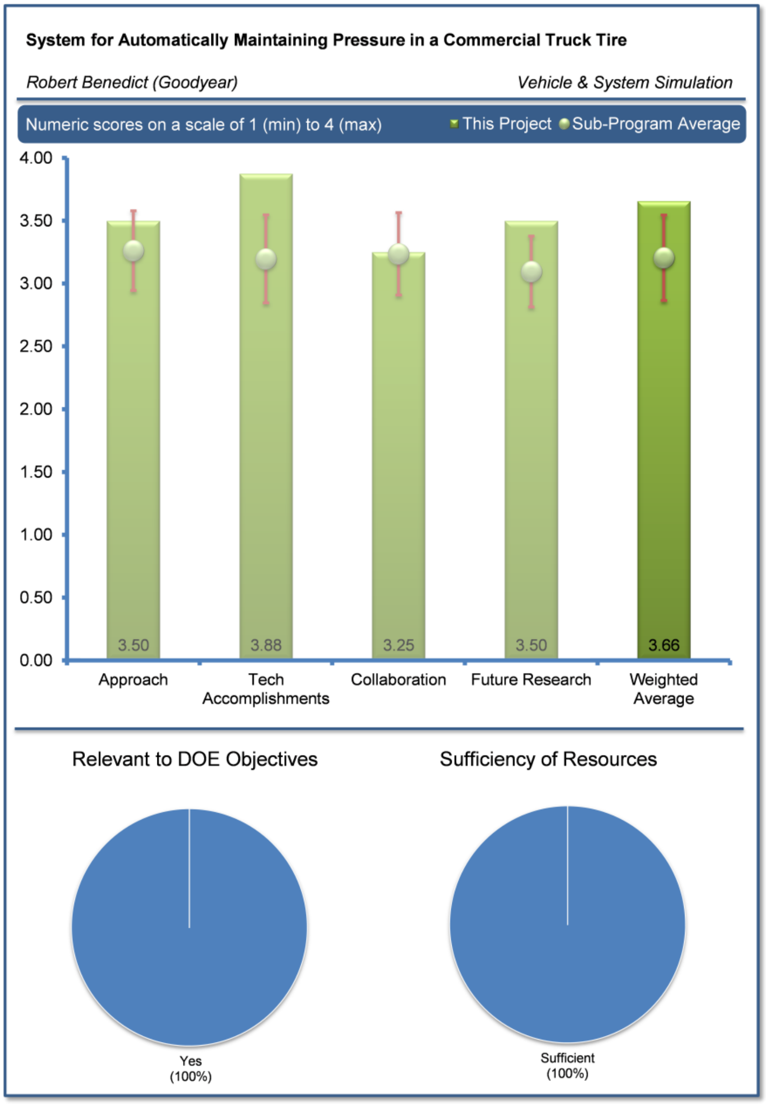
Reviewer 1:

The reviewer said that resources appeared to be adequate to perform the work planned for the project.

Reviewer 2:

The reviewer found that the project has sufficient resources.

System for Automatically Maintaining Pressure in a Commercial Truck Tire: Robert Benedict (Goodyear) - vss085



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer complimented that this project is very well managed, the progress is very clear, and the benefits are huge not only for fuel saving but for automotive safety as well.

Reviewer 2:

The reviewer noted that this project addresses objective of reducing fuel consumption through improvement to tire inflation maintenance.

Reviewer 3:

The reviewer remarked that barriers to development and implementation of the system have been well-identified and addressed using a systematic project approach. Commercial barriers have also been addressed through a survey with customers, and it appears there is significant interest in the product. The reviewer noted that cost information was not included as part of the survey, however, which could impact the final acceptance. Design improvements addressing size, weight and cost have been pursued effectively, and on-vehicle testing has been initiated. The reviewer concluded that overall, the project has been executed very well and is progressing favorably.

Reviewer 4:

The reviewer found that the project has a good approach by using a device that can automatically maintain air pressure for the life of the tire. Also, the device is contained within the tire casing with some changes to the tire structure that would not prevent tire retreading or repair.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer complimented that the project showed excellent progress in several areas, for example, design optimization, laboratory tests, passing DOT requirements, and significant vehicle testing.

Reviewer 2:

The reviewer said that optimization of the design and extensive testing conducted indicates good progress of this proposed concept.

Reviewer 3:

The reviewer said that testing of the inflation system using several test methods has been completed (and additional testing is continuing) to evaluate the performance and durability of the device. The project set appropriate performance targets and work focused on meeting these. The reviewer commented that the project team optimized and redesigned the system to overcome prior technical barriers and to address concerns for bead durability and other performance attributes of the inflation system. The research activities have been very proactive to develop a quality product and there is a clear attention to detail in the development. The reviewer noted that performance of the redesigned system, as measured in the laboratory, in a test fleet and at Goodyear Proving Grounds, has been very good. Endurance testing was identified as a barrier/critical need in previous developments, and Goodyear has addressed this directly with extensive testing.

Reviewer 4:

The reviewer said that the goals were successfully achieved.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that this project showed excellent collaboration with Eaton in the design process.

Reviewer 2:

The reviewer noted that Goodyear is the sole project participant, but the project team has worked closely with its suppliers (particularly with Eaton) to develop and thoroughly evaluate a quality product. It was apparent to the reviewer that the work to develop the regulator and other components of the system was conducted with very good coordination with the supplier.

Reviewer 3:

The reviewer acknowledged that there are good indicators of collaboration with parts manufacturers.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer detailed that future research plans include improvements in the manufacturing process, refinements to the system design, and continuation of long-term performance and durability testing, using both machine testing and on-road evaluations. The project will perform tire re-treading evaluations and conduct initial testing in a commercial vehicle fleet. The reviewer noted that evaluations and design iterations are very thorough and address all major technical barriers identified.

Reviewer 2:

The reviewer commented that the fuel consumption testing planned on vehicles with air maintenance technology (AMT) tires and without AMT tires is useful to quantify the benefits of the new technology. It was unclear to this reviewer whether this testing would include any conditions for the non-AMT tires to simulate under-inflation. The reviewer noted that rolling resistance and 180-day air retention testing is listed as part of the Technical Release Testing for 2014/2015. The reviewer recommended that it would be beneficial to have more information (timeline, details, and results if completed) for these tests to support project goals.

Reviewer 3:

The reviewer said that the project plan covers several tire development and evaluation points. Also, the project future showed that significant tests will be performed to assist in improving developed system performance.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer found that this project supports DOE objective of fuel reduction.

Reviewer 2:

The reviewer commented that the project would support DOE objectives by maintaining the tire air pressure, which can result in less fuel consumption and reduced wear, beside other benefits.

Reviewer 3:

The reviewer detailed that maintaining tire pressure at proper levels will result in improvements in rolling resistance, with a direct impact on reductions in fuel consumption. The impact on fuel efficiency was shown to be 2.4% for 20% tire under-inflation. The reviewer pointed out that it was not clear if a specific goal for fuel efficiency improvement was defined, but the overall benefit will clearly depend on specific fleet practices and the number of tires that are typically under-inflated. This reviewer is skeptical that 20% under-inflation is representative of a majority of tires in heavy-duty commercial trucking fleets, so the actual benefit may be considerably less than the 2.4% shown. Nonetheless, according to the reviewer, this technology can be expected to have a very positive impact on fuel efficiency, emissions, wear and tire durability. The benefits for reducing roadside breakdowns due to tire failures as described in the presentation has additional potential for reducing the petroleum consumption associated with tire production in addition to time and costs associated with loss of service.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

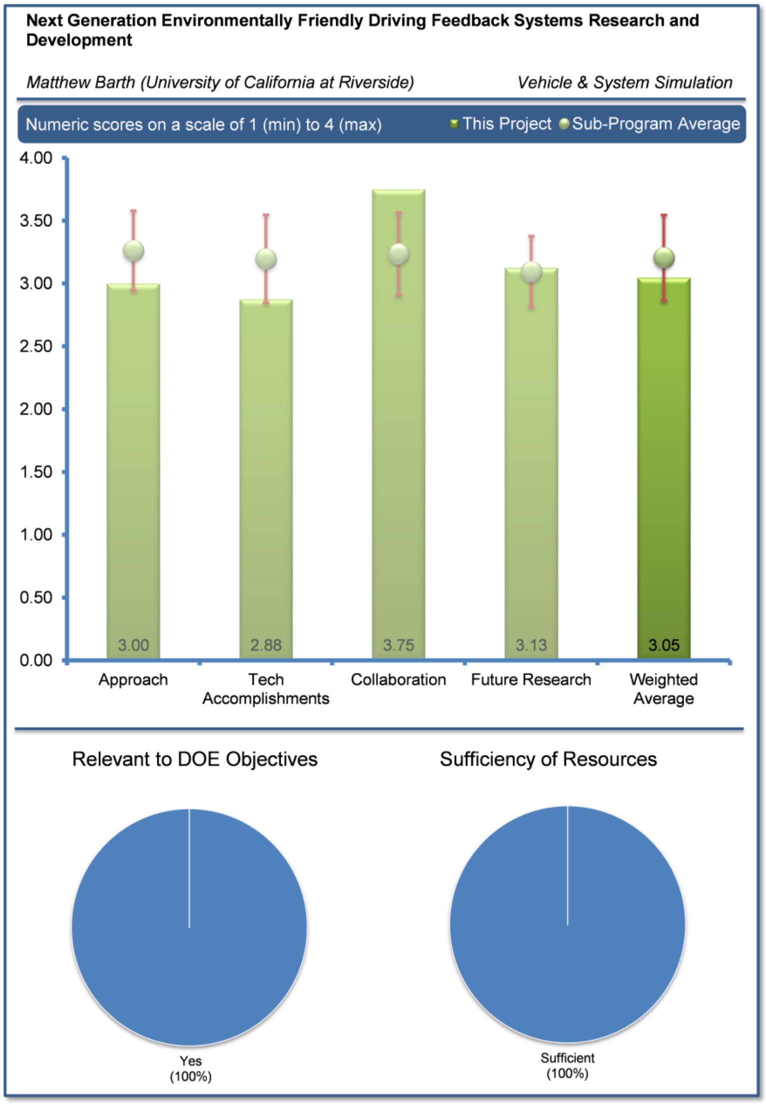
Reviewer 1:

The reviewer said that the resources for the project appear to be adequate and appropriate for the planned research.

Reviewer 2:

The reviewer found that this project has adequate funding.

Next Generation Environmentally Friendly Driving Feedback Systems Research and Development: Matthew Barth (University of California at Riverside) - vss086



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that the overall approach seems to have been sound, including trip scheduling, navigation, driver feedback and eco-scoring/ranking elements. Pertinent information, such as real-time traffic, seems to be included, and the team seems to have arranged for a good variety of test vehicles for the field operational test (FOT). The reviewer suggested that further validation of the fuel measurement approach would have been helpful, as the presenter referred to a separate study suggesting that CAN fuel measurement is within 3% of actual fuel use. The reviewer pointed out that this uncertainty level is above the greater than 2% fuel efficiency improvement goal, and it is unclear whether this comparison was made on the actual vehicle models planned for use in the FOT.

Reviewer 2:

The reviewer remarked that the presentation focused too much on the technology and data collection effort rather than the much more important aspects of the driver. Too little discussion was given to the human-machine interface, driver acceptance of the feedback mechanisms, whether the driver felt being pressured into driving unsafely (even when some of the feedback was merely advisory), and the issue of the control being taken away from the driver. The reviewer pointed out that although 11 experts were used for the system design, driver acceptance of the system should always be a final and ultimate goal. Driver acceptance of the system was not obtained nor was there a survey conducted of the drivers about their feelings about the system and the feedback provided. The reviewer strongly emphasized that another issue not discussed was driver selection – whether this was random. Even if not random, it would have been advantageous to the researchers if the drivers selected were among the worst in fuel economy.

The reviewer recommended that the project should have clarified whether the eco-routing navigation software was for passenger cars or for truck, and take into account height clearance, size and weight restrictions, and turning geometries. The reviewer recommended that the project should have also clarified whether the engine is idling for power take-off to operate lift equipment and if so, whether this type of legitimate idling is taken into account in the fuel economy for driving.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer wished the project had been able to integrate with the scheduling software used by Riverside. The reviewer understood why this was not possible.

Reviewer 2:
The reviewer pointed out that this study has a period of performance of three years, and that the study should be closer to 85% completed.

Reviewer 3:
The reviewer pointed out that the comparison to the baseline was not clear, given the 2% goal, and because of the uncertainty of data collected from the vehicles' engine control unit (ECUs), the benefits shown might not be within the statistical significance. The reviewer commented that the results might not be conclusive.

Reviewer 4:
The reviewer detailed that accomplishments in the past year seem to have included design of the eco-driving feedback system using a modular on-board diagnostics (OBD) plus Android human-machine interface (HMI), which should be easily replicable in a variety of vehicle settings The eco-score development seems to have been thoughtfully arranged so that custom weightings could be applied as best fits for different applications and so that drivers are not penalized for conditions out of their control. The reviewer said that it would have been helpful to hear more about the team's recommended process for developing customized weightings for the eco-score components. It seemed to the reviewer that it would be more appropriate to measure the speed component against the eco-advisory speed band (with a drop in the score when the driver deviates both above and below the band) rather than only when the driver exceeds the speed limit. The reviewer remarked that it would also be helpful to attempt to correlate the eco-score with fuel savings achieved and to adjust the score methodology accordingly to align it with the best efficiency that one could expect to achieve over a given cycle. For example, adjust the distribution band on the acceleration/deceleration score components, or credit the driver for minimizing any use of the brake pedal versus maximizing coasting/engine braking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged that there appears to have been extensive collaboration and coordination on this effort.

Reviewer 2:
The reviewer suggested that the investigators should have more control over selection of drivers among the collaborators. According to the reviewer, if driver selection was not intended to be random, the investigators could have taken the opportunity to select the worst drivers to get the maximum improvement in fuel economy performance.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that completion of the FOT and corresponding analysis are the remaining tasks for the project. The reviewer noted that in response to a question the presenter expressed a good plan for trying to control for factors such as increased air conditioning usage between the baseline, and experimental data collection periods of the FOT. This can be challenging, particularly for limited sample sizes, so it may or may not work out. The reviewer hopes that it does.

Reviewer 2:
The reviewer commented that there is no future research except completing the last module of the system, system integration, and field operations test.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

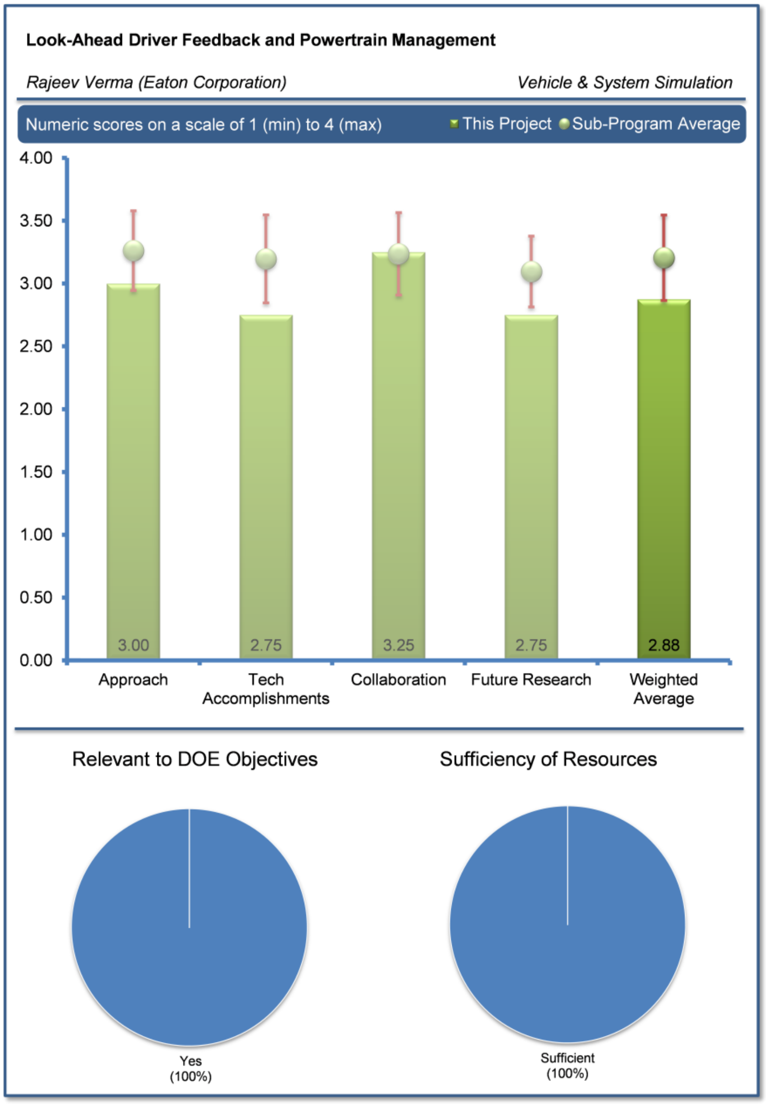
Reviewer 1:
The reviewer acknowledged that the project is directly relevant to displacing petroleum consumption.

Reviewer 2:
The reviewer commented that studies have shown that improving driver performance can improve fuel economy by as much as 17%

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Look-Ahead Driver Feedback and Powertrain Management: Rajeev Verma (Eaton Corporation) - vss087



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer thought the project had limitations from its original design, but within those limitations the approach has been correct and efficient. The reviewer said that the PI's have been consistent and true to the approach.

Reviewer 2:

The reviewer found that the overall flow of the approach is good, moving from evaluations with simulation tools to concept creation, prototype development/testing/refinement, and then deployment in a larger pilot test. The reviewer commented that the planned incorporation of some automated eco-assist features to remove some of the dependence on driver compliance also seems like a good idea. The reviewer thought that the details of the planned system evaluation following the pilot test were not very clear, particularly the planned use of Autonomie mentioned at the end of the presentation. The reviewer thought that it would be reasonable to use a simulation tool to evaluate the approach over cycles beyond those captured during the pilot test, but according to the reviewer it was not clear if that is the intent. If that is not the intent, then the reviewer suggested that clarification is needed on what additional insight is expected from the simulated versus measured results. If that is the intent, then the reviewer suggested clarification is needed on how the researchers plan to complete the non-trivial task of deriving second-by-second speed profiles representative of driving with the look-ahead system on versus off.

Reviewer 3:

The reviewer observed that the investigators did not properly present the baseline measures, and the benefits would be hard to quantify.

Reviewer 4:

The reviewer found that the presentation was too focused on the technology (i.e., Gen 1, Gen 2, and Gen 3, signal phase and timing, certification of modified TECU code, etc.) and data collection, and spent very little time on the much more essential issues, such as human-machine interface, driver selection, and how feedback was provided to the driver. The reviewer pointed out that after all, this is a study of improving driver's fuel economy performance, so the first and foremost focus should be on the driver. Most important, the reviewer noted that the baseline for each driver was omitted. The reviewer said that the investigator hardly described the baseline, so how can one compare improvement; the reviewer asked what fuel economy improvement would be compared to. The reviewer suggested that driver input (instead of the fleet manager) should have been solicited on human-machine interface as well as receipt of feedback on driving performance and taking away control of the vehicle. The reviewer noted that the driver input is much more important than getting approval from the fleet manager because the topic is improving driver performance, not fleet manager performance. The reviewer pointed out that it cannot be assumed that the driver accepts the system (stated on Slides 4-5 of the presentation). The reviewer strongly recommended that the driver must always be tested, or queried, for driver acceptance.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the team seems to have made good progress on evolving the prototype system and on demonstrating the strengths and limitations of the dedicated short-range communication (DSRC) component. The reviewer cited as an example that it does a good job estimating the distance to the next vehicle but that the signal needs to be improved in order to get more advanced information from RSE equipment at upcoming intersections. The reviewer said that the team has also integrated the system into a prototype vehicle and performed initial testing with Eaton employees, suggesting fuel economy improvement in the 1%-7% range. The presentation stated that 30,000 miles of pre-pilot data collection was planned on the instrumented trucks – the reviewer presumed that this will be the baseline and a comparable amount of data will be collected during the pilot with the system turned on.

Reviewer 2:

The reviewer wished the pilot test could have been completed prior to the AMR. However, the reviewer thought that the PI's are making good progress and are doing what the project team set out to do. The reviewer noted there were some delays, but overall well done.

Reviewer 3:

The reviewer pointed out that this project has a period of performance of three years ending in September 2014. The reviewer thought that the project should be about 85% done rather than 75% done. The reviewer believed that the pilot test should have been completed and the validated, and safety certification should have been completed. The reviewer commented that on Slide 14, it was not clear why an automobile is being shown for the driving simulator study. A truck simulator should have been used.

Reviewer 4:

The reviewer said that simulation results from the models could be presented to show possible benefits. There is no data to suggest that the claimed benefits will be within the specified range.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer found that there seems to have been good collaboration between several organizations.

Reviewer 2:

The reviewer believed that Con-Way fleet management approval should have been restricted. The reviewer believed that the driver approval is much more critical. Otherwise, collaboration with ORNL and University of Michigan Transportation Research Institute (UMTRI) are okay.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that future research is catching up with the schedule (i.e., completing Phase 3).

Reviewer 2:

The reviewer pointed out that completing the pilot test and analysis of the results seemed to be the main remaining items for future work. The reviewer noted that details were limited on the specific data analysis plan.

Reviewer 3:

The reviewer did not have a good sense for the overall commercial viability of this type of system. The reviewer would like to hear more about how the fleet managers involved in the upcoming pilot test regard this type of system and its potential. The reviewer thought that the research team was working well within the boundaries of the project.

Reviewer 4:

The reviewer said that proposed future work was discussed very briefly, but the next stage was not clear.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project is directly relevant to reducing petroleum consumption for vehicles on the road.

Reviewer 2:

The reviewer remarked yes, studies have shown that changing human driver performance can yield as much as a 17% improvement in fuel economy.

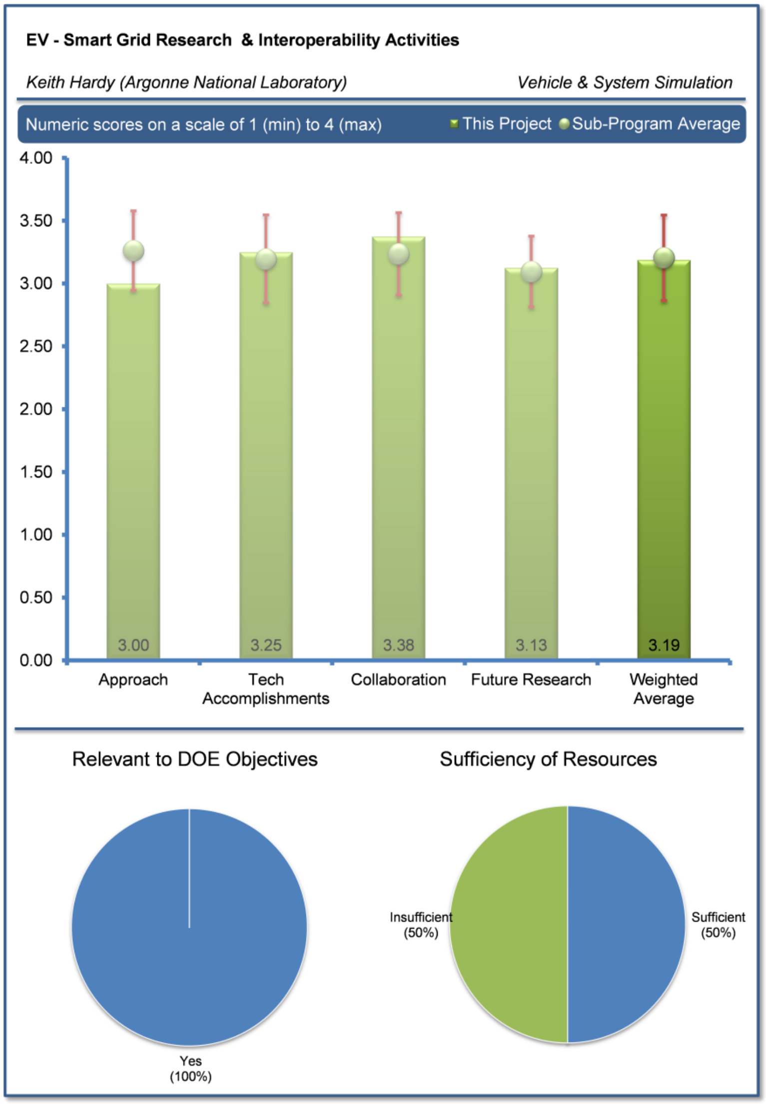
Reviewer 3:

The reviewer said that the project has been able to document reasonable expectation of petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

EV - Smart Grid Research & Interoperability Activities: Keith Hardy (Argonne National Laboratory) - vss095



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that the stated barriers are valid. There is considerable integration of activities. The reviewer remarked that the scope appears to be overly ambitious for the funding resources.

Reviewer 2:

The reviewer commented that the project team is integrated with the relevant standards committees and is leveraging and progressing existing standards to achieve goals. The reviewer observed that the standards committees are making good progress. The reviewer commented that the team has developed a capable lab to test the interoperability of many different permutations and combinations of electric vehicle supply equipment (EVSE) and PEVs.

Reviewer 3:

The reviewer said that the barriers are clearly difficult but it was not clear from the presentation how the overall approach addresses the barriers in an efficient manner. It was unclear to this reviewer how these efforts were coordinated with the many other similar efforts at other laboratories, companies, and universities. While the project team certainly works with other organizations, it was unclear to the reviewer how well these synergies work and how efficiently ANL uses funding provided.

Reviewer 4:

The reviewer remarked that it seems interoperability is quite important, but the problem needs to be clearly stated with an example. The reviewer inquired about the following: which standards/protocols differ the most between various OEMs and charger manufacturers; which ones matter the most; is it possible to get consensus on the ones that are most important; and how do these affect the actual performance. The reviewer perceived that working towards interoperability is a vague term and could use a better definition or explanation with a specific example.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that the project presented numerous tangible technical accomplishments.

Reviewer 2:

The reviewer remarked that getting the interoperability center built and operating is a big deal and goes well with SAE J2953 test procedure. The reviewer expected for the next AMR that there would be a listing of interoperability testing completed and plans for future vehicles and EVSEs. The reviewer recommended including a list of typical shortcomings and pitfalls (if applicable) for vehicle builders and EVSE suppliers that result in interoperability issues. The reviewer was unsure if the listing would be appropriate to be included in the standards document or not.

Reviewer 3:

The reviewer said that it seems progress is being made with the excellent laboratory capability. However, it was unclear to the reviewer if any testing was done with high power charging, simulating grid behavior, etc. Even with one sample set of standards in place, it would be helpful to see test results and outcomes.

Reviewer 4:

Given the importance of this metric, the reviewer would have assumed the presenters would have spent much more time clearly presenting their accomplishments. It was clear from the presentation that the project team is busy but it was not so clear how the team is progressing towards goals and overcoming barriers. The reviewer said there is no doubt that setting standards is slow and complicated, but the project team should still be able to quantify progress more clearly.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer acknowledged much collaboration globally with China and Europe regarding harmonization of standards. The reviewer recognized that this is going to be very hard to achieve given that some parties see an advantage to being different as a way of protecting their market or market-share. Regarding Grid Connectivity, the reviewer observed a good mix of vehicle OEMs, EVSE suppliers, utilities, and standards groups.

Reviewer 2:

The reviewer found that collaboration was very clearly stated and highlighted. The task of making common standards required collaboration and it seemed like this was happening.

Reviewer 3:

The reviewer said that it was clear that the project team works with other organizations, but it was not at all clear how well that works. The reviewer expressed confidence that ANL is well thought of and effective, but again the presentation did not give any metrics about effectiveness.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the future work proposed covers a continued and broad array of activity that includes further work on standards development, grid connectivity (V2G, V2I, V2V), compliance testing, interoperability testing, and reporting. The reviewer said that given all of the activity, it seems that the funding is inadequate. The reviewer wondered if perhaps a greater degree of in-kind funding should be accounted for (unofficial if required).

Reviewer 2:

The reviewer found that the path outlined seemed good, but the reviewer would highlight conducting tests that highlight which standards are important or matter the most. This is the only way to push the envelope and make progress (or obtain consensus) faster.

Reviewer 3:

The reviewer found that the future work had low information content regarding future standards development schedule. The reviewer would like to know how future work maps to community consensus priorities such as the American National Standards Institute (ANSI) Roadmap 2.0.

Reviewer 4:

The reviewer said that proposed future research has a strong flavor of more of the same; trust us and we will do good things. For this reviewer, it was hard to see what is new and what critical metrics are being used to measure progress toward barriers and goals.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that if done well, it will get more chargers in the field for vehicle electrification.

Reviewer 2:

The reviewer said that the standards issues, particularly regarding integrating with the grid, is a critical market barrier that takes a long time and a lot of work to address. This person further noted that it is hard to be patient with standards definition organizations (SDOs), but it is what it is, and for DOE to be effective here, the commitment has to be solid.

Reviewer 3:

The reviewer said that electrification directly attacks dependency on petroleum and carbon emissions. The project team's activities directly affect the rate and potential for adoption of electrified vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer referenced a comment made in question four. It seemed to this reviewer that the funding was not adequate to achieve all of the stated goals.

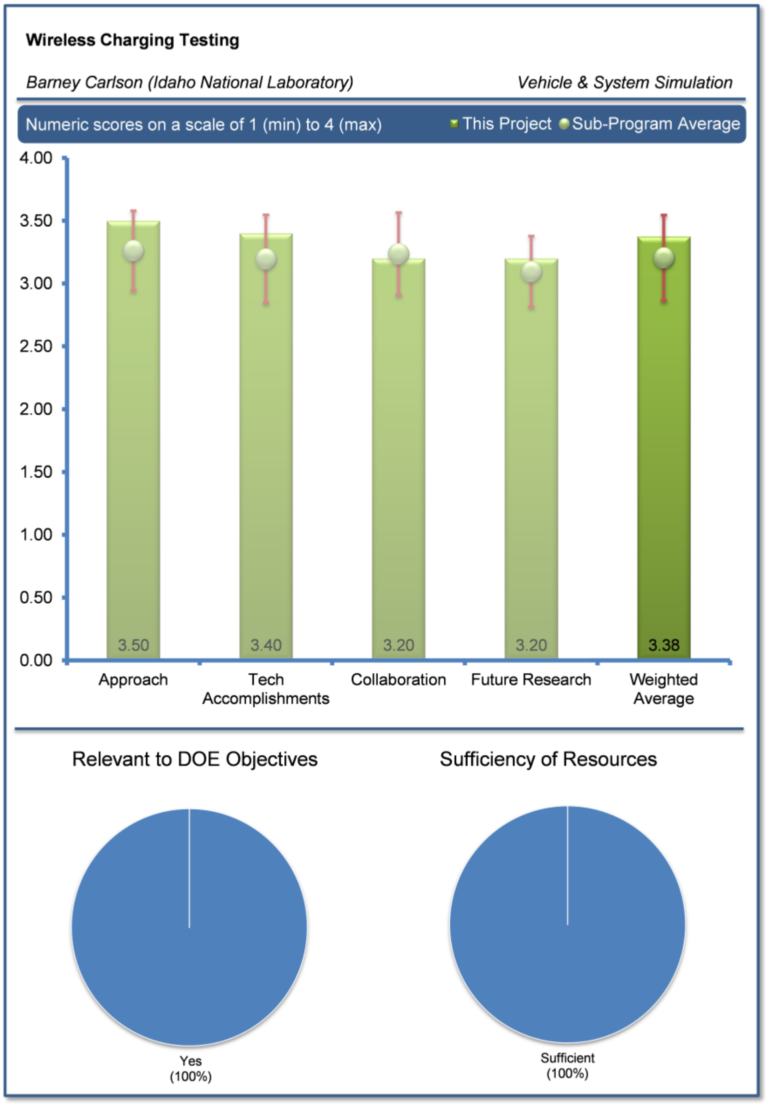
Reviewer 2:

The reviewer acknowledged that it was hard to tell for sure from such a short presentation, but the reviewer's sense was that either the scope was too large for the resources or the resources were too low for the scope. The reviewer said that like many similar laboratory programs, there is a large cost in ongoing basic support to fund engaging the industry.

Reviewer 3:

The reviewer said that the project may want to narrow its scope to match funding.

Wireless Charging Testing: Barney Carlson (Idaho National Laboratory) - vss096



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that given the emerging nature of the subject area, the approach was excellent in quantifying system performance.

Reviewer 2:

The reviewer applauded excellent approach, and commented very methodical in building the test apparatus, the design of experiments, and presentation of data.

Reviewer 3:

The reviewer observed a good approach to the work. The reviewer noted new work on Debris Tolerance and System Response. The reviewer also observed an interesting summary on Efficiency Results (at 3.3 kW output with 100mm gap).

Reviewer 4:

The reviewer commented that the layout of the wireless charging test rig created a very controlled environment for systems evaluation, and then the testing moved to greater levels of fidelity to an actual vehicle system test. The reviewer acknowledged that this allowed for isolation of system, vehicle, and foreign object effects.

Reviewer 5:

The reviewer commented that a high-quality test facility for wireless charger testing had been completed. It does and will continue to provide useful data on wireless charging efficiency.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the wireless charging evaluation facility was completed, and seems to be producing useful data. The reviewer said no major issues in this area, and progress seemed very good.

Reviewer 2:

The reviewer complimented excellent progress in establishing test procedures and testing available equipment.

Reviewer 3:
The reviewer said excellent progress to date in developing the test set-up for wireless changing system and evaluation of the Evatran wireless charging system with the Chevrolet Volt.

Reviewer 4:
The reviewer commented that the researchers completed the testing of Evatran's PLUGLESS wireless charger in coordination with the Apollo Demonstration Program. The commenter also noted that the INL charger test facility was established.

Reviewer 5:
The reviewer found that the targets for wireless charge transfer efficiency seemed adequate. However, the reviewer recommended that targets needed to be specified over a range of output DC bus voltage. Measuring efficiency at a fixed bus voltage was not as informative as listing the complete charge efficiency over the entire SOC window for the battery. The reviewer requested that the project please incorporate this into the targets and experimental plan.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that appropriate partners were established with excellent communication.

Reviewer 2:
The reviewer acknowledged that the project clearly demonstrated collaboration in all areas. The commenter explained that it was very important that testing parameters are established as well as SAE test procedures and standards development. The reviewer appreciated that INL slogged through the SAE standards because that is very important.

Reviewer 3:
The reviewer said good presentation of the overall plan.

Reviewer 4:
The reviewer said that the project team seems to have only one industry partner, but the SAE committee work will have significant contributions to the industry in general. The reviewer noted that more industry partners would aid the project though.

Reviewer 5:
For this reviewer, it was unclear in the briefing the degree to which Evatran participated in the evaluation of the system. However, according to the reviewer, the degree to which they are needed for honest broker testing of the system should be limited as well.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that future work seemed to be in line with addressing/overcoming barriers.

Reviewer 2:
The reviewer said that future work was somewhat constrained by vendor equipment availability and willingness to cooperate.

Reviewer 3:
The reviewer commented that, instead of writing generalities, they would like to see a more strategic approach as to what INL would like to test including identifying where there are "holes" in the SAE procedures and standards, and suggesting a way to plug the holes.

Reviewer 4:
The reviewer recommended that the project please add the above recommendation on dynamic DC voltage (to emulate a battery) to the future research plan.

Reviewer 5:
The reviewer said that the proposed future work is good. However, the timing of the proposed future work is not clear and depends on the availability of systems. The reviewer commented that agreements for (timing of) collaboration to complete work needs to be highlighted or identified to provide confidence that the proposed work is achievable. The reviewer suggested that a Gantt chart be used in the future.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that wireless charging will help to overcome a barrier to electrification of vehicles, which is simply plugging in a vehicle.

Reviewer 2:
The reviewer remarked that the project advances test procedures and standards for wireless EVSE, which are needed for increased EV acceptance in the market.

Reviewer 3:
The reviewer agreed that wireless charging is a key enabler to customer acceptance of EVs. This work will help the industry understand how efficiently this sort of charging can be, and what customer issues may be.

Reviewer 4:
The reviewer said that wireless charging would increase the adoption of EV vehicles; however, safety needed to be considered for this trade-off.

Reviewer 5:
The reviewer confirmed that wireless charging would increase the adoption of EV vehicles; however, safety needs to be considered for this trade-off. The reviewer suggested that INL may even want to consider establishing the safety codes on debris, etc. The reviewer concluded by exclaiming that the researchers keep going.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

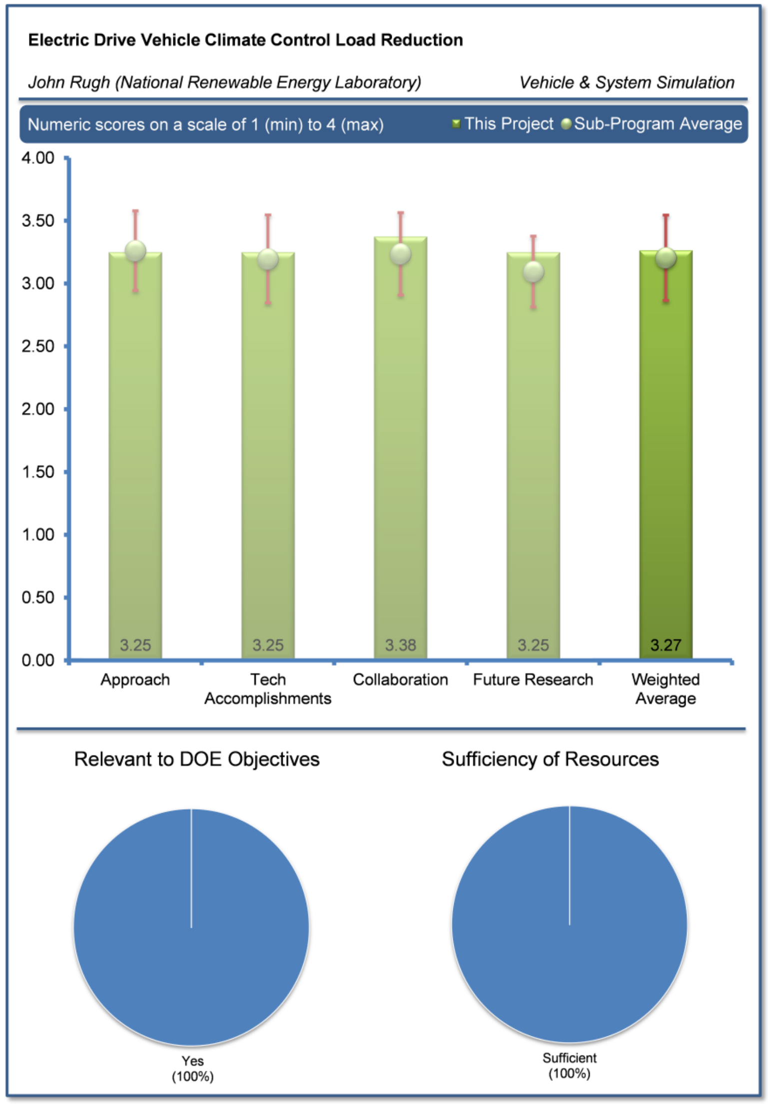
Reviewer 1:
The reviewer said that that project appeared to have adequate resources.

Reviewer 2:
The reviewer said that test facilities were sufficient, and that the project should be very useful for years ahead.

Reviewer 3:
The reviewer agreed that the progress seems to be sufficient and as such, they would say resources are sufficient. The reviewer asked what else the researchers can do with their resources. The commenter also asked how far INL can push on this. The reviewer concluded by stating that this looks like a great start.

Reviewer 4:
The reviewer said that the test set-up and approach are excellent. Most of the risk has been removed through the thoughtful test approach. The reviewer said that the greatest risk lies in getting the systems and participation of the manufacturers to complete the testing.

Electric Drive Vehicle Climate Control Load Reduction: John Rugh (National Renewable Energy Laboratory) - vss097



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project is robustly looking at the alternatives and tradeoffs, including cost. The project's goal of a 10% goal is bold, but seems achievable. The reviewer was excited to see early engagement with Ford, and remarked great.

Reviewer 2:

The reviewer remarked that the effort has a greater focus on occupant comfort rather than overall vehicle cooling with a goal to increase range by 10% through improved thermal management while maintaining or improving occupant comfort. The reviewer asked if the automaker can incorporate sensors into each seat position, similar to those used for passenger detection for the airbag system, or use seatbelt latch sensors, to selectively open vents to minimize cooling for non-present passengers.

Reviewer 3:

The reviewer found that this project specifically targets efficiency improvements of the vehicle HVAC system, which has a large impact on EV range and hence is a large technical barrier for EV adoption and ultimately energy consumption. The reviewer remarked that the zonal approach to climate control and the use of a manikin are a novel and potentially effective ways to evaluate and minimize climate control loads, while providing the occupant(s) with a comparable comfort level as conventional systems today. The reviewer found that with a range reduction of 20-40% due to climate loads, the program target to improve range by 10% is insufficient in magnitude to overcome barriers. The magnitude of the technical barrier needs to be matched with equally ambitious goals.

Reviewer 4:

The reviewer found that the objectives, approach and strategy seem to be too broad as they cover everything from cost to comfort evaluation techniques. It is almost an "all of the above" approach to vehicle climate controls in EDVs.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer detailed that the PI completed cold weather testing on the vehicle to assess techniques during the heating mode. Level 2 chargers have been installed in test area. The test vehicles have been set up/reconfigured to have full control and awareness of the HVAC state and sensors. The reviewer described that software improvements and manikin updates have been identified as a result of testing, which resulted in constructive feedback to the manufacturers of those systems. The energy savings due to zonal configurations (including overhead vents) has been quantified. The reviewer noted that the impact of window glazing has also been assessed, resulting in a measured 5.3°C decrease in interior temperature under specific test conditions. The reviewer acknowledged that the positive impact of a 15-30 minute pre-ventilation cycle is now understood. The performance of climate control systems can be rather subjective. The reviewer asked if there was sufficient diversity in the test group participants to capture the sensation and comfort ratings.

Reviewer 2:

The reviewer detailed that the project created necessary test cycles for heat soak and cooling. The reviewer commented zonal cooling advantages, window tinting, and ventilation, for heating, insulation, etc. The reviewer found that the practical use of various potential solutions was very good. Real world in vehicle testing that helps ensure believability of data. The reviewer observed simulations, and overhead AC vent.

Reviewer 3:

The reviewer said that practical approaches such as overhead or lap ducting configuration showed improved passenger comfort as measured on the manikin can be maintained with lower blower settings with some energy savings. The reviewer said that pre-ventilation shows promise as a simple measure for minimizing energy; however, predicting timing to begin pre-ventilation remains a challenge. These represent good incremental improvement, but the reviewer suggested looking at more aggressive thermal measures to further climate load reduction.

Reviewer 4:

The reviewer said that for the conducted sub-studies, results supported by test data were shown. For some cases, it was not clear if the small delta in temperatures was a significant improvement in the performance. The reviewer said that the sensitivity of the interior air temperature in each case was not obvious.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer found that clearly the project was working well with Ford and a few HVAC automotive suppliers.

Reviewer 2:

The reviewer observed good coordination with other laboratories, and that it looked like excellent work with Ford to maintain applicability.

Reviewer 3:

The reviewer noted that the PI discussed collaboration with Ford, Gentherm, Measurement Technology Northwest (MTNW) and ThermoAnalytics. The project also has further crosscutting with VTO and national laboratories, specifically ANL.

Reviewer 4:

The reviewer noted in-kind support and guidance from an OEM – Ford – as part of a CRADA. The reviewer suggested that the project would benefit from supplier collaboration for thermal measures as well (e.g., insulation and glazing).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the PI alluded to investigating other novel thermal measures, such as seats, which was welcome. The reviewer said that another round of summer testing, as well as fitting the vehicle up with a prototype design for testing, are reasonable next steps to prove out these measures.

Reviewer 2:

The reviewer said that it seems like the project has a steady stream of various climate control investigations to conduct. Looking forward, according to the reviewer it appears the project will cover more diverse topics, such as manikin performance, winter/summer testing, and even improved range calculations.

Reviewer 3:

The reviewer said that the PI has proposed investigation into heated windshield de-fog testing, as well as an additional round of summer vehicle evaluation.

Reviewer 4:

The reviewer said that round two of summer and winter tests will clearly help with more robust tests.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project rightly targets the HVAC system as an area of focus to reduce energy consumption in EVs and increase range.

Reviewer 2:

The reviewer said that climate control for EVs is an area of great interest to get EV driving ranges to a customer-acceptable level.

Reviewer 3:

The reviewer commented that a reduction in climate control load will result in less fuel used in vehicles.

Reviewer 4:

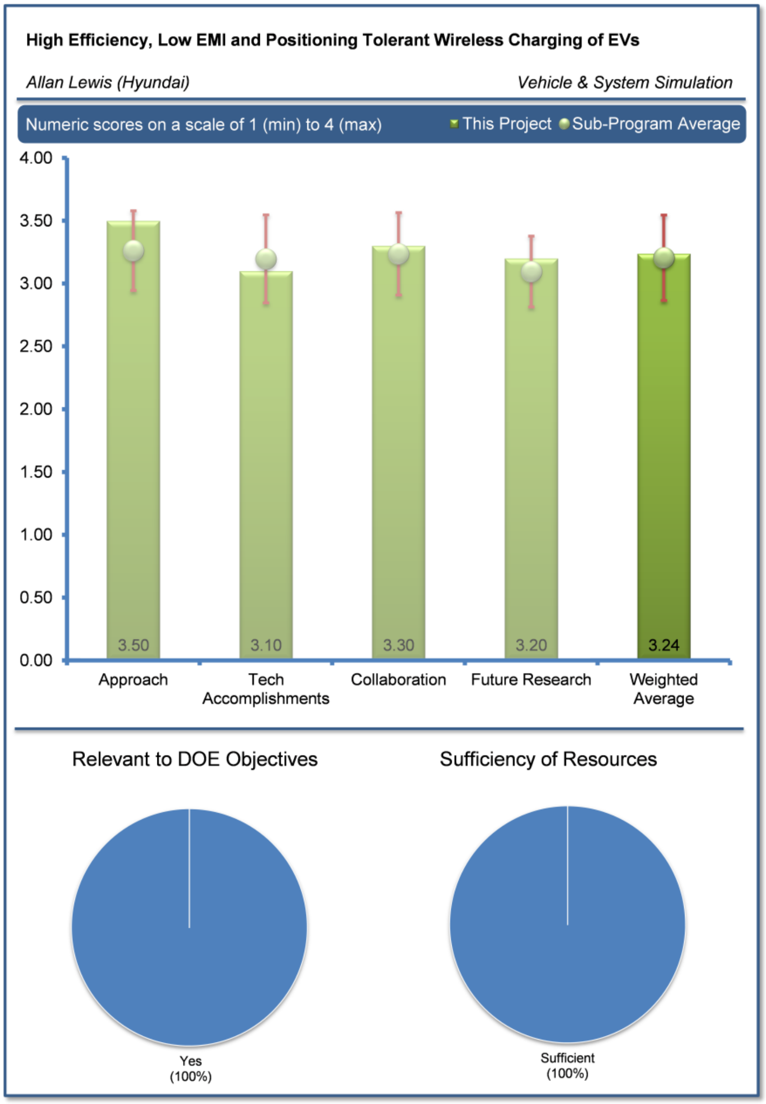
The reviewer said that EV range anxiety and climate control is a big deal for this. The reviewer said no free heat for heating.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that the project is on track with the current level of resourcing.

High Efficiency, Low EMI and Positioning Tolerant Wireless Charging of EVs: Allan Lewis (Hyundai) - vss102



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer thought that the technical approach used to overcome EV adoption through wireless charging of vehicles at similar efficiencies as a wired charging system and also attacking the alignment flexibility through use of asymmetric coils was an excellent approach.

Reviewer 2:

To this reviewer, the systematic development including the assessment of symmetric and asymmetric coils was sound. The reviewer added that the project appeared to have clear objectives and a path for achieving them.

Reviewer 3:

This reviewer observed that the project was very much led by the vehicle company from a true production integration perspective. This gave the project a solid dose of reality. The reviewer added that this would help define the issues, and new development and validation requirements for these systems.

Reviewer 4:

This reviewer stated that the objectives were appropriate and thought that the stretch target of 19 kW charge power was ambitious.

Reviewer 5:

The reviewer praised the well done presentation. The commenter noted that the researchers are behind on the timing for this project. The reviewer reported that Hyundai believes that there is a small take-rate for "Self Park" functionality and also believes that a high power transfer rate is required, especially for high density living areas.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said so far so good. The reviewer especially noted that when a phase was not completely finished the OEM would rather get an extension than to short change the effort toward the results. The reviewer said this showed a firm commitment to the project as a potential application by the OEM.

Reviewer 2:
This reviewer stated that the technical accomplishments were good but in general the project appeared to be running about six months behind milestones. The reviewer pointed out the need to look at how the schedule can be recovered or realign milestones with timing that is executable. The reviewer also commented that the second generation efficiency of 86% with asymmetric coils is very good. The reviewer added that the longitudinal offset tolerance of the system at over 40 inches is excellent.

Reviewer 3:
This reviewer observed good progress. The reviewer continued to say that the level of detail was relatively lacking compared to the Oak Ridge National Laboratory (ORNL) wireless charging project.

Reviewer 4:
According to this reviewer, the slippage of the December 2013 milestone is concerning. It was not clear that this project could get back on track, and there was nothing in the presentation to provide confidence that a contingency plan had been developed. The presenter mentioned asking for a no-cost extension, but did not provide details for why this had been necessary. The reviewer added that the experimental results were encouraging, and if the design for Gen III could be completed expeditiously, this project has the potential to achieve its objectives.

Reviewer 5:
The reviewer simply indicated that the project is 50% complete.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that partners included Hyundai and Mojo Mobility.

Reviewer 2:
This reviewer stated that there were good collaboration partners with a scope appropriate for their background and capabilities. The collaboration listing of the partners and the scope for each partner is excellent. It allows the reviewer to understand what each partner is doing. The reviewer finished by saying that this was a best practice.

Reviewer 3:
This reviewer commented that the collaboration between the wireless charger developer and the auto OEM was coupled quite closely out of necessity.

Reviewer 4:
This reviewer recounted that this was an auto company project and it seemed that the collaborations were the same as any other OEM led program. The OEM is leading and conforming the project to its mode of doing business and the collaborators are operating within that system.

Reviewer 5:
This reviewer recalled that the collaboration with Mojo Mobility appeared to be insufficient. The reviewer then added that this project would likely benefit from more collaboration with industry and perhaps with other research groups to help with the design.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
Assuming the Gen II design is completed, this reviewer commented that the demonstration project of five PEVs with wireless power transfer (WPT) should provide useful real-world data.

Reviewer 2:

The reviewer mentioned that the FY 2015future research includes a fleet build-up and validation.

Reviewer 3:

According to this reviewer, although admirable as an ultimate goal, it was not clear how technical roadblocks to 19 kW charging would be overcome.

Reviewer 4:

This reviewer recounted that the next steps are to follow the task pattern of a production program but with the inclusion of this new technology that will require new test and validation protocols be developed to assure durability, reliability and safety. To this reviewer, it would be very informative to see what the outcome of the new test requirements will be.

Reviewer 5:

This reviewer suggested that the proposed future work plan be revisited due to a six month schedule slip versus the original plan. The plan to reduce x-axis length makes sense since a greater than 40-inch misalignment is more than what should be required. The reviewer noted that the FY 2015 proposed work includes national laboratory testing without any national laboratory listed as a partner. According to this reviewer, the FY 2015 scope that includes building up a small fleet and completion of durability testing (with other tests) sounds ambitious.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer said that the project addresses an issue with EV adoption and is making good progress on wireless charging coil size optimization and driving frequency as a factor for efficiency in the operation. The reviewer added that the project was also demonstrating excellent efficiency of wireless charging versus available wired charging efficiency systems.

Reviewer 2:

This reviewer said the project supported technology for increased market acceptance of EVs.

Reviewer 3:

The reviewer explained that the goal is to reduce dependence on conductive charging stations, and develop a wireless charging system that meets industry guidelines.

Reviewer 4:

This reviewer acknowledged that if more people adopt EVs due to ease of charging, more petroleum would be displaced.

Reviewer 5:

This reviewer said that the need for WPT is debatable, at least for stationary charging (quasi-stationary seems to be more obviously attractive), but that research must be done to explore this technology and determine its feasibility from both a technical and commercial standpoint. This reviewer concluded that the project should make a significant contribution to this effort.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

To this reviewer, a project that involves designing a product requires the level of funding provided.

Reviewer 2:

This reviewer said it seemed that the OEM was committing the resources required, not limiting it to the funding available.

Reviewer 3:

According to this reviewer, this project appeared to have adequate resources.

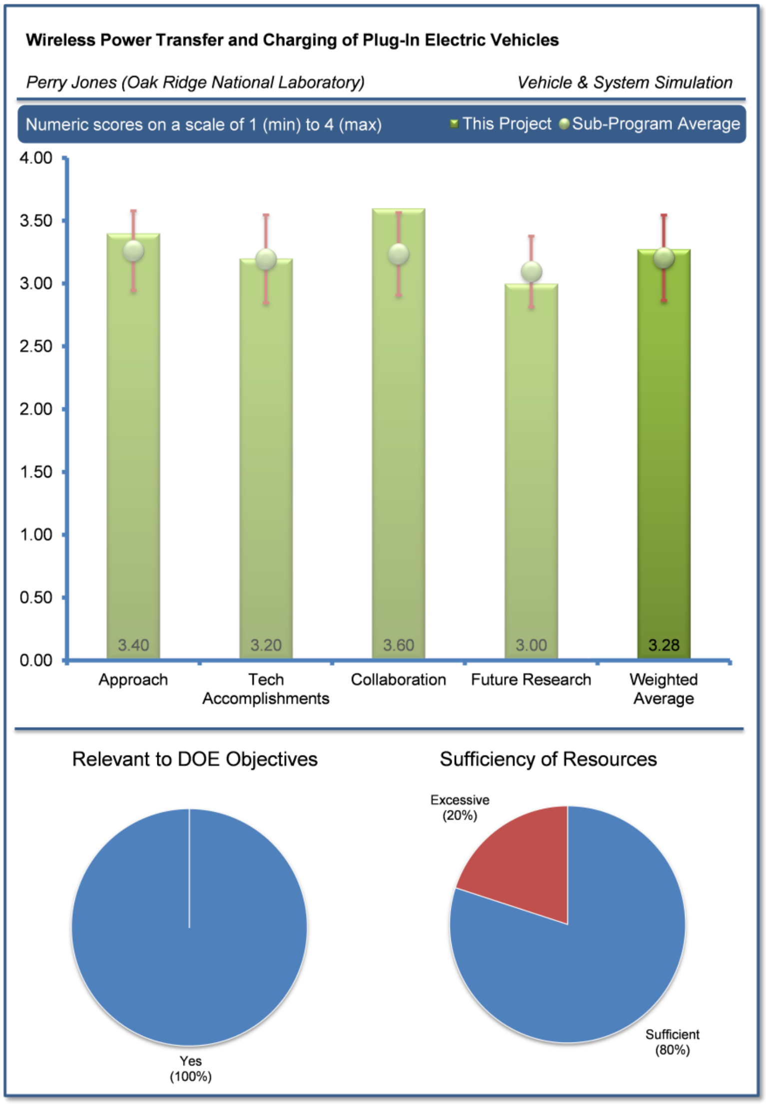
Reviewer 4:

The reviewer offered that the researchers need to ensure they stay on time for the project. It would be helpful for the reviewer to have seen a more intense timing plan which includes where the project is behind, and a plan for how to catch up on time.

Reviewer 5:

This reviewer commented that while the funding for FY 2014 appeared to be sufficient, the funding levels for FY 2015 were not provided and would need a boost to complete the proposed scope.

Wireless Power Transfer and Charging of Plug-In Electric Vehicles: Perry Jones (Oak Ridge National Laboratory) - vss103



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer noted the excellent technical approach in attacking known difficulties.

Reviewer 2:

The reviewer really liked this project and the combination of partners (e.g., Toyota, Evatran, Clemson University, and ORNL.

Reviewer 3:

This reviewer said that overall, the justification for the project is sound and all sorts of factors (including market need and acceptance) were taken into account. The setting of targets were well justified and the set-up of experiments (misalignment, frequency, etc.) were also thorough. This reviewer commented that the efficiency target needs to take into account changing DC voltage on the output side. In other words, the target should not be efficiency at just one DC voltage point, but the entire range of the battery SOC/voltage. Power electronics losses (and hence efficiency) will change as a function of this.

Reviewer 4:

This reviewer observed that the project addresses EV adoption barrier of plugging in the vehicle. The Approach and Strategy (Slide 8) highlights Opportunistic, Quasi Dynamic, and In-motion/Dynamic wireless charging, but this long term view is not addressed in any timing/larger time frame schedule. This reviewer added that wireless charging at the same efficiency as a wired charging system is a good accomplishment and supports that this is a good direction to go with charging of vehicles.

Reviewer 5:

The reviewer said that the project approach appeared sound based on accomplishments and partners included. This project seems to be an integral part of DOE's multi-pronged effort to explore wireless charging. The support of the private sector by a national laboratory is a good model for how DOE projects are supposed to impact the technology sector. One comment the reviewer had would be that it would have been good to know why the second OEM vehicle partner was lost and to be more specific about how this impacted the project.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
This reviewer noted that the technical objectives were achieved, with innovations in wireless charging design. The reviewer indicated that a very good efficiency was achieved.

Reviewer 2:
This reviewer noted that the data was well presented and it seemed the project was on its way. The reviewer added that more resolution can be added to the set of experiments that include misalignment and frequency. The reviewer also suggested that data at intermediate frequencies and misalignment distances should be added to provide a more complete trend/picture. The data output should be in the form of a plot rather than a table. According to this reviewer, this would be quite useful.

Reviewer 3:
The reviewer would like to see more emphasis on the "uniqueness" of ORNL's developed wireless power transfer technology. The reviewer thought it was a little "undersold" in the presentation. The commenter requested that presenter should have shown why ORNL is good at this, and why it is not coming from industry.

Reviewer 4:
The reviewer pointed out that the technical accomplishments were being met and that the project was on track. One thing that was not clear was whether the SAE decision to go with a different frequency would negatively impact this project going forward and whether Evatran would abandon the technology in favor of one that adheres to the SAE standard. The reviewer suggested that providing evidence of a contingency plan for this situation and a discussion of what the reasons are for the SAE decision would be good additions to future presentations.

Reviewer 5:
This reviewer commented that milestones of significance that are one and a half years apart are too long. There should be more track-able mile markers in the process that provide guidance on project timeliness. Slide 14 shows percent misaligned. There is no measure with this data and needs to be grounded with dimensions to be relevant. The bench test set-up showed more of a breadboard layout for the system. To this reviewer, this looked like it was a long way off from vehicle integration. The reviewer did note that gaining an agreement with Toyota as a vehicle partner was a big achievement and congratulated the team.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer emphasized that it was a great idea to think about technology proliferation and collaborating with Evatran. The reviewer added that it was great to see national laboratories work towards implementation of the technology as opposed to making just research reports. The reviewer strongly urged to please keep pushing this.

Reviewer 2:
This reviewer said that all appropriate partners were included, from OEM to device manufacturers and standards committees. The reviewer also noted that there was good communication.

Reviewer 3:
To this reviewer, all of the players were on board to achieve success in demonstrating wireless charging on vehicles.

Reviewer 4:
This reviewer identified that having a major vehicle OEM as well as the preeminent wireless charging OEM as partners speaks to the successful collaborative efforts of this project, despite the loss of one vehicle OEM.

Reviewer 5:
The reviewer really liked the collaboration of partners. Of course, the reviewer thought it was a bit disappointing that this is not a GM or Ford project, but instead it was a Toyota project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer motivated that ORNL keep going on this work. The reviewer asked what else ORNL could do with more time and money, and to outline it.

Reviewer 2:
This reviewer stated that the future research plans were reasonable and achievable up until the March 2015 milestone, but no details on what would be done subsequent to the initial deployment were given.

Reviewer 3:
This reviewer saw good future objectives. The reviewer said that the benefits of vehicle testing could be spelled out more clearly, and further inquired about what would be achieved in-vehicle that was not feasible on a test buck.

Reviewer 4:
This reviewer observed that the proposed future research and the planning provided in the briefing did not adequately provide appropriate decision points, risk mitigation plans/alternate pathways. The project is behind schedule due to loss of a vehicle OEM. However, there are other elements that appear to be behind as well. The reviewer concluded that the goals of the project were not addressed in the proposed future work or in the milestones.

Reviewer 5:
This reviewer pointed out the need to include full SOC window on the output side. The reviewer also suggested more resolution to understand variability. Also the reviewer recommended considering other topologies and to do a cost/efficiency tradeoff analysis.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer really liked Slide 3, which showed the Project Relevance.

Reviewer 2:
This reviewer said that the project supported the advancement of EV ease-of-use for better market acceptance.

Reviewer 3:
According to this reviewer, the project addresses barriers for EV adoption which directly impacts petroleum displacement.

Reviewer 4:
The reviewer said that the need for WPT is debatable, at least for stationary charging (quasi-stationary seems to be more obviously attractive), but research must be done to explore this technology and determine its feasibility from both a technical and commercial standpoint. The reviewer concluded that this project should make a significant contribution to this effort.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer personally liked seeing the milestones that were laid out and a clear indication of whether the researchers can meet them, or not. And, if the milestones were not met, a plan was presented of how the researchers will be able to make up the timing.

Reviewer 2:

This reviewer noted that the resources appeared adequate.

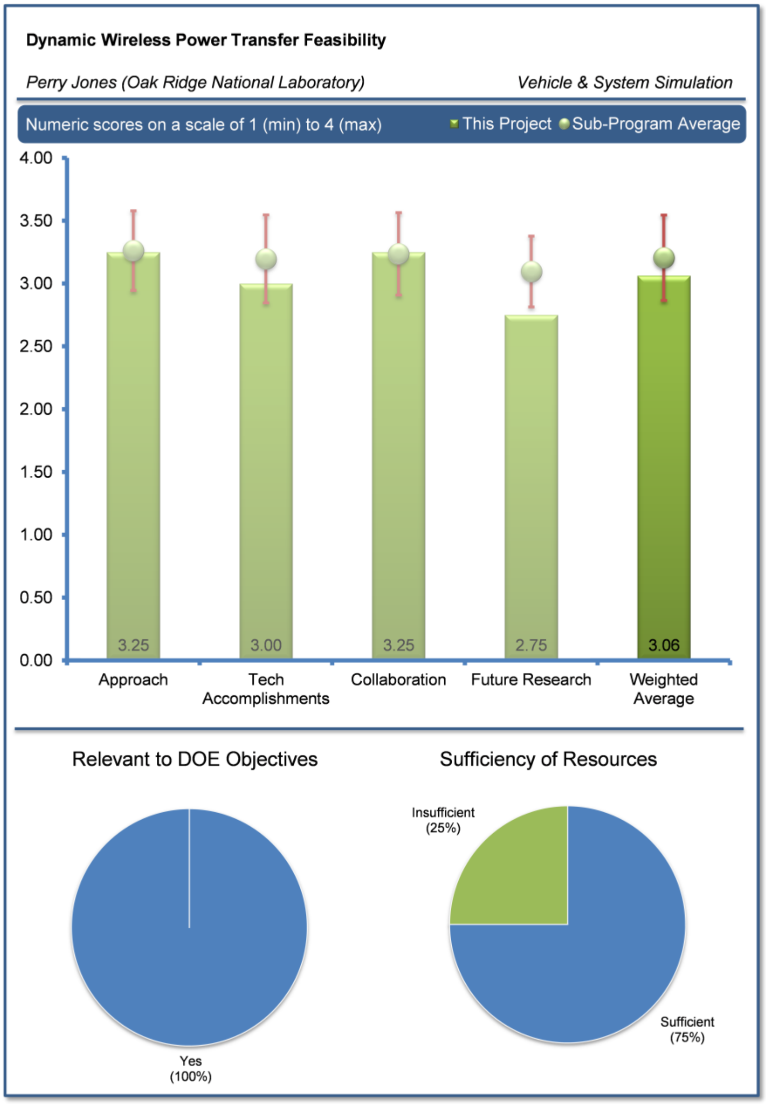
Reviewer 3:

The reviewer noted that the project funding was sufficient, although the funding from the DOE to the partners is 8:3, and it would be better if this ratio was more even. Also, the reviewer noted that without knowing how many vehicles were going to be deployed, that it was difficult to judge the level of funding.

Reviewer 4:

This reviewer said that there is a lot of funding for the project and it was not clear on what elements the funding was being applied or when the funding was being spent. Given the level of funding, more detail should have been provided for the spend plan and how project risks were being addressed.

Dynamic Wireless Power Transfer Feasibility: Perry Jones (Oak Ridge National Laboratory) - vss104



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer liked this presentation because it was far-reaching and, there was enthusiasm from the presenter.

Reviewer 2:

This reviewer noted that the approach was excellent because it was focused on defining requirements for dynamic wireless power transfer (DWPT) and that that it used real world data as a basis to inform the analysis.

Reviewer 3:

The reviewer said that the idea of estimating dynamic wireless charging costs was a good one. Doing that with not many working systems is challenging.

Reviewer 4:

This reviewer commented that the availability of existing traffic data is cited as a barrier, but no reference is provided on the sources sought. FHWA may be a good source to check on traffic statistics, classification and volume. It is stated that it is difficult to obtain quantitative comparisons of current DWPT technologies. The reviewer asked if this was presumably because of the level of maturity of the systems and IP concerns. Perhaps, the reviewer added, that more than one could be compared side by side by DOE to aid in this with confidentiality agreements in place to gain insight to support the rest of the study. At some point DWPT is going to have to be evaluated at a test track to verify the assumptions made for this high level impact study, as well as evaluating their performance, spatial requirements, construction, operation and durability. The reviewer suggested that this should be proposed future work. The reviewer also added that a key slide for all the acronyms would be very helpful for reviewers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that this was a study, versus something exceptionally technical.

Reviewer 2:

This reviewer stated that getting the cost estimates for the wireless charging infrastructure was a good accomplishment. The reviewer would like to see more detail behind those calculations if it is not proprietary to see where areas for improvement lie.

Reviewer 3:
This reviewer described the results as credible and noted that they satisfied the minimum requirements of the primary objectives.

Reviewer 4:
This reviewer observed that some aspects that affect DWPT deployment were not stated, such as safety and durability. More detail is needed on the rationale for choosing 25kW as the power level, coil spacing and pavement type for the cost projection. The reviewer said that the following did not come through in the presentation: whether 1/2 mile and 667 coils are at 25kW; what was needed to maintain a light-duty (LD) vehicle charge at 40-45mph; and how much was each coil.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged the excellent coordination between labs. In fact, at this poster review the reviewer and presenter were able to get all the labs to discuss the "market penetration slide," which the reviewer indicated that they did not agree with, although the commenter agreed that it could be directionally correct.

Reviewer 2:
This reviewer observed that the collaborations were good except a dynamic wireless charging company would be helpful to have on board if one could be brought to the table. Also, the non-attaining Air Quality Management Districts (AQMD) in California would be good collaborators if not already on the team.

Reviewer 3:
This reviewer suggested more interaction with DOT for traffic data for the deployment scenarios and future field trials to obtain in service performance evaluation on a closed course test track.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer commented that the future work proposal is narrow which is okay if it were presented in the context a strategic view of the DWPT R&D.

Reviewer 2:
The reviewer reported that this was a futuristic look. The commenter would like to see some cross-pollination with German and the Dutch researchers on this topic. The reviewer indicated that they have had the Dutch Government give them presentations several years ago that were in this same space.

Reviewer 3:
This reviewer did not know if it made sense for another project or extension unless there was a company interested in assisting with the dynamic wireless charging that provided something that could be more commercially feasible than what is available from ORNL.

Reviewer 4:
This reviewer noted that it is stated that infrastructure impacts would be investigated, but does not specify which infrastructure. It appears the project is referring to an electrical grid infrastructure, but the pavement infrastructure is likely to be a much larger hurdle. This reviewer recommended considering field trials with both coil and linear transfer configurations.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that this project is trying to answer how we can charge vehicles on the go, and thus displace petroleum.

Reviewer 2:

According to this reviewer, DWPT is an innovative way to fuel transportation vehicles that potentially enables EVs to further exploit advantages inherent to the technology (e.g., speed of light energy transfer and high efficiency energy conversion characteristics). These characteristics enable the increased use of renewable energy and will displace petroleum consumption.

Reviewer 3:

This reviewer commented that roadway and vehicle electrification will go a long way toward DOE, and also support DOT and EPA goals of cleaner air and reduced fossil fuel consumption for the transportation sector.

Reviewer 4:

This reviewer observed that this would help reduce petroleum use and emissions if it can be done at an acceptable cost to the driver/government. The cost for benefit would need to be evaluated versus other technologies such as generator on-board series hybrid, all electric vehicle, etc.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer stated that the resources were sufficient for the initial phase of investigation. This area deserves more R&D and additional resources.

Reviewer 2:

This reviewer observed that the resources were sufficient, except that the next steps would benefit from an interested industry partner such as Siemens is with the Catenary system (which obviously is not possible for this effort because it is not wireless.)

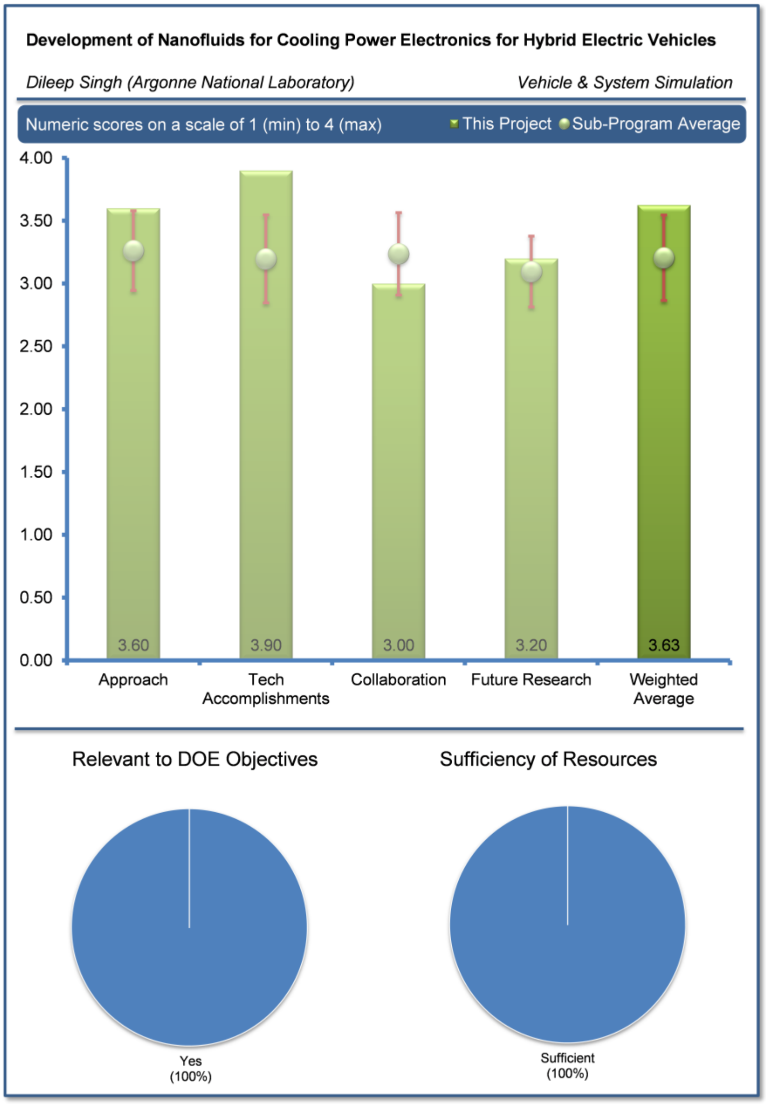
Reviewer 3:

This reviewer opined that to really make significant advancements in evaluating the feasibility of DWPT, actual field trials of the technology need to be conducted to learn many things about installation, performance, maintenance, service, communications, spatial requirement, etc. This will support a much more robust projection of broader implementation viability studies.

Reviewer 4:

The reviewer indicated that this was a futuristic study.

Development of Nanofluids for Cooling Power Electronics for Hybrid Electric Vehicles: Dileep Singh (Argonne National Laboratory) - vss112



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this project sought to develop an advanced coolant based on nanofluid that would allow for the elimination of low temperature cooling system in future HEVs. This reviewer observed that the project was carried out in three steps: defining the figure of merit of the proposed nanofluid through thermal analysis; lab scale formulation of nanofluids; and preliminary scale-up test and reliability tests. The reviewer noted that the approach was very well thought out, challenging yet feasible, and excellently executed. It provided a solid framework, both theoretically and experimentally, for future development and commercialization.

Reviewer 2:

To this reviewer, it appeared to be a thorough well planned and executed investigation of the alternatives that nano-particles provide to enhance cooling. The reviewer noted that from the presentation, it was hard to tell what efforts had been done this past year versus over the past several years, but as a whole--good approach.

Reviewer 3:

This reviewer said that this was a very strong project which is focused on cooling power electronics for HEVs and which has executed a strong approach throughout its duration. It has built heavily upon and is a natural extension of previous nanofluid work conducted at ANL with regards to heavy duty vehicle applications. An effective nanofluid engineering approach to formulate Graphite nano-Platelets (GnP) optimized suspensions has been implemented to meet property requirements defined by thermal analysis of cooling requirements for HEV power electronics. The reviewer added that the approach is very structured and strongly supported marching towards the desired project conclusion.

Reviewer 4:

This reviewer stated that cooling electronics would save energy through reduced weight.

Reviewer 5:

This reviewer indicated that the approach was quite unique and did not think it was necessarily limited to power electronics. The application to IC engines is an over looked extension.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the project had demonstrated numerous technical accomplishments in FY 2013. The study of shape effects and surface functionalizaon of graphite nano-platelets shows that surface functionalization creates core-shell structures and helps to improve suspension stability. Thermo-physical properties of GnP in ethyl glycol/H_2O were examined and concluded that surface functionalization negatively degrades thermal conductivity (approximately 45%) but dramatically lowers viscosity (greater than 100 times less viscous). Diameter/thickness are critical for viscosity indicating an optimal geometry is needed. The experimental nanofluid was evaluated in laminar and turbulent flow and the goal of the thermal conductivity of greater than1.5 of the base fluid was achieved. ANL has successfully demonstrated a nanofluid F-B- GnP in ethyl glycol / H_2O, which is beneficial in both laminar and turbulent regimes with approximately 80% and 35% improvements in heat transfer coefficients, respectively. A top level cost analysis was conducted showing that the GnP additive will increase the cost of the coolant by 20% per volume, but has the potential to incur cost savings through reduced coolant requirements; smaller, simpler, single cooling systems; reduced vehicle weight, and increased fuel efficiency. In FY 2014, ANL has optimized the GnP nanofluid preparation procedure for scale-up including investigating the effects of ball milling on thermo-physical properties and the effect of the GnP additive on properties of commercial Prestone 50/50 coolant. It was found additives in the Prestone coolant interfere modestly with graphitic additives, but that ball-milling decreases viscosity by approximately 3% while leaving thermal conductivity unaffected. The reviewer recounted that ANL successfully scaled-up the nanofluid in quantities sufficient for heat transfer test. The reviewer added that quality control steps were introduced to offset the sensitivity of the nanofluid properties to the fluid parameters. ANL achieved the properties of the small batch nanofluid on the larger 0.5 liter scale. The efficiency of the nanofluid at real heat exchanger conditions has demonstrated an experimental average heat transfer coefficient enhancement of 1.46. Test fouling and erosion experiments of the nanofluid coolant in close to real exchanger conditions has demonstrated no clogging after hundreds of hours of testing with an estimated pumping power penalty of only approximately 7.5% more for the nanofluid than the ethyl glycol/H_2O base fluid. The reviewer also recounted that the technology-to-market efforts have led to three patent applications, an NDA with Dynalene Inc., and additional commercial interest from Hussman Corporation, a refrigeration systems manufacturer. Overall, the reviewer acknowledged that there was a very impressive list of accomplishments.

Reviewer 2:

The reviewer noted a good understanding of the technology by the PI.

Reviewer 3:

This reviewer observed that the accomplishments were aligned with the project and DOE objectives. The reviewer found the topic and its application really quite interesting and worthy of further investigation.

Reviewer 4:

The reviewer said that there appears to have been great progress this year in narrowing options for enhanced heat transfer fluid by using graphite particles. Assuming the results continue to hold through further testing, the reviewer indicated that the results will be very important to the auto industry in general.

Reviewer 5:

This reviewer recounted that the main achievements of the project are the identification of the figure of merit for the nanofluid and the development of a stable nanofluid system, currently the only known system that meets the figure of merit. The project has progressed as proposed and the scale-up and reliability tests were also very impressive as they have brought the technology a lot closer to commercialization. The reviewer concluded that the results of the projects can find commercial applications beyond the HEVs and in general HVAC systems.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer commented that there was not a lot of emphasis on this, but that it appeared to be a good path forward with an industrial partner.

Reviewer 2:

The reviewer opined that the project needed more collaborators including OEMs and battery manufacturers. National Institute of Standards and Technology (NIST) has done a lot of work in this area and should be a collaborator. The reviewer added that Purdue University is working in the area and may be a good collaborator.

Reviewer 3:

The reviewer would like to see collaboration with an engine manufacturer and a coolant manufacturer so that the full potential for this technology can be fully appreciated.

Reviewer 4:

This reviewer said that there was not a lot of information provided with regards to collaboration and coordination, and it appears that it has been relatively limited. Reviewing the reviewer comments from last year, it appeared to the reviewer that ANL has worked with NREL to help identify cooling requirements for HEV power electronics and has received some input from industrial manufacturers. It very well may have been beneficial to expand the breadth of collaborations especially on the industrial side to best understand commercial requirements and issues that may pose a barrier to commercialization and gauge overall industry acceptance.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

It was not clear to this reviewer what the next step for technology transfer was. Although the results are very impressive, there still exists a gap to real commercial deployment. This reviewer asked if since this project was wrapping up this year, if Valvoline or Dynalene will license the technology and continue the development work. The reviewer wanted to know if an OEM will work with ANL to continue the development through a CRADA and if further development work would be carried out in another government program.

Reviewer 2:

The reviewer said that the project targets completion in FY 2014 and is on schedule to do so. Efforts are underway to find additional industrial partners to commercialize the technology through the ANL Technology Development & Commercialization. The primary question the reviewer had was if there were additional justifiable efforts that could be undertaken to further garner industrial interest in the technology and improve the likelihood of commercialization. For example, the reviewer asked if longer fouling/clogging and/or suspension studies under extreme conditions should be conducted and if it was possible to further build off this project to enhance the viability of nanofluids for HD truck applications.

Reviewer 3:

The reviewer suggested including more nanofluid research, which the team are experts in--nanoparticles will improve heat transfer rates and fuel economy. The reviewer observed that the project was coming to an end but there was much more to do.

Reviewer 4:

According to this reviewer, the proposed future work should include running an engine durability cycle and determining how the nano-particles remain in suspension, what erosion is experienced, and how the thermal properties deteriorate over time.

Reviewer 5:

The reviewer said that apparently DOE funding would be ending, and it was not clear if there was a path forward to continue the development efforts. The team did suggest some options that were being pursued.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer observed that this project was very relevant as successful development and commercial implementation of nanofluids for cooling power electronics in HEVs could eliminate the need for a low temperature cooling system leading to reductions in cost and weight, as well increased efficiency and lifetime of power electronics. These benefits would increase the viability of HEVs in the general market place with their concomitant energy efficiency and fuel displacement benefits. The reviewer added that the development of nanofluids have significant potential as well with regards to improving cooling in HD vehicles which can lead to cost and weight reductions as well as increased aerodynamic flexibility to improve fuel economy.

Reviewer 2:

According to this reviewer, making engines more efficient and burning less fuel is very much aligned with DOE objectives.

Reviewer 3:

The reviewer commented that this technology could provide energy savings to the existing cooling system without combining the high temperature and low temperature systems. This is important as it helps to technology gain market foothold before the new cooling system is in place.

Reviewer 4:

The reviewer said that heat transfer was important in PEV and EV vehicles. The reviewer added that thermal interface materials (TIM) thermal conductivity above 7.5 W/M-K is high and may not be available.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

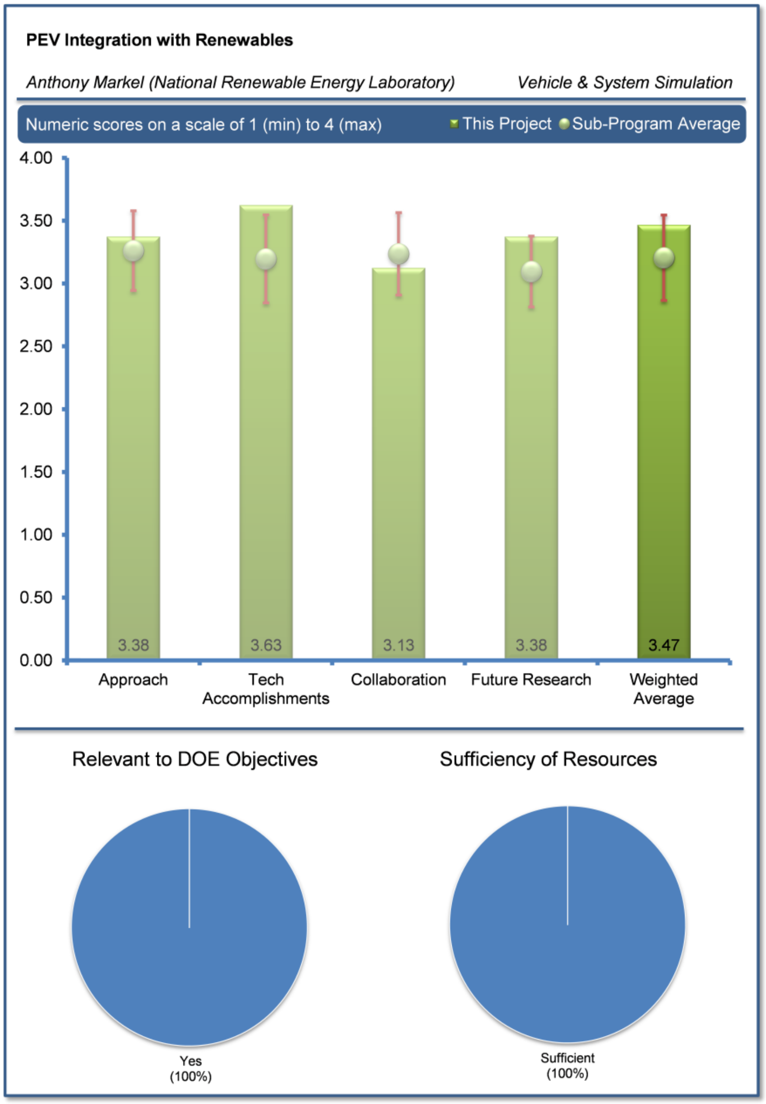
The reviewer commented that there was a low budget for the quality of the output being received--excellent leveraging.

This reviewer observed that the project best utilized the group's expertise in thermal nanofluids and that it has sufficient resources to carry out the technical development efficiently.

Reviewer 2:

This reviewer stated that the resources were sufficient for the project as outlined.

PEV Integration with Renewables: Anthony Markel (National Renewable Energy Laboratory) - vss114



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that, given the complicated nature of interactions between the grid, renewables, vehicles, and building loads, it was refreshing to see some work/thinking that shows all of this in slide/presentation.

Reviewer 2:

The reviewer felt this was important work--renewables can have improved reliability from EVs.

Reviewer 3:

The reviewer relayed that the approach is designed to gain an understanding of how, when and if vehicles could be integrated into a local grid segment or to a specific building to create benefits. This is an important question and should be studied. The reviewer believed that by gaining an understanding of how solar and vehicles may be able to interact is one step in that direction.

The reviewer pointed out that in the discussion it was cited that the needs of the vehicle users must be programmed into the system if a V2G system would ever be broadly implemented. The reviewer asked how this could be done without adding new activity to the driver should be studied.

Reviewer 4:

The reviewer stated that there did not seem to be a unified approach to addressing the central problem of integrating renewables using PEVs; a number of analyses appear to be combined together. The reviewer thought it was promising to see that there is a lab that incorporates the correct tools/functionality to highlight these interactions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that the project is maximizing the available data, and stated that charge management was important.

Reviewer 2:

The reviewer found the plot showing potential revenue impact of various energy storage sizes for various building loads to be very helpful.

The reviewer suggested that the cost associated with incorporating bi-directional capability into vehicles be further refined and included in the analysis. This shouldn't be difficult to calculate. A first pass attempt at this is necessary and could follow with review/input from OEMs.

Reviewer 3:

This reviewer remarked that it seems like interesting work has been done, but there does not appear to be a clear roadmap towards producing a result that directly addresses the central goal. This may be caused by an ill-defined goal, continued the reviewer. If so, the reviewer opined that the project should be redirected towards a general value analysis, which appears to be the unifying theme of the work presented.

Reviewer 4:

It seemed clear to the reviewer from the discussion that the results of this project are indicating that it will be far into the future when vehicles can have any significant effects on the grid. This is due to the need for high numbers of vehicles to have significant effect - this answer is a significant output of the study. The reviewer felt that to know when and why the grid could make use of vehicle energy storage is seen as potentially having real benefit.

The reviewer suggested the alternative is to also look at how permanent energy storage vs. mobile energy storage would compare on a function/cost/benefit basis, and also understand the full cost to the vehicle owner when the battery capacity degradation may be accelerated due to added cycling of the battery.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that this is work in progress, but that it was great to see that test sites are being built in Colorado.

Reviewer 2:

The reviewer thought that the most significant collaborations are still planned, and that it will be good to see the value created as these collaborations are exercised.

Reviewer 3:

The reviewer saw that collaboration to date appeared to be weak, but that the proposed partners looked good.

Reviewer 4:

The reviewer recommended expanding collaborators to universities, such as Virginia Tech, as some universities are very strong in the area. The reviewer also stated that utilities need to be on board, and pointed out that NIST is also working on smart buildings.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer felt there was an excellent research plan, and that emergency power is great.

Reviewer 2:

The reviewer thought the completion of this work plan would help to clarify the questions about vehicle to grid and quantify the parameters required to make such grid interface useful and economically viable.

Reviewer 3:

The reviewer concluded that the path forward seems worthwhile, but asked to please incorporate the cost of bi-directional charging for vehicles and considers how using vehicle batteries compare with stationary storage cost assuming some cost per kilowatt-hour of power (or a range of values).

Reviewer 4:
There does not seem to be a clear roadmap to reach a well-defined goal. Interesting work has been done, however, so it seems that the project definition should be changed to allow the continuation of the general valuation work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer was impressed by the primary investigator, and felt this was an excellent use of cost data.

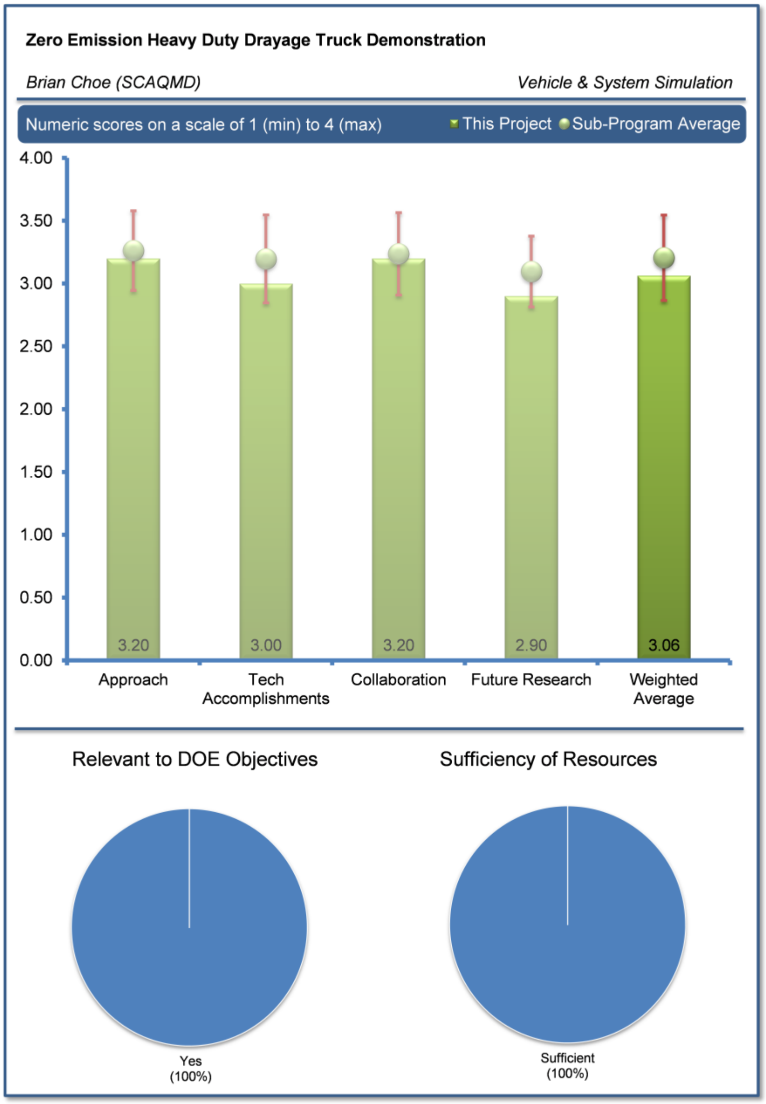
Reviewer 2:
The reviewer stated that decreasing the cost of PEVs will increase sales and decrease petroleum use.

Reviewer 3:
The reviewer concluded this project was mostly on the grid side, rather than on the vehicle side.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that this wasn't directly addressed, but seemed sufficient.

Zero Emission Heavy Duty Drayage Truck Demonstration: Brian Choe (SCAQMD) - vss115



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer thought that the approach of developing four different types of zero-emission dryage trucks to be used in near dock operation, local operation and regional operation will provide an excellent set of real world data to help evaluate this technology.

Reviewer 2:

The reviewer opined that this is another one of the "just do it" projects. This person commented that to find out if these trucks will work for this type of application, build them and put them into service. The reviewer described this as elegant and not so simple. The one piece the reviewer was uncertain about was how the trucks are matched with routes. The reviewer further inquired about how the trucks were scheduled, if recharging impinged on their work time, and if the range was matched to the routes. The reviewer suggested that this optimization bears discussion.

Reviewer 3:

The reviewer found the overall project scope to be thorough and well thought out, consisting of multiple manufacturers with multiple powertrain offerings, dynamometer performance testing to evaluate, and real world applications.

The reviewer suggested that the target objectives could be more specific, and would like to see a quantitative determination of success. The reviewer asked what the performance expectations for the OEM partners during design were. A year to design and implement an entire platform ready for real-world testing seemed to the reviewer to be a bit optimistic.

Reviewer 4:

The reviewer said this was a very interesting project; overall, a good project when viewed through the lens of technology demonstration. As a technology commercialization effort, the reviewer would be wary of the tech providers, and would further like to see the fuel cell truck go head to head with the electric trucks. These trucks are a niche within a niche within a niche. The reviewer did not believe that two different technologies can survive in this market niche. Comparing them head to head would narrow the field down so that it can be commercialized in the future.

Reviewer 5:

The reviewer felt that, in concept, multiple versions of four types of hybrids would give a good cross section of drayage truck technologies. It appeared to the reviewer that the technologies and vehicle developers selected have a long way to go in developing a proven platform. The reviewer warned that results from unrefined technologies may give false indication of the performance possible, but understood how the project was scoped and originally planned. It is good that the fleet size is limited and only a single location is being used.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer felt that design of the HD EVs is a big accomplishment. The hardware and software improvements were key to making trucks like these commercially feasible.

Reviewer 2:
The reviewer thought progress was satisfactory. Given the project partners and the nature of these vehicles delays are to be expected.

Reviewer 3:
The reviewer saw that there has been some progress in each of the four different types of trucks with TransPower having four BEVs completed. The other three truck designs have recently started vehicle integration or will start shortly and all vehicles will be on the road in 2015. The reviewer stated that even though the vehicles are all to be on the road in April 2015 and the project has been extended to 2016, there is concern that the project will be able to collect two years' worth of data.

Reviewer 4:
The reviewer reported that most of the technical accomplishments to date were reporting out on the development progress from the various suppliers. The reviewer believes the product development for each manufacture of each of these vehicles to be a substantial effort and expected having reliably running vehicles to be considered a significant accomplishment. The reviewer would caution against making judgment on the performance of these fairly immature prototypes. Clearly the project team recognizes this with the TransPower design improvements that occurred over this past reporting period.

Reviewer 5:
The reviewer said it was still in the early stages for the project so it was difficult to judge progress to date. Based on the schedule on Slide 5 and the future work on Slide 16, it appeared to the reviewer that the project was behind schedule.

Question 3:
Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer felt that, given the problems some of the other EV projects have encountered, it was very wise to use several suppliers. This also gave an interesting mix of designs. The reviewer concluded that the analysis and testing teams are excellent, and although there is only one fleet partner, it is in the perfect niche for the test.

Reviewer 2:
The reviewer reported that there is good collaboration and coordination with the participants in the project. Four EV manufacturers will provide a range of technology to be evaluated. The reviewer expected that using NREL for data collection and University of California Riverside for dynamometer testing would provide for excellent results.

Reviewer 3:
The reviewer stated the list of collaborators and expertise was very diversified and applicable. The reviewer exclaimed well done.

Reviewer 4:
It appeared to the reviewer that the vehicle developers were still making progress and demonstrating good collaboration with the DOE team.

Reviewer 5:
Collaboration appeared satisfactory to the reviewer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer felt the proposed future research continues to follow the approach path and is well laid-out.

Reviewer 2:
The reviewer stated that the plan for future work is logical, but was concerned that the demonstration portion may get cut short.

Reviewer 3:
The reviewer would like to make sure there is a component of the work that deals with optimizing vehicle scheduling for various routes to best utilize the different vehicles. The reviewer was also assuming it will be hard to get two years of data by the scheduled project end date.

Reviewer 4:
The reviewer relayed that the project has a schedule to have all of the vehicles on the road by April 2015. By getting these vehicles on the road and collecting and analyzing in use data the project will be able to address the identified barriers.

Reviewer 5:
The reviewer found that the plan for FY 2014 and FY 2015 did not support the overall project objective of demonstrating the performance of these new vehicles. This is primarily due to the long development cycle that is required to design, manufacture, develop and test a vehicle platform. The reviewer suggested that the first phase of the project could be just getting the vehicles designed and prototyped, with the second phase of the project being testing, and only if the vehicles have completed a basic validation phase.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that, obviously, using EVs instead of diesel trucks reduces petroleum use. In this case, improvement of air quality is an even more important benefit.

Reviewer 2:
The reviewer believed that obtaining zero emission drayage truck data in real world operation would help promote market acceptance of this technology. By gaining market acceptance this technology is likely to be used and will support the DOE objective of petroleum displacement.

Reviewer 3:
The reviewer found the objectives to be directly aimed at petroleum and emissions reduction and the target market shows promise to be significantly impactful.

Reviewer 4:
The reviewer pointed out that these trucks are petroleum free.

Reviewer 5:
The reviewer said the vehicles are expected to reduce the use of petroleum, but that validation will have to occur at a much later date or possibly in another project.

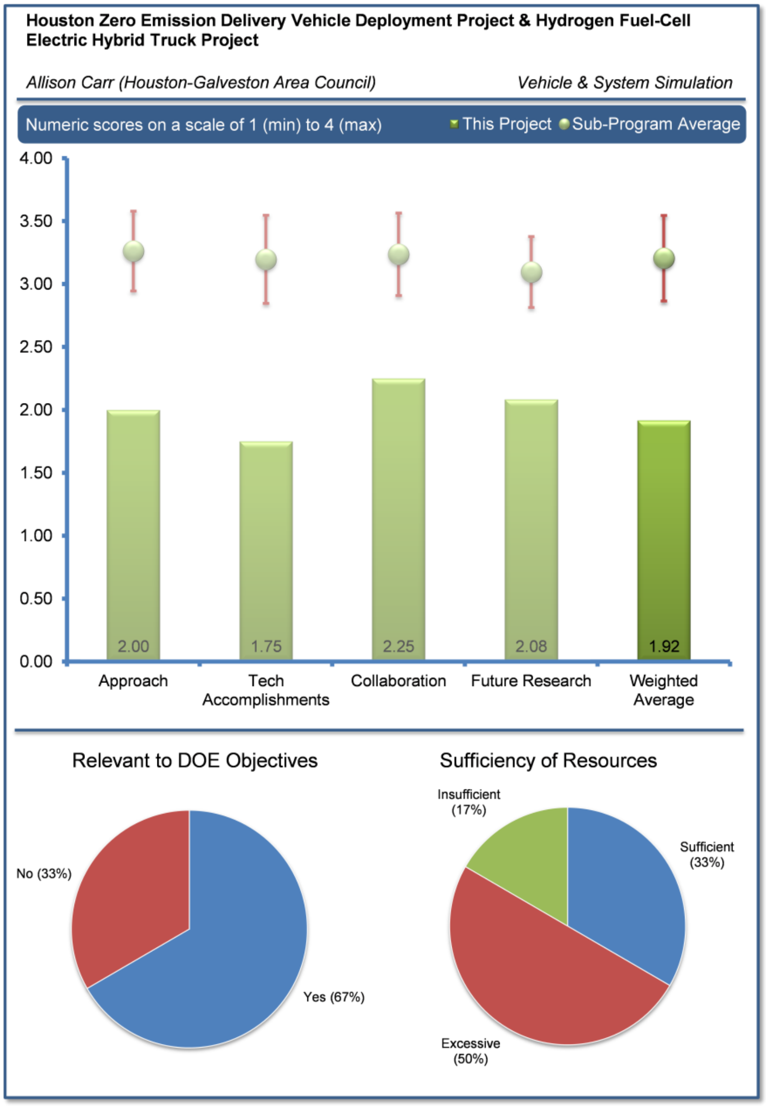
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that funding appeared adequate for the stated milestones.

Reviewer 2:
The reviewer thought that, given all of the design work required, this project is pretty trim. But, as with all the large projects, it is hard to evaluate with no budget data.

Reviewer 3:
The reviewer judged that funds appeared to be sufficient, but there is a concern that the project has spent only 20% of the DOE funding and the project is over 60% complete.

Houston Zero Emission Delivery Vehicle Deployment Project & Hydrogen Fuel-Cell Electric Hybrid Truck Project: Allison Carr (Houston-Galveston Area Council) - vss116



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the current approach, of identifying fleet and OEM partners for the project, providing funding to selected partners, to begin vehicle monitoring, and data collection, is adequate.

Reviewer 2:

The reviewer stated that the project is not likely to contribute to overcoming barriers. The reviewer added that too many hurdles exist outside the control of the project leadership. Also, the reviewer said that high percentage cost share projects are difficult to execute now in today's economic reality.

Reviewer 3:

The reviewer said that the chances of success of this project seemed slim, as the difficulty to identify infrastructure and available production vehicles provided significant barriers that may be unsurmountable.

Reviewer 4:

The reviewer observed that the cost of this project would be way too high, and the reviewer was not sure if this technology can be even seen in production in 2030 and beyond.

Reviewer 5:

The reviewer reported that the objective and approach statements are beyond the scope and abilities of the Houston-Galveston Area Council. The reviewer added that even with complete commercial partnerships the project is too challenging to consider. The reviewer said that there is a big disconnect between funding and expenditure. This is another project struggling with the supplier partners. Two projects are part of this review. The reviewer pointed out that smith trucks are unable to supply the product. The reviewer indicated that it is a bit discouraging how project is unable to pursue objectives as stated. The reviewer added that there are big process problems, sounds like government. Also, the project team is conducting a call for projects. The reviewer stated that the project team is looking for OEM partners. The reviewer said it was a tough call on this project, and the project scope is under revision. The reviewer stated that a lot of time was spent trying to re-scope the project. The reviewer added that this project seems like money in search of a project. The reviewer remarked that Amp electric and UPS are likely candidates. The project looks promising as a containment action. The appropriate path forward is an ongoing theme.

Reviewer 6:
The reviewer stated that this review is for two truck deployment projects, one of which is larger ($8 million) than the other, and also considerably more nebulous and poorly planned. The reviewer added that the types of vehicles and their planned uses are not well-defined, so it is hard to know if there was going to be a good match. The reviewer stated that the researchers relied on one vendor for electric trucks, which turned out to be unfortunate, and could not find anyone, who could build the fuel cell trucks, probably because such vehicles might not make much sense. Also, the reviewer said you cannot deploy and test if you do not have vehicles.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer reported that since the project has been delayed there have been no technical accomplishment, but progress has been made by determining the old partners will not be in the program and the project needs to be restructured.

Reviewer 2:
The reviewer hated to be so harsh, but observed that the project team really did not get anywhere. Then again, continued this reviewer, the team did not spend much money.

Reviewer 3:
The reviewer indicated that the project had slow progress and was limited to no technical accomplishments.

Reviewer 4:
The reviewer stated that the progress is limited and that partnerships have been formed but the technology providers are not committed.

Reviewer 5:
The reviewer observed that given the inability of the commercial market to support the Houston-Galveston Area Council there have been no significant accomplishments.

Reviewer 6:
The reviewer stated that not too much progress has been made so far on the hydrogen fuel cell; in the meantime, the zero emission delivery vehicles were suspended.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that there is evidence of good collaboration from partners, but too many hurdles exist for the collaboration to be effective.

Reviewer 2:
The reviewer remarked that because the project is being restructured, it is not known yet who the project will be coordinated with.

Reviewer 3:
The reviewer said that the project team had some competent looking partners.

Reviewer 4:
The reviewer asked what happened to the partners that should have been in place for the project to receive the award.

Reviewer 5:
The reviewer commented that the project relied too much on the commercial partners.

Reviewer 6:
The reviewer stated that an industrial or fleet partner should be chosen to show a certain level of support from industry.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated that this future plan may be satisfactory as a plan, but it will significantly delay project timing for ability milestones. The reviewer added that the lack of supporting infrastructure and available validated hardware seriously jeopardizes the likelihood of success for this project.

Reviewer 2:
The reviewer stated that the next steps for the fuel cell electric hybrid project is to identify and agree upon a path forward for procurement and deployment of zero emission Class 8 trucks. The reviewer suggested completing the call for papers and selecting zero emission delivery vehicle partners for deployment of at least 30 trucks.

Reviewer 3:
The reviewer mentioned that if Smith starts production again, maybe this team will be able to deploy some electric delivery trucks, but the reviewer does see the team actually getting anywhere on the hydrogen (H_2) trucks.

Reviewer 4:
The reviewer remarked that it is difficult to justify continuing with current project objectives.

Reviewer 5:
The reviewer claimed that the zero emission delivery vehicle has to start over again, and no clear path can be seen.

Reviewer 6:
The reviewer stated that the path forward for the project is dubious.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer indicated that this project is relevant to the DOE objectives because it is to accelerate the introduction of electric transportation technologies into the cargo transportation sector.

Reviewer 2:
The reviewer pointed out that the project can be relevant if the benefits of the cost part can be shown.

Reviewer 3:
The reviewer said sure, if the project team ever deployed any trucks, the team would displace some oil.

Reviewer 4:
The reviewer stated that the value of the project will be to redirect to simulation and proper duty cycle definition for future product specification. The reviewer added that deployment should no longer be a focus.

Reviewer 5:
The reviewer commented that the lack of technology providers does not support the objective of petroleum reduction.

Reviewer 6:
The reviewer stated that no impact to petroleum displacement was demonstrated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that it is not clear if the funding identified for this project is adequate or not since at this time the project is being restructured.

Reviewer 2:
The reviewer indicated that the funding is insufficient to obtain the quantity of vehicles desired.

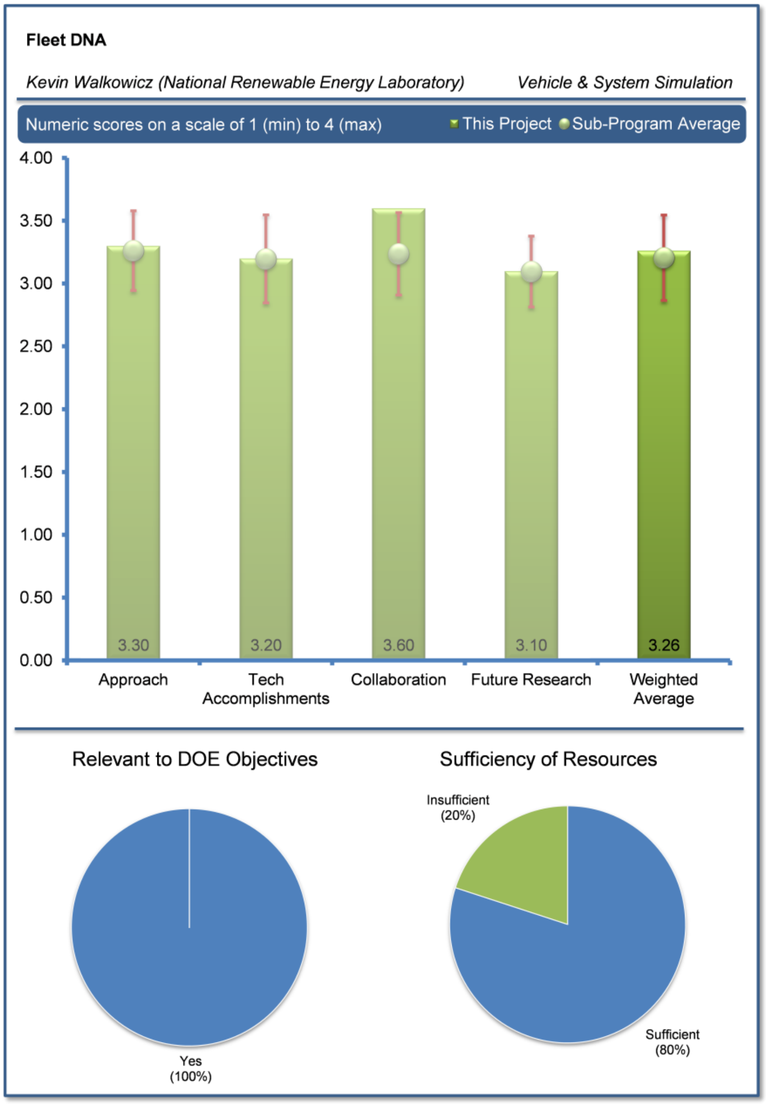
Reviewer 3:
The reviewer said that the current low spend status shows misalignment with project funding.

Reviewer 4:
The reviewer does not see this team actually accomplishing their tasks; the reviewer thought the team should send the money back.

Reviewer 5:
The reviewer is not sure that the program can even get started.

Reviewer 6:
The reviewer observed that the resources would not have been excessive if the hardware deployments and correct partnerships had been made, but given the lack of progress on this project it should be considered for cancellation.

Fleet DNA: Kevin Walkowicz (National Renewable Energy Laboratory) - vss119



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach provided is excellent. The development of the five distinct phases of the project is a well-structured plan that will provide for a successful project. The reviewer added that the specific phases of secure data storage, data base structure, data selection, data collection and data reporting is well designed.

Reviewer 2:

The reviewer stated that the approach addresses the intent of transparency along the lines of the open.gov initiative. The reviewer added that the project is an acknowledgement of the requirement challenges of data management and security that is addressed up front in a thoughtful and meaningful way. Although, it appears that the data management and reporting is in line with the Data Quality Act (DQA) is not mentioned.

Reviewer 3:

The reviewer remarked that this research provides objective vehicle use data that is both timely and relevant to numerous stakeholders including state agencies, federal agencies and end users. The reviewer added that the project is timely and relevant in the sense that the data created in this research will be used by policymakers who are crafting rulemaking to regulate greenhouse gas emissions. The reviewer stated that the project is also well designed to cover a broad spectrum of commercial vehicle classes and applications. The large sample size was greater than 2,000 before the program end. The data will also be used to provide useful drive cycle data for simulation tools commonly used at the national laboratories and in industry. The reviewer commented that it was stated that this project will assist in determining benefits of using technologies such as hybrid, electric vehicles, alternative fuels, etc. It would arguably bring more benefit to fleet owner by evaluating conventional technologies to save fuel. For example, engine rating, transmission gearing, overdrive versus direct drive, axle ratios, tires, etc. Furthermore, public access to data is limited to sanitized, simplified reports. The more useful drive-cycle data access is limited. To increase the benefits of the program, it would be worthwhile to look into ways to make some drive-cycle data available; for example in some anonymize form, or without global positioning system (GPS) coordinates and curvature information in the drive cycle.

Reviewer 4:

The reviewer reported that the project strong point appeared to be characterization of fleet drive cycles of MD and HD vehicles used in specific real world vocations. The reviewer pointed out that the project weakness appears to be insufficient resolution/detail regarding component and system characteristics necessary to enable robust model development and validation. For instance, they estimate a vehicles mass but have not yet validated their estimation algorithm. The reviewer stated that the project team appeared to be documenting system level usage patterns of technologies at a high level without trying to capture independent variable and component details that could inform development of component and system level models.

Reviewer 5:
The reviewer said that the overall project objective was sound and provided a useful data storage and dissemination tool. The reviewer added that the novel methods for calculating road grade and estimating vehicle parameters from field data appear to be significant contributions; however, it was unclear why there were not many known mass data points. The reviewer asked if the vehicles in the study were not known, and if so, why not. The reviewer also reported that one limitation of the data appears to be that only open-source OBD data or OEM-supplied data are available and no "CAN cracking" was performed for the vehicles in which data loggers have been installed. The reviewer asked as more vehicles is being introduced by companies that are not partners, how the data from high voltage (HV) batteries will be obtained. The reviewer also asked if the plan was to increase the number of partners, engage in CAN cracking activities, or ignore vehicles for which neither was an option. The reviewer commented that the justification for use of FastSim at all rather than Autonomie exclusively doesn't appear to be compelling. The advantages of the former should be explicitly stated in subsequent years. The reviewer added that the term "kinetic intensity" is obscure and should be explained, for example using the equations from SAE World Congress paper 2007-01-0302.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer reported that significant progress has been made in expanding deployments and harmonizing data, which is a very complicated and tedious process. Additionally, the reviewer stated that more detail on how this is accomplished should be well documented. The reviewer added that the website is a very effective tool and a very valuable resource for education. The foresight to integrate existing analysis tool where possible is commendable. The reviewer indicated that this is an enormous amount of work, but it is important. The reviewer added that some information should be provided on data formats, such as xml. The reviewer asked what, if any, standards were being followed.

Reviewer 2:
The reviewer stated that improvements to the data storage warehouse, positions the program well to handle large amounts of data in a useable format. The reviewer commented that a robust and structured approach appeared to be in place to be scaled up to handle a large population of vehicle data. The project is well set-up for the future. The reviewer added that additional analytics such as algorithms for gross vehicle weight estimation and elevation grade data are a good foundation to enhance capabilities, such as fuel consumption analysis.

Reviewer 3:
The reviewer stated that the project team has made significant progress in collecting vehicle data. The reviewer added that this start in the right direction that should be built upon to provide information to inform future R&D and regulatory efforts.

Reviewer 4:
The reviewer stated that the technical accomplishments provided in FY 2014 have shown good progress towards the project objectives. Accomplishments include development of initial phase two interactive website and preliminary method to estimate mass based on drive cycle, fuel consumption and road grade information. The reviewer added that several tools have been developed in FY 2014 including the fuel economy modeling FASTSim integration with Fleet DNA Project.

Reviewer 5:
The reviewer stated that the project appeared to be on schedule. The reviewer would have liked to know a little bit more about the mass estimation study (which the reviewer would call the parameter estimation study since it appears as though the PI is estimating the ABCs, and not just mass). The reviewer then asked if there are milestones involved or simply a target date of sometime in FY 2015.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that most of the key players cited as collaborators are there, but DOT is an obvious omission. The DOT may provide valuable information about not only their own fleet, but also about all the commercial traffic from which they collect information. The reviewer suggested that the researchers consider collaboration with the National Information Exchange Model because data harmonization is such a large part of the effort (https://www.niem.gov/Pages/default.aspx). The reviewer stated that the Indianapolis project was a good application of research results example.

Reviewer 2:

The reviewer stated that this project appears to have strong collaborations with industry and government data providers. The reviewer added that it also appears to have strong collaborations with ORNL for data collection.

Reviewer 3:

The reviewer reported that collaboration and coordination with other institutions is very good. This year there is more interaction with industry/government and OEMs. The reviewer added that there are additional industry partners, more interaction with national laboratories, government and universities as well as OEM and industry groups.

Reviewer 4:

The reviewer indicated that evidence of strong collaboration was provided based on specific examples when asked. The reviewer added that numerous partners in industry as well as federal/state agencies and national laboratories were described in detail.

Reviewer 5:

The reviewer said that this project has an impressive array of project partners and participants. The reviewer added that it appears as though efforts are continually being made to add partners and participants to the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked that there are several key areas for proposed future work including integration of results into the Alternative Fuels Data Center, the integration of additional modeling software with the fleet DNA data base and into non-DOE tools such as EPA Motor Vehicle Emissions Simulator (MOVES). In addition, the reviewer said that the project is looking at selective cycles and vehicle type to evaluate potential for fuel cost savings over a range of technologies and fuels is planned for future work. The reviewer added that the project will be applying the fleet DNA to several other areas including helping EPA GHG Phase 2 regulations as well as SCAQMD and CARB next year.

Reviewer 2:

The reviewer said that the data reporting and website plans appeared to be well-established, but the modeling aspect does not have the same structure. The reviewer added that the plans to bring more vehicles with known parameters into the parameter estimation study needs to be made more solid.

Reviewer 3:

The reviewer indicated that the target to add vehicles to the dataset will help to increase the objectivity and relevance. Conducting what if scenarios using advanced technologies are also a useful outcome. The reviewer added to also conduct what if scenarios with conventional technologies as well, because conventional technologies also have a large influence on fuel consumption (engine rating, transmission, axles, and tires). The reviewer added that with the program ending in FY 2015, questions arise regarding maintenance and further data collection efforts beyond. This research has merit and the outcome add value to numerous stakeholders. Also, the reviewer said it would be recommended to draft a plan for operation of the data servers and maintenance of the data after the project ends.

Reviewer 4:

The reviewer stated that additional sensor information on ride quality may be considered. These days, accelerometers are everywhere, so some indication of the effect of ride quality on the fleet performance would be valuable to determine effects of pavement condition on the overall fleet performance relative to other variables.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project is extremely relevant and will be useful to the VTO. The reviewer added that the data gathering activity will provide information to government, OEMs fleets and researchers to help provide for drive cycle development, customer use profiles and provide a data source for modeling and simulation.

Reviewer 2:

The reviewer stated that the project is helping researchers to collect data for assessment of real world technology requirements and system level performance of advanced MD and HD vehicles.

Reviewer 3:

The reviewer reported that this project provides objective and relevant data how commercial vehicles are being used, which several consumers rely on including policy and decision maker at federal/state agencies as well as industry to effectively create rules that are effective in displacing petroleum in support of DOE's mission.

Reviewer 4:

The reviewer noted that any slight gains that can be made in fleet efficiency translate to a large effect on GHG emissions and fuel consumption.

Reviewer 5:

The reviewer claimed that while LD vehicles get most of the attention, MD vehicles and HD vehicles account for a significant proportion of the U.S. petroleum consumption. The reviewer added that the Fleet DNA tool enables stakeholders from a wide variety of areas to access data that can help make fleet and design decisions to reduce petroleum consumption of these vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that with funding 60% complete and the project in Year 3, it appears funding will be sufficient to complete the project.

Reviewer 2:

The reviewer claimed that funding appears to be sufficient.

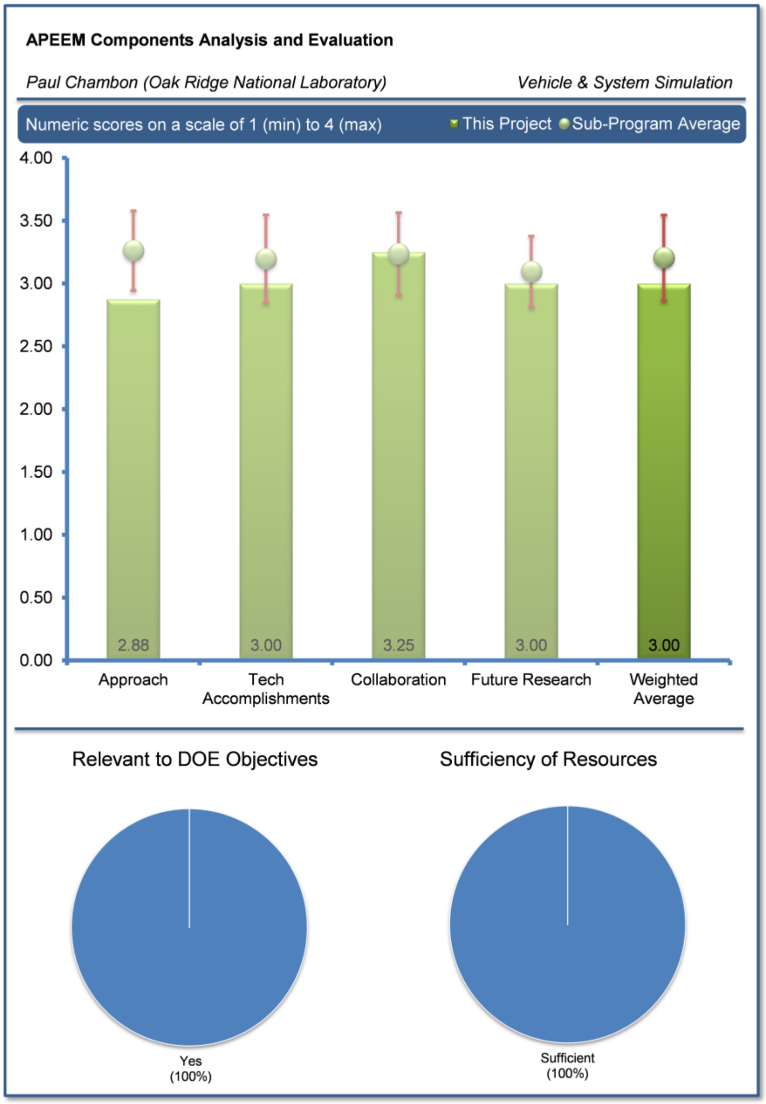
Reviewer 3:

In talking with the presenter, the reviewer concluded that it did not appear as though more funds were required to complete the project and the level of current funding is appropriate for the scope of work.

Reviewer 4:

The reviewer said that to fully address the project objectives, the team should have more resources to increase the depth of information that they capture regarding component characteristics and system states.

APEEM Components Analysis and Evaluation: Paul Chambon (Oak Ridge National Laboratory) - vss121



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that this is a program with exciting potential. The reviewer added that it is good to see that the project is making it through the initial difficult stages of setting up a dynamometer laboratory. Also, the reviewer said that the next stage is the evaluation of some known components to establish a validated capability.

Reviewer 2:

The reviewer noted that significant thought was given to the need for the facility and its integration with other lab functions; however, hardware purchases lacked formality of a rigorous technical specification development. The reviewer said that more thought should be given to both calibration and validation of the hardware and the Autonomie models that are planned to drive it.

Reviewer 3:

The reviewer stated that the approach to procure and commission a test cell to characterize steady state and transients of hybrid electric powertrain components provides for an adequate way to reach the goals of the project.

Reviewer 4:

The reviewer commented that it is not clear how "Validate, in a systems context," is a barrier. The VTO Multi-year Program Plan lists it as a goal for VSST. This statement could serve as a goal for this project, but the reviewer would imagine that the barriers in this case are costs, and a lack of standard protocols for transient testing, and the goal of this project would be to address the latter.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the project has had good progress to date. The reviewer added that it takes a long time to set-up this type off facility.

Reviewer 2:

The reviewer commented that all procurement activities have been completed and commissioning of the test cell is scheduled for July 2014. The reviewer added that preliminary electric machine characterization has been successfully completed.

Reviewer 3:
The reviewer indicated that hardware purchases are on schedule; however, startup and calibration (where you typically do not know what you do not know) are yet to be completed.

Reviewer 4:
The reviewer stated that significant progress appears to have been made in the set-up of the test cell. It is not clear though, whether the e-machine characterization (shown on Slide 11) is an accomplishment from the standpoint of transient testing. If these are steady state maps for the motor, this capability already existed at ORNL. The reviewer suggested to make it clear in the presentation if this is a result of transient testing.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer asserted that there was an excellent thought process to integrate the test results of the new facility with other ORNL laboratory functions, and with other laboratories.

Reviewer 2:
The reviewer noted no issues here.

Reviewer 3:
The reviewer stated that collaborations between ORNL, ANL, U.S. Drive Electrical and Electronics Tech Team, the VTO Advanced Power Electronics and Electric Motors (APEEM) group have been essential to provide the necessary information for the project to move forward.

Reviewer 4:
The reviewer pointed out that collaboration is mostly internal at this point and understandably. The reviewer thought it would be interesting next year to see how the facility is intended to be used by the access to technologies for test, both production and developmental. The reviewer added that the mix should be more developmental but validated through current production systems.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer described proposed future research as good so far, and suggested expanding as the facility is established.

Reviewer 2:
The reviewer stated that after the commissioning of the test cell it would be an excellent plan to support the DOE APEEM program through the use of the new test facility.

Reviewer 3:
The reviewer said that in the response to reviewer comments from 2013, the PI stated that scope of this project is the procurement and commissioning of the new test equipment, and that the actual projects will be funded by other projects. With this in mind, the reviewer asked if the nucleate boiling project is considered as a part of this project, or if it is a separately funded project. The reviewer added that if the FY 2015 future work is not part of vss121, it should perhaps be made clear that vss121 is completed with the commissioning of the test cell.

Reviewer 4:
The reviewer reported that the creative parts of the project are complete, with the purchase of the facility hardware. The reviewer added that the detail work of getting the pieces to work together has yet to be done.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer indicated that this project can assist the DOE and industry in the selection of relevant technologies for pursuit/investment and could shorten an industrial selection process if properly established.

Reviewer 2:
The reviewer claimed that the ability to benchmark transient response of current technology and establish improvement areas will help direct DOE efforts to improve electric drive components.

Reviewer 3:
The reviewer said that this test cell will be important to the future work of the advanced power electronics and electrical motors R&D activity and will support the goal of petroleum displacement.

Reviewer 4:
The reviewer stated that steady state characterizations of powertrain components are frequently (perhaps always) used in evaluating the fuel economy potential of advanced technologies; however, by neglecting the transient characteristics, there may be testing powertrain configurations that are not necessarily acceptable from a customer experience standpoint, perhaps in terms of performance, or drivability, or some other dimension. The reviewer added that characterizing transient behavior of these components and incorporating them in simulations should make the simulation more realistic and the results of the simulation more in line with customer expectations.

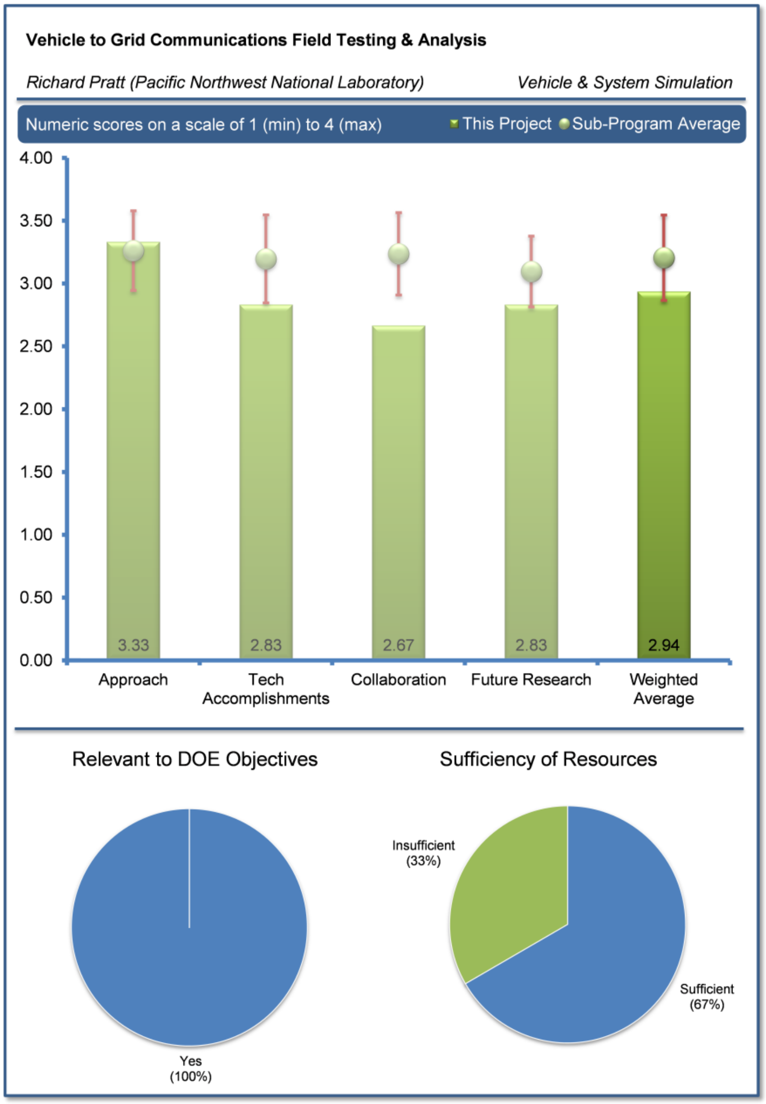
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer felt that the resources are sufficient to complete this project but future work identified in the presentation has not been funded yet.

Reviewer 2:
The reviewer said that care should be exercised to obtain proper resources to startup and calibrate the facility. The reviewer added that validation of the initial test results should be a serious consideration and will require both technical and operational resources.

Reviewer 3:
The reviewer said that resources were sufficient, but bordering on insufficient. The reviewer added that next year’s progress will determine how fast the lab achieves validation and more importantly recognition by industry for what it is trying to do.

Vehicle to Grid Communications Field Testing & Analysis: Richard Pratt (Pacific Northwest National Laboratory) - vss122



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that the project is a blend of grid and vehicles. The project provides a path that recognizes that both can work better together with a system of systems approach. The reviewer added that the project is looking to leverage the growing existing fleet's technology to perform grid interactive services to enable a stronger grid and provide good battery charging capability.

Reviewer 2:

The reviewer noted that the use of employee-owned vehicles saves money and gets buy-ins. The reviewer liked the fact that the project starts out simple and advances. The reviewer also liked the fact that the approach tries to look at the impact of on and off charging multiple vehicles at one time; however, the importance of some manual override to allow the homeowner to decide what should get priority on the household electric load cannot be underemphasized and was omitted from this project. The homeowner should be allowed to decide whether electric vehicle charging is more important or running the air conditioner and certain household HD appliances (i.e., dishwasher, washer, dryer, etc.) is more important during peak periods when there is a goal of capping the electric power demand.

Reviewer 3:

The reviewer stated that the project approach addressed some of the barriers mentioned in the presentation. The reviewer would have liked to hear more about how the charging scheme biased charging to meet owner preferences and provide communication between chargers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the project had excellent results in demonstrating the capability of load coordination in minimizing the peak loading of a home over a day. The reviewer suggested that the project include a follow-on scope to investigate the fiscal viability of peak shaving and other grid services to offset the cost of an EV.

Reviewer 2:
The reviewer said that the fact that the project is only 50% complete, started October 2013 and is due to end September 2014 does not bode well. The reviewer assumed that progress must be linear in the absence of a schedule of milestones in the presentation. The reviewer claimed that the project should have been about 66.6% to 75% completed.

Reviewer 3:
The reviewer reported that, for the testing approach, the project used a home load assumption. The reviewer commented that the project would have benefited from doing more testing on the assumption of the home load. The reviewer added that it appeared that the amount of charge needed for each car was a manual input, which is not ideal; however, if the EVs could not be modified and that information was not part of the standard set of signals provided the reviewer could see why manual adjustments were necessary.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that Bonneville Power Administration was not listed on Slide 2 or Slide 14 as a collaborator. The reviewer asked why electric power from a utility, whose source of electric power generation is primarily hydroelectric, was chosen should have been answered. Also, the choice of Professor Steve Letendre from University of Vermont was not listed on Slide 2. The reviewer concluded why this person was chosen was not clear.

Reviewer 2:
The reviewer indicated that the partners provided on Slide 2 do not align with the list of collaborators on Slide 14. The reviewer added that having SAE and NIST are not really partners, committees are not partners. The reviewer stated that the only partner that appears to have contributed/benefitted is AeroVironment.

Reviewer 3:
The reviewer commented that the project acknowledged collaborations with SAE and the University of Vermont as well as industrial partners involved in the project. The reviewer added that further coordination with utilities to verify the home load assumption would have been useful.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that future research seems to be focused on catching up to complete the project by September 2014; there is no vision beyond that.

Reviewer 2:
The reviewer noted that the project is ending at the end of FY 2014. The reviewer suggested a follow-on scope to look at the fiscal value of grid services.

Reviewer 3:
The reviewer explained that the project still has field testing to do which will enhance the findings of this effort. The reviewer added that a useful scenario would be to look at the California International Organization for Standardization (ISO) and what happens in the Spring/Fall with the influx of rooftop solar.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that this project is highly supportive of the overall DOE objective of petroleum displacement.

Reviewer 2:

The reviewer indicated that the project clearly demonstrated that EVs can have a positive impact on the grid by reducing peak loads and spreading loading out more evenly which can improve utility efficiency and reduce utility investments.

Reviewer 3:

The reviewer stated that charging multiple vehicles at home may be an issue; we do not want brown-outs when everybody in the neighborhood is doing it.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

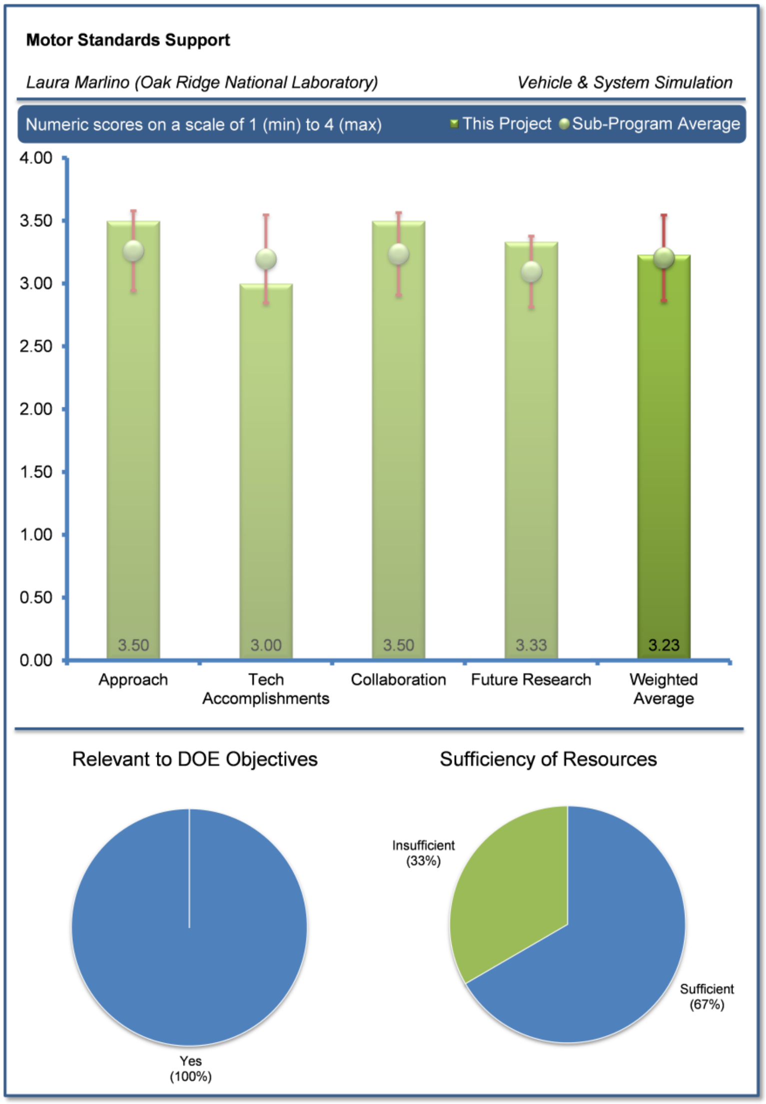
Reviewer 1:

The reviewer explained that the project team had a very resourceful approach to use employee owned vehicles; however, this introduces risk to the project in that the vehicles can easily be denied from the research. The reviewer suggested that funding be increased to provide the vehicles required.

Reviewer 2:

The reviewer said that the resources for the project were sufficient.

Motor Standards Support: Laura Marlino (Oak Ridge National Laboratory) - vss123



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that it is great to see this effort underway again. The reviewer pointed out that some of the outstanding issues that were brought up are extremely relevant and worth getting resolution on. The reviewer asked which inverter should be used for testing because this has an impact on motor operating points, losses, etc. The reviewer also stated another issue was that efficiency maps need to include how the input and output power was measured and the accuracy of those sensors, especially for low torque points, which are critical for EPA testing.

Reviewer 2:

The reviewer said that this was an essential task that needed to be accomplished, and probably would not see much progress from the manufacturer's side if there was not an external organization that was facilitating the whole process.

Reviewer 3:

The reviewer stated that the approach being used in this project to address the lack of standardized test protocols seemed sound. The project is going through the SAE project and collecting input for all the key stakeholders. The reviewer added that the main point associated with the testing is that this project seeks to test the motor-inverter combination using the inverter designed for the given motor rather than a standard inverter. In order to get the apples to apples comparison sought by this project, the reviewer said that further research is needed on measurement accuracy and how to look at losses.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the project has made a lot of process with researching standards and test procedures. The reviewer added that the project defined the five tests that will be performed as peak power, torque, continuous power, continuous torque and efficiency mapping.

Reviewer 2:

The reviewer said that the progress of this project is not entirely within the control of the PI, and requires the OEMs to play a more active role. The reviewer added that given the nature of the beast, the project is likely to progress slowly.

Reviewer 3:

The reviewer commented that it seems like this work is in its early stages. So, it is hard to judge technical progress.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that it seems like the correct committees are involved and that there are enough motor experts on those committees. The reviewer added that it would be useful to have inverter/power electronics input as well.

Reviewer 2:

The reviewer indicated that collaboration with SAE, national laboratories, OEMs, universities and Tier 2 suppliers was mentioned. Also, international collaboration with China and Nissan was mentioned. This sounds like many parties to orchestrate with limited funds. The reviewer added that other collaborations that should be considered are with the standards committees associated with cooling and isolation requirements, and perhaps Ricardo.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer claimed that the future issues are clearly outlined; however, getting resolution towards them will be tricky.

Reviewer 2:

The reviewer would like to have heard more from the current PI (as opposed to a previous contributor in the audience) about how the future work was going to be accomplished. The PI proposed to validate test methods on LD in FY 2015. That seems hard to do and it was unclear where the funding is for validation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said yes, by ensuring that the performance numbers published by all the OEMs can be compared on the same basis, it helps the customer make a more informed decision (even though the average customer may not even be aware of it).

Reviewer 2:

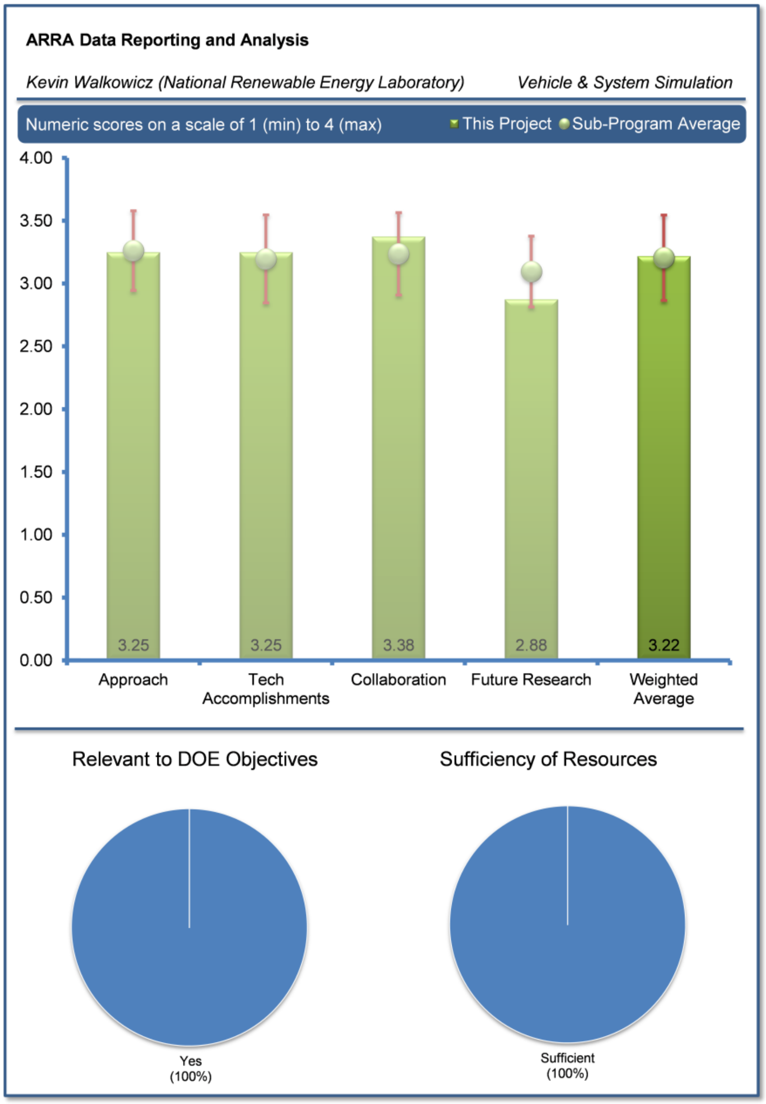
The reviewer pointed out that standards by themselves do not displace petroleum, thus the project provided secondary support to the DOE's objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources seemed a little low given the level of coordination needed and the little direct control the PI had over the other contributors to the project.

ARRA Data Reporting and Analysis: Kevin Walkowicz (National Renewable Energy Laboratory) - vss124



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach to collect and analyze data on over 25 parameters from each vehicle, to provide reports to the general public is very good. Also, it will help to educate the public about truck electrification. The reviewer added that the truck electrification project has collected data over a one-year period at 50 sites. This data showed that by using this technology, over 32,000 gallons of diesel fuel was saved that would have otherwise been used during idle. This information could help fleets to move toward this technology.

Reviewer 2:

The reviewer remarked that the approach to data collection and reporting on four separate projects appeared to meet the requirements for analysis and dissemination.

Reviewer 3:

The reviewer stated that this project is only receiving and analyzing the data from ARRA funded projects without any input to vehicle deployment and operation (i.e., listen only mode). The reviewer commented that the project team had a relatively standardized approach to data collection and reporting. The reviewer added that it would be good to see vehicle uptime as it compares to conventional diesel vehicles. Also, the reviewer said that it was good to see plans go through the dataset after the collection is complete for a more in-depth analysis.

Reviewer 4:

The reviewer indicated that regarding project planning the project start/end dates and overall project structure are not clear. The reviewer perceived it was hard to judge what was accomplished this year and in the past. The reviewer noted that a large data set of in-service vehicle use was collected, which is valuable. That being said, the real benefit of the project is the analysis of the data to generate insights and draw conclusions. The reviewer added that while periodic reports were created to highlight vehicle usage, there did not appear to be a robust analysis plan in place or an explanation of what sort of objectives are sought upfront.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer said that the progress in this project has been very good. The reviewer pointed out that a large amount of data has been collected and analyzed on the 500 Smith EVs. The reviewer added that analysis has determined the potential grid load effects and how these vehicles may impact electrical demand.

Reviewer 2:
The reviewer stated that large datasets are being collected, and will hopefully be used for further analysis and be made available to the public. Because some of the vehicles are not commercially available anymore, it would be nice to see these data used as lessons learned for development of future electric trucks.

Reviewer 3:
The reviewer said that all four projects appeared to be meeting all execution and reporting requirements. The reviewer added that all projects are either substantially complete or completing in 2014.

Reviewer 4:
The reviewer commented that detailed data collection on 459 Smith EVs, 101 Navistar eStars and 1,000 electrified truck stop pedestals culminated in the creation of 23 reports. The reviewer said that the project appeared to be largely a data collection effort to date.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that the partners involved in the project represented good collaboration with industry and local government. The reviewer added that this type of coordination has provided for a successful project.

Reviewer 2:
The reviewer explained that data reporting was a requirement of ARRA funded projects. The reviewer noted that it would be nice to see an opportunity for NREL to provide feedback to fleet users, besides quarterly summary reports, on potential opportunities for operational optimization (are vehicles used on proper routes, would driver training be helpful in case there is significant variation in the data set). The reviewer added that it is understood that this was most likely out of scope for the current project but since the data set is very significant there could be a lot of lessons learned based on data summary as well as on individual fleet operations.

Reviewer 3:
The reviewer noted that this project had collaboration with numerous fleets and vehicle OEMs for data collection efforts.

Reviewer 4:
The reviewer said that collaboration with project partners was an essential part of these projects and the fact that all are substantially complete demonstrates the effectiveness of the collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that collecting additional data through FY 2015 will help this project address the barriers identified of obtaining unbiased data and variable commercial fleet use. The reviewer added that the new effort proposed for FY 2015 and FY 2016 to use data to analyze operation for energy efficiency, energy storage cost improvements and better placement of vehicles into fleets to optimize return on investment should be considered by the DOE.

Reviewer 2:

The reviewer thought it was nice to see plans for in-depth data analysis after the collection of data is completed. Additional parameters of interest in follow-on analysis would be battery pack failures (if any), battery/range degradation, vehicle utilization (uptime, miles between road calls) if possible compared to typical baseline vehicles. In general, the reviewer said that the opportunity to incorporate some fleet feedback might compliment the current dataset for a more complete analysis. For example, MGP equivalent might look great but there could have been start ability, cold weather issues, inadequate vehicle speed and performance according to drivers that would not necessarily come out of the current dataset.

Reviewer 3:

The reviewer said that it was mentioned that for FY 2015, the data analysis portion of the project will begin. The reviewer would have liked to see a clear understanding what insights would like to be gained upfront, from the data collection and analysis activities.

Reviewer 4:

The reviewer reported that more definition on the future analysis that is or could be undertaken is needed. The reviewer added that the secondary analysis that was done as a result of what was learned could also be pursued.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that this project collects and analyses data from electric trucks to allow better understanding of the state-of-the-art of the technology. The reviewer added that the MD EV data collection will help design, purchase and research investments and in the long term help with petroleum displacement.

Reviewer 2:

The reviewer remarked that all technologies employed for these studies very directly address the reduction in petroleum consumption.

Reviewer 3:

The reviewer noted that this project collects data on electric drive vehicles and provides operational summaries. The reviewer added that this data will not only be useful to potential fleets interested in purchasing these vehicles but also for development of future generations of electric trucks. Therefore, this project is directly supporting increased EV deployment in MD and HD truck segments.

Reviewer 4:

The reviewer said that this project's activities of collecting and analyzing vehicle technologies in service provide a measure of impact is highly aligned with DOE's goal of displacing petroleum.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer pointed out that, for FY 2015-2016, DOE should consider funding follow-on work to conduct in-depth analysis and engage fleet operators as appropriate to get a better understanding of the vehicle use and performance from the operator's perspective. Additionally, there could be valuable lessons learned and recommendations that could be made for specific fleets based on how their individual data sets compare to the aggregated average. The reviewer added that making this large data set available in some form to researchers at the national laboratories, universities, other OEMs and suppliers if not to the general public, would be very helpful for additional analysis, future generation electric vehicle technology development, as well as fleet education.

Reviewer 2:

The reviewer stated that funds appear to be sufficient for the activities planned in this project.

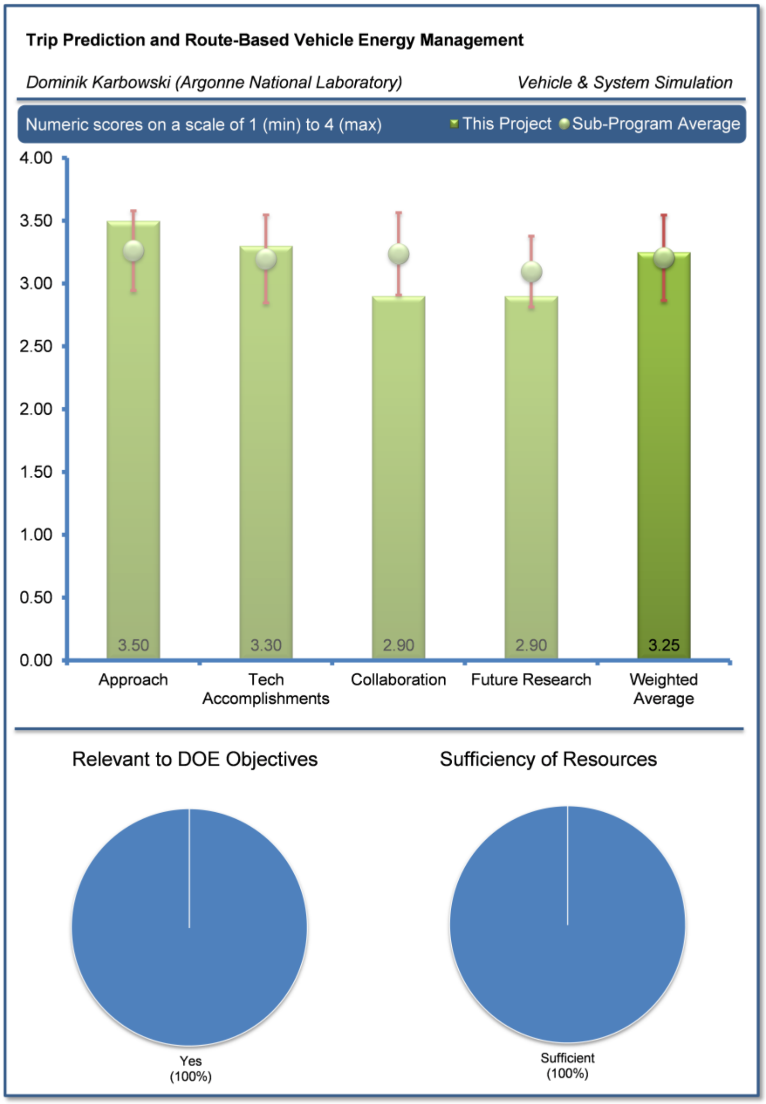
Reviewer 3:

The reviewer said that the project funding appears to be sufficient.

Reviewer 4:

The reviewer did not identify any deficiencies in meeting objectives/milestones, so the reviewer concluded that resources must be sufficient.

Trip Prediction and Route-Based Vehicle Energy Management: Dominik Karbowski (Argonne National Laboratory) - vss125



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this is an excellent piece of work, showing what the capabilities are with the availability of big data and computing power.

Reviewer 2:

The reviewer said that the approach developed for trip prediction and route based energy management is very good and should provide the tools to complete the project.

Reviewer 3:

The reviewer reported that the approach for the subject was good. The reviewer supports the concept of developing incremental improvements to the existing geospatial mapping systems that can be translated into an efficiency improving product.

Reviewer 4:

The reviewer noted that trip prediction and route-based vehicle energy management is an interesting concept with the potential to improve vehicular trip efficiency across a variety of vehicles and trip itineraries. The reviewer added that the approach for this project appears sound basically using existing technology and information including drivers input, traffic information, and GPS data to feed an itinerary computation. Also, the reviewer stated that the detailed segment-by-segment information is then fed into a speed prediction algorithm generated from a constrained Markov Chain approach, where synthetic speed vehicle speed profiles are generated. The outputs are processed and filtered and ultimately a transition probability matrix is constructed. The reviewer commented that an optimal control strategy is subsequently developed based upon the Pontryagin Minimization Principle (PMP). The benefits of the optimal energy management strategy are then evaluated. The reviewer saw no glaring deficiencies evidenced in this approach and it is good that the proposed technology can likely be accommodated in today's technology vehicles.

Reviewer 5:

The reviewer mentioned that the trip prediction and route-based energy management are an important area for petroleum displacement. This project appears to be creating the fundamentals that will lead to the real-time control that is needed for trip prediction and energy management to realize the potential efficiency improvements for all types of vehicles. The reviewer added that on Slide 11, the PMP results only improve upon the reference case late in the drive. The reviewer asked if this was a consistent result for the Prius PIP. The reviewer also wondered if finding the instantaneous optimization for each time step does indeed get one the global optimization for the route. The average savings was 5% for the Prius, but the reviewer asked how this relates to the best that could be done if a complete optimization was done by eliminating the stochastic nature of driving.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the analysis appeared to be well-supported and logical.

Reviewer 2:
The reviewer stated that the progress in the project has been very good. Showing 5% fuel savings through optimal energy management is an excellent result and shows how this work will help to ultimately provide for reduced petroleum consumption.

Reviewer 3:
The reviewer explained that overall, the technical approach is very good. The reviewer had one concern (which the reviewer thought could be easily remedied) when the reviewer looked at the synthetic speed profiles on Slide 8. The speed trace appears, at times, to have rather abrupt transitions from one speed to another. This is not an issue when using steady state maps to predict fuel consumption. But, based on some other presentations from this year's AMR (e.g., vss121), the intention appears to be to move towards better representation of transient behavior to capture the system behavior. The reviewer added that some smoothing of the speed profiles may be required to prevent unacceptable levels of accelerations. The plot on Slide 8 may just be a cartoon to convey a point, in which case, please ignore this comment.

Reviewer 4:
The reviewer said that this is a two year project currently scheduled to end in September 2014. The reviewer added that based on the duration of the project and funding levels, a significant amount of progress has been achieved. The project is roughly on schedule (maybe a little behind). The reviewer stated that the basic concept has been scoped with specific technical accomplishments.

First, the reviewer noted the speed profile generated from constrained Markov Chain where for each itinerary segment the algorithm generates a stochastic speed profile until the a solution matches the segment constraints and subsequently the entire trip is the concatenation of stop periods and sped profiles from all segments.

Second, and in reference to synthetic vehicle speed profiles, this reviewer observed multiple stochastic speed profiles for the same target micro-trip have been generated and combined to form one synthetic speed profile for one entire itinerary.

Third, and in reference to Markov Chains, the reviewer commented that using real world data, processing and filtering of trip data has been successfully undertaken. This reviewer further stated that each trip was being quantized and a probability matrix has been defined after normalization.

Fourth, and in reference to energy management using the Pontryagin Minimization Principle, this reviewer reported that optimal control strategy for a Prius PHEV has been identified and implemented in a control strategy for Autonomie.

Fifth, this reviewer indicated that the benefits of the optimal energy management strategy have been evaluated for the Prius PHEV over the defined itinerary resulting in an approximate 5% savings. The reviewer observed a solid list of accomplishments over the last year and a half.

Reviewer 5:
The reviewer said that the project appears to be progressing, and the Prius results show that the approach is sound. It would be helpful to the reviewers for specific milestone dates to be listed to allow for a better understanding of the project status. The reviewer asked why some of the milestones are broken up into two sections.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer perceived that the overall collaboration/coordination for the project seemed good. Partners include HERE for a free demo license of ADAS-RP and support for data processing. Internal coordination exists with ANL's Transportation Research and Analysis Commuting Center (TRACC) for traffic dynamics support and stochastic tool development, and coordination with OEMs. The reviewer added that one possible notable omission is the lack of coordination with other national laboratories such as ORNL, which has done work in the recent past using Markov Chains (Andreas Malikopoulis).

Reviewer 2:

The reviewer commented that listed in the proposed future work is integrating other real world trips from other databases (presumably the PI is referring to the Transportation Secure Data Center that is maintained by NREL). The reviewer said perhaps this should have been done sooner rather than later, it would have helped to validate the approach and assumptions going into this project much better.

Reviewer 3:

The reviewer said that collaboration with HERE, which provided a free license of ADAS-AP, was essential to the project. The reviewer added that other groups including ANL transportation research and analysis computing center and OEMs also participated in the project.

Reviewer 4:

The reviewer opined that the collaboration front is satisfactory at best. Nokia is a minor player in the market trying to survive. The reviewer suggested that the project team should go after a company like Google or Apple. The OEMs will be buying the software from one of them anyway. The reviewer stressed that the project team needs to think bigger.

Reviewer 5:

The reviewer stated that the only significant collaboration appears to be with HERE. The reviewer said that there is discussion with OEMs mentioned, but nothing to indicate the level of collaboration. Also, the reviewer reported that collaboration with other modeling groups, from other national laboratories, industry, and academia, might be useful additions to the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the proposed future research is exactly where this project should strive to achieve. The reviewer added that the listed future tasks are appropriate and feasible.

Reviewer 2:

The reviewer reported that the proposed future work of evaluating other applications such as trucks and buses as well as different configurations would be useful information to obtain.

Reviewer 3:

The reviewer commented that evaluating trip plans by developing an algorithm is admirable but needs to address the many inputs that will affect the process, only a couple have been addressed here.

Reviewer 4:

The reviewer pointed out that the proposed future research contains good elements, but appears to jump the gun. While initially promising results (approximately 5% fuel economy improvement) have been demonstrated for a Prius PHEV over a single itinerary, this may very well prove to be a high water mark. The reviewer added that the presenter indicated the Prius PHEV may be an optimal vehicle for this type of technology and the drive cycle chosen appears to be fairly optimal as well. As a result, this technology may have considerably less promise than seems on the surface when it is examined across the benefits to the vehicles that will predominate in the nation's fleet for many years and over more typical driving cycles. Also, the reviewer said that prior to conducting future research on this topical area, it is recommended that a thorough assessment be done as to the comprehensive real potential of this technology across the nation's fleet. As part of this assessment, coordination with OEMs should be conducted to assess the cost of the technology to the consumer through its benefits.

Reviewer 5:
The reviewer referenced previous comments regarding integrating other real world maps from other databases.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the project is relevant to the VTO goals because it will help enable highly efficient cars and reduce energy use.

Reviewer 2:
The reviewer indicated that by utilizing more realistic drive cycles, it will bring in a real-world dimension to the calculations and petroleum displacement predictions.

Reviewer 3:
The reviewer reported that while unproven, trip prediction and route-based vehicle energy management does offer the potential to improve vehicle trip efficiency over a wide range of vehicles and driving applications, potentially leading to solid petroleum savings.

Reviewer 4:
The reviewer said that being able to enter one's destination into the vehicle computer and then having the vehicle optimize the control system (in real time) would significantly reduce petroleum consumption. The reviewer added that this project has potential to add considerably to the art.

Reviewer 5:
The reviewer commented that incremental improvements to our mapping system will always be needed.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

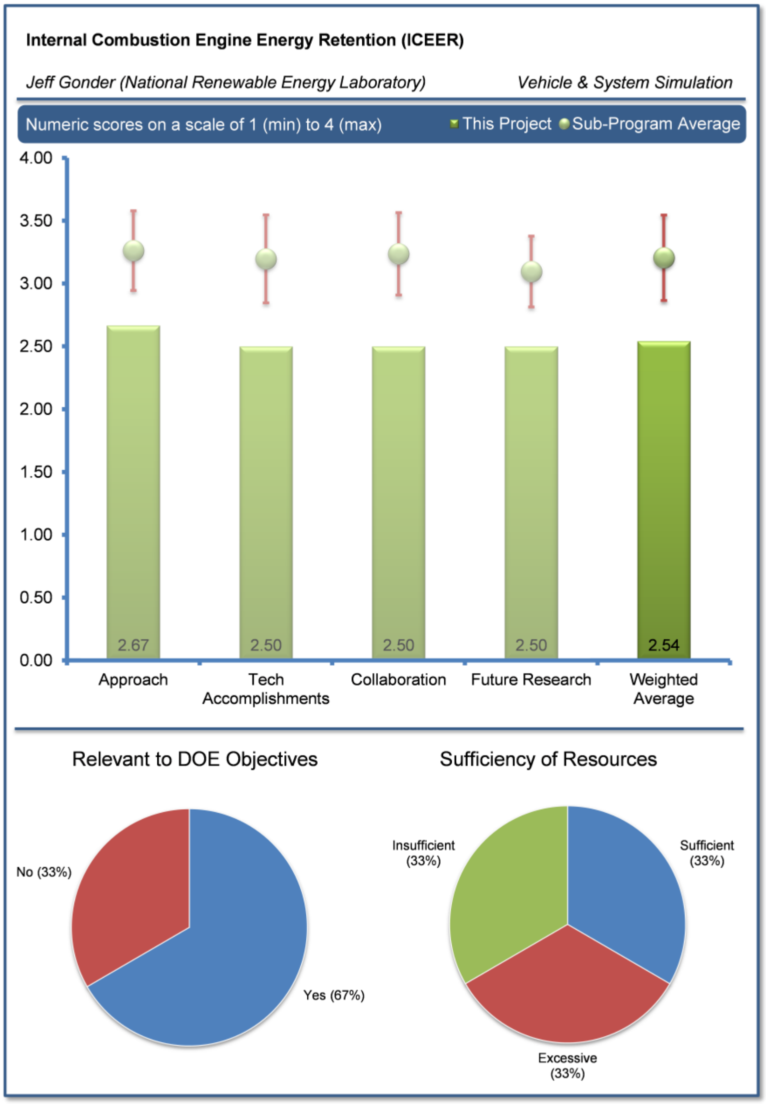
Reviewer 1:
The reviewer remarked that the resources are adequate to complete the proposed work.

Reviewer 2:
The reviewer stated that resources are sufficient until the program management expands the vision of what this project can do and who it is working with.

Reviewer 3:
The reviewer commented that the resources applied to the project are sufficient.

Reviewer 4:
The reviewer reported that the resources for this project appear appropriate and commensurate with the level of effort required for success.

Internal Combustion Engine Energy Retention (ICEER): Jeff Gonder (National Renewable Energy Laboratory) - vss126



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the approach of coordinating with ANL's APRF in the collection of dynamometer data on a conventional Ford Fusion, and obtaining industry feedback is very good.

Reviewer 2:

The reviewer reported that any effort to improve the efficiency of vehicles is worth pursuing, this project addresses one of the areas where the solutions may be easier, lower cost, and be applicable to the vast majority of vehicles on the road. The reviewer added that it was not clear to the reviewer the extent to which the five-cycle methodology does not capture the cold start penalty when a cold start Federal Test Procedure (FTP) cycle is included. The reviewer commented that the presentation for subsequent years might quantify the gap between the current five-cycle methodology and what the project finds is a more reasonable approach (i.e., cold start cycles for Highway Fuel Economy Test (HFET) and US06). Also, the reviewer thought that what is missing in the project is a comprehensive survey of what technologies or techniques there are for energy retention that can be used to address this problem, and what the individual potential of each for energy retention is. If none exist, or none can be implemented in a cost effective manner, then a significant portion of the project might be less relevant. Finally, the reviewer stated that it was not clear why FASTSim was used instead of Autonomie since their modeling was to be quite detailed.

Reviewer 3:

The reviewer commented that this appeared to be an unconnected project that someone was sponsoring for NREL education only. The reviewer added that the engine/auto industry and even EPA had a good understanding of this issue and approaches to manage (or not). The reviewer warned that unless the team gets a real connection to the industrial members addressing this issue then the program should be seriously questioned.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that accomplishments and progress in this project have been very good. The reviewer added that cold start data and cold start model developed of fuel consumption over time correlated very well. In addition, it was shown that cold start fuel consumption rate is much higher than for hot start. The reviewer noted that engine oil temperature rise over time for the data versus the developed model also showed a very similar result. The reviewer also said those cold start penalties were found to be sensitive to time of year, geography and drive profile.

Reviewer 2:
The reviewer commented that the modeling progress appears to be proceeding well but the reviewer did not get a sense of what the status is exactly. Slide 10 says "reasonably accurate," but a more specific quantification would have been welcome. The reviewer believed this project should be concurrently researching possible energy retention strategies, especially if a prototype design and build is planned.

Reviewer 3:
The reviewer commented that there is questionable value in test results that appear to simply report generally accepted facts.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer reported that NREL, the lead of this project, has been working with ANL and OEMs Chrysler, Ford and GM. Working with these partners show good collaboration and are well-coordinated.

Reviewer 2:
The reviewer noted that the collaboration with ANL seems solid, with the dyno data being shared and put to use; however, “conversations” with OEMs is not very specific. The reviewer suggested that the project team should collaborate with university researchers, as it may be fruitful.

Reviewer 3:
The reviewer said that "Active conversations with USCAR OEMs during otherwise scheduled meetings" is not adequate for collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the proposed future work to develop equivalent models for hybrid electric and large truck or SUVs and to investigate which energy retention strategies merit, further investigation will help to overcome barriers of reducing petroleum usage.

Reviewer 2:
The reviewer explained that the plans for model improvement are sound; however, the plans for the prototyping do not appear to be well established.

Reviewer 3:
The reviewer suggested a re-evaluation of the program content, direction, and who the project team works with before going further. The reviewer stressed that industry relevance is important.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked that as the presentation suggests, energy retention in ICE vehicles is a low-hanging fruit for petroleum displacement, and this project could have a significant impact on the transportation fleet.

Reviewer 2:
The reviewer stated that since laboratory cold start impacts show an increase in fuel use around 10%, than by addressing cold start issues would help reduce fuel use and thus support petroleum displacement. The benefit of a 1% efficiency improvement from cold start improvement translating into taking nearly 2.5 million vehicles off the road may be exaggerated since any energy reduction strategies would apply to new vehicles not to the legacy fleet.

Reviewer 3:
The reviewer said that this project is an internal test program that has little relevance from an industrial perspective, if it does not matter to anyone then it will not change anything.

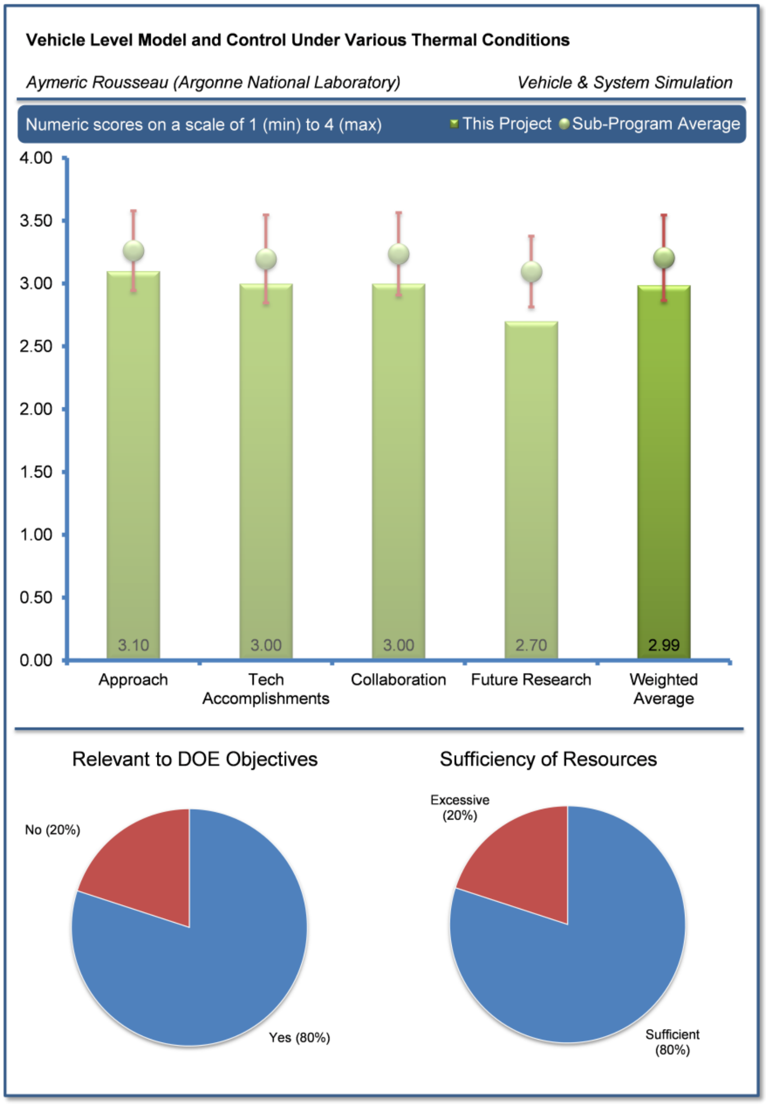
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that it is possible that the resources for the prototyping stage will be insufficient because the modest amount allocated is currently going towards modeling alone.

Reviewer 2:
The reviewer stated that the funding for this project is sufficient.

Reviewer 3:
The reviewer believed the project needs to be reevaluated.

Vehicle Level Model and Control Under Various Thermal Conditions: Aymeric Rousseau (Argonne National Laboratory) - vss127



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the approach of using test data from ANL APRF, to develop control and performance analysis. Then, comparing test data and simulation data. The reviewer's model validation is excellent.

Reviewer 2:

The reviewer said that these are good vehicles to model; many are in the marketplace. The reviewer added that the need to model the components and system and validate the models is clear. The reviewer said that more of the time/budget could have been allocated to the controls.

Reviewer 3:

The reviewer stated that the approach, in general is very good; however, when dealing with systems that have discontinuous on-off behavior, such as thermostats, there can be a significant spread in the results because of small changes in initial conditions. This will have to be captured, perhaps by using Monte Carlo simulations to predict the average behavior of a population of vehicles. The reviewer is not entirely convinced at this point, that after understanding the characterizing the average behavior of the vehicles, any significant advantage can be gained by using detailed models and large scale simulations to quantify the benefit achieved in real world drive cycles. A tool such as FastSim may be more appropriate for this task. As mentioned before, the reviewer is not entirely convinced (either way) and perhaps one way of understanding the level of detail that is needed in these models to perform large scale analyses, may be best answered by comparing the results from both FastSim and Autonomie. The reviewer did not mean to imply that Autonomie is of not an appropriate tool, but perhaps in some cases, when looking at the very big picture, a tool with a coarser resolution may be more appropriate.

Reviewer 4:

The reviewer was conflicted with this project, and noted that it appeared to have been well run, but lacked real world relevance. The reviewer asked for whom the model was made. The reviewer wanted to know how the model improved the industry, and asked how the model impacted the energy efficiency of the on-road vehicle.

Reviewer 5:

The reviewer stated that Autonomie is a well-established tool that is used by many in academia and industry. Therefore, improvements to the models' fidelity are always welcome. The reviewer added that thermal system management is crucial, especially in advanced vehicles, and this project is useful in helping modelers achieve results that approach real-world data. As an aside, the reviewer was confused by the schematic of the Prius on Slide 8, in which the EM connected to the sun gear on the planetary gear with the engine was labeled "MOT2' and the one connected to the ring gear on this same planetary gear was labeled "MOT". From everything that the reviewer had read about the Prius, Toyota labels the former Motor 1 and the latter Motor 2.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated great work.

Reviewer 2:
The reviewer commented that the work on the model and the validation was very thorough. The reviewer added that the controls work, hopefully, would be done in the end of this project and future projects.

Reviewer 3:
The reviewer said that the milestones are being met and are on track to be completed by the end of the project. The reviewer added that technical accomplishments on Slide 18 show very good results for the simulation versus test results regarding fuel consumption, SOC and temperature. Unfortunately, due to the animation used on Slide 18 in conjunction with the required PDF format, the first set of data shown during the presentation is covered up by the second set of data and not available to the reviewer. The reviewer said that because animation was used on Slide 18 all of the results presented during the meeting could not be seen on the file that is saved in PeerNet. This may be a common problem for other presentations and should be addressed in the future.

Reviewer 4:
The reviewer claimed that considerable progress has been made in the models' development, and the project appears to be on track to meet its targets and milestones. The reviewer added that the simulation results shown are very good, although the SOC of the battery and engine temperature did not track as well, which becomes obvious when it stops tracking after doing so before, for example, the SOC, after approximately 440 seconds and for the engine after approximately 630 seconds.

Reviewer 5:
The reviewer indicated that in an isolated sense this project seems to have accomplished a reasonable amount for the funding; however, national laboratory projects that are performed for the benefit of the laboratory do not impact transportation efficiency and generally result in a report on the shelf. The reviewer did not see much of a connection to the real world in this presentation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that ANL has collaborated with several entities including OEMs, national laboratories and battery suppliers to help develop component thermal models. The reviewer added that these collaborations have been essential to the success of the project.

Reviewer 2:
The reviewer indicated that the project team collaborated with OEMs and national laboratories to get their models. The reviewer wondered what other controls the team is investigating and if the team would share them with this project, especially NREL on the Advanced Climate Control mentioned in this presentation.

Reviewer 3:
The reviewer stated that the project has gathered a sizeable number of participants. The reviewer wondered about the OEM contributions for the EM and transmission, the reviewer asked if the data will be open source or if these model blocks be closed from viewing.

Reviewer 4:

The reviewer said that this was an isolated lab study, with little connection to the industry. The reviewer noted that when asked the presenter had no idea why some of the vehicles responded to the tests the way they did. The reviewer asked if anyone talked to the OEM for a critical evaluation

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said please see earlier comment. The reviewer added that the title of the project does not seem to indicate that this project is restricted to HEVs, extended range electric vehicles (EREVs), PHEVs, etc. Vehicle thermal management system (VTMS) is of equally great concern to vehicles with conventional powertrains as well, and more vehicles are being equipped with advanced thermal management systems such as active grille shutters, transmission oil heater, etc. The reviewer said that it would be worthwhile to extend the scope of this project to examine the effect of VTMS on fuel economy improvement in vehicles with conventional powertrains as well, to try to quantify the true benefit of these systems, and perhaps to provide assistance to EPA in their rule making.

Reviewer 2:

The reviewer indicated that the suggestions of future work, to quantify temperature impact of electrified powertrains, under different driving conditions, and the development of controls to mitigate the impact of temperature on vehicle energy consumption would be useful to peruse, but because the current project ends in FY 2014, additional funding would be necessary.

Reviewer 3:

The reviewer said that the presentation mentions future controls work. To reinforce the title of this work, if time and budget allow, this reviewer would recommend work on what controls can be used to improve fuel efficiency. The reviewer added that the insulation and WHR mentioned in another presentation (vss126) would be helpful but the fuel fired heater should not be ignored.

Reviewer 4:

The reviewer stated that the project is complete this year.

Reviewer 5:

The reviewer commented that the proposed future work listed is more like aspirational goals than developed plans for how to achieve results. The reviewer added that more detail on the path to achievement is warranted for future presentations.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that better models mean better design, and if Autonomie can improve its thermal management system models, OEMs can use this tool to develop improved physical systems that will consume less energy and there is a potential for significant petroleum displacement as a result.

Reviewer 2:

The reviewer said that yes, temperature has a big effect on hybrid efficiency currently. The reviewer added that the next step is what actions (improvements to systems, components, and controls) should be taken once the system is modeled.

Reviewer 3:

The reviewer stated that because temperature has a significant impact on electric drive energy consumption this project is very relevant to the DOE objectives of petroleum displacement.

Reviewer 4:

The reviewer said that the OEMs are investing tremendous effort in developing VTMS, presumably with the goal of improving fuel economy, There is no doubt that effective thermal management will improve the fuel economy of any vehicle, conventional or otherwise. The reviewer added that this project should help quantify the benefits of these technologies better, and perhaps offer some insights into how these systems can be further improved.

Reviewer 5:

The reviewer noted that there was no apparent connection to the industry the team is evaluating.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that because funding for the project is 80% complete and ends in September of this year, there are sufficient funds to complete the project and achieve the stated milestones.

Reviewer 2:

The reviewer stated that more resources for controls work to improve the thermal system looks to be needed.

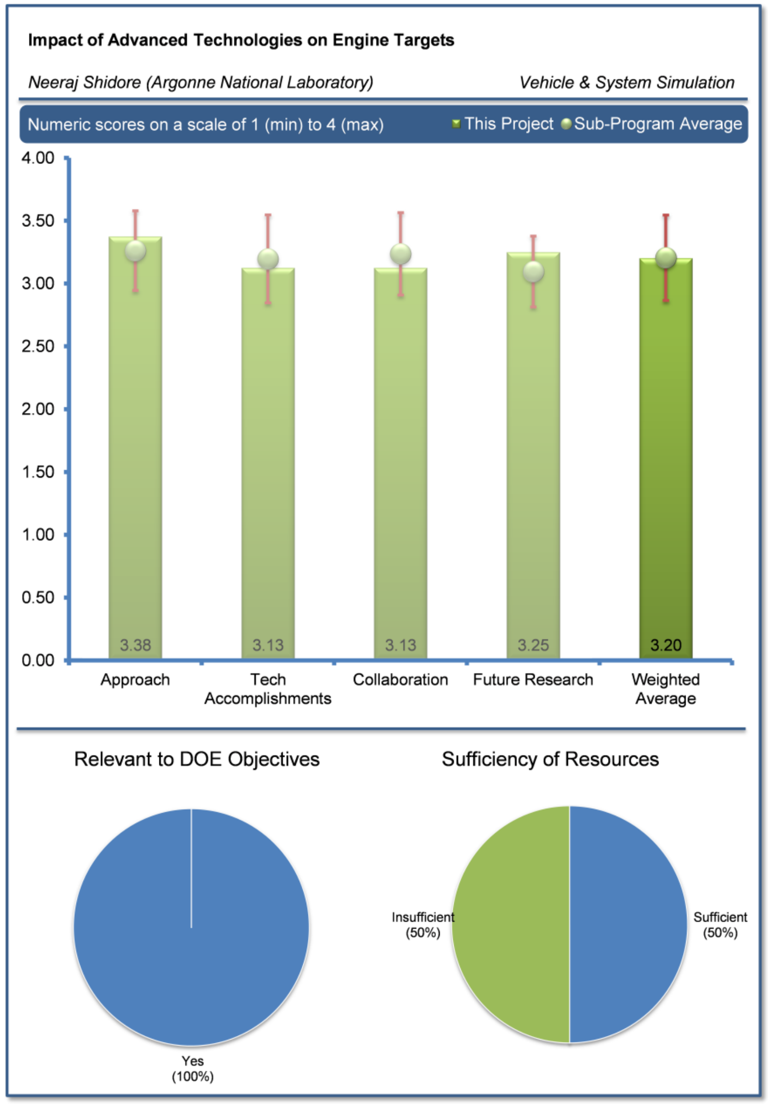
Reviewer 3:

The reviewer commented that the resources appear sufficient and appropriate for this project; however, the reviewer was confused as to why the funding for FY 2013 was twice that of the other two years. The reviewer added that an explanation would be useful for subsequent reviews.

Reviewer 4:

The reviewer indicated that the DOE should carefully consider the content of a project and if the project team is duplicating tests and modeling that have been conducted by industry.

Impact of Advanced Technologies on Engine Targets: Neeraj Shidore (Argonne National Laboratory) - vss128



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the technical approach is very good and helps to address deficiencies in this type of study.

Reviewer 2:

The reviewer reported that the overall approach to the challenge of evaluating engine technology is good. In particular, using simulation tools to consider engine technologies as part of an overall powertrain should provide a more realistic evaluation of performance. The reviewer stated that as a starting point, use of steady state engine fuel maps is reasonable, but this does have some limitations, particularly for certain types of engine technology (high EGR engines, highly boosted engines, and etc.). The same limitation holds for the fairly simplistic transmission models used (e.g., while in general it might be reasonable to set a limit on low speed, high torque operation, there are some engines that are designed to run in that regime – like diesels). The reviewer added that the use of dynamic engine models and transmissions that have been optimized for those engines may give better results. Instead of focusing on an evaluation of engine technology, the reviewer said that another option would be to focus on powertrain technology and only consider engine and transmission together as a unit. The reviewer stated that another consideration that did not seem to be covered was a sensitivity analysis of the model output to the model inputs, and to model design. In other words, an evaluation of the fuel economy impact of different input parameters like shift schedule, engine fuel map, and engine model type (static versus dynamic) might provide some guidance in terms of where to focus efforts to improve accuracy. If small changes in shift strategy result in +/-5% fuel consumption, but using a dynamic engine model instead of a static fuel map only impacts fuel consumption by +/-1%, then perhaps the steady state fuel map is good enough and focus should be on the shift schedule. The reviewer added that the choice of technologies selected for evaluation seemed reasonable. The reviewer commented that an additional focus on diesel may make sense given the focus on fuel economy. The reviewer added that stop/start technology should be considered for all powertrain options.

Reviewer 3:

The reviewer observed that the concept of modeling improvement from various engine technologies is a very good one especially since comparing real world engines was not possible. The reviewer added that validating the modeled results on a single real engine would have benefits.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that there was good work in achieving project objectives. The reviewer added that where possible, error bars should be incorporated into the results rather than showing an absolute benefit for the technology changes. For example, the 8-speed transmission benefit is dependent on the particulars of the transmission rather than being constant. Also, the reviewer said that if known, the error estimates for the engine map changes should be incorporated.

Reviewer 2:
The reviewer reported that good progress had been made on the models. The reviewer added that uncertainty estimates for the results, especially where there is not an exact physical model, as suggested by another reviewer would be helpful for evaluating the results.

Reviewer 3:
The reviewer stated that the progress so far seemed reasonable.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted good communication with U.S. DRIVE Advanced Combustion & Emissions Control (ACEC) tech team and good expert engine modeling support from Ingenieurgesellschaft Auto und Verkehr (IAV).

Reviewer 2:
The reviewer observed that the collaboration with other project partners seemed to support the project objectives. The reviewer added that greater collaboration with industry partners might provide additional value.

Reviewer 3:
The reviewer stated that the collaboration with IAV and U.S. DRIVE is strong. The reviewer added that collaboration with the OEMs would be valuable especially if the OEMs helped with the single physical engine to validate the model.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the future work is well defined and clearly supports project objectives.

Reviewer 2:
The reviewer stated that the proposed future activities include improving the fidelity of the engine and transmission models, this is a good step. The reviewer suggested that the next steps also include use of thermal and emissions models. Generally, these kinds of models do not return very good results without significant calibration and validation effort, which may be outside of the scope of this project. The reviewer added that instead of focusing on emissions and cold start, a good next step would be a sensitivity analysis to a range of different parameters to better understand the sources of error and uncertainty in the analysis. Then efforts could be focused on those factors which have the largest impact.

Reviewer 3:
The reviewer is not sure how accurate emissions prediction is likely to be. A significant effort and a plethora of test data are needed to develop accurate GT engine models. The reviewer commented that this is a challenging task because many of the studies described here are not in production. The reviewer added that this is similar to what was done by IAV over the past many months, the reviewer is not sure that using high fidelity engine models will bring anything more to the table, given the goals of the project. For the level of accuracy

expected from a project of this nature, it may be sufficient to use engine maps, and perhaps a mean value model to obtain a better dynamic response. This reviewer concluded that Einstein's quote, “Everything should be as simple as it can be but not simpler,” applies.

Reviewer 4:

The reviewer indicated that the final results and suggestions for optimizing fuel economy while keeping the costs acceptable will be very helpful for DOE goals. The reviewer suggested that the project team should consider validating the model on a single actual physical engine if there are resources or future funding. The reviewer realizes that the displacement differences will be difficult and expensive to put in a physical model. Perhaps a direction for impact could be obtained by looking at just two displacements.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that this is the first comprehensive study that the reviewer has seen that quantifies the effect of advanced technologies on engine targets. The reviewer said that as this process gets more refined, it should improve the accuracy of fuel economy improvement predictions from various advanced technologies, and provide a quick check to verify the accuracy of manufacturer's claims.

Reviewer 2:

The reviewer stated that this project supports DOEs goals by helping to provide a better evaluation of how powertrain technologies can reduce fuel usage in the real world. The reviewer added that often in research efforts, the linkage between real world impact and the component or sub-system performance is not well established. This project establishes a methodology and tools for making that evaluation.

Reviewer 3:

The reviewer said that this project provides detailed understanding of benefits of future engine developments to guide direction for best fuel efficiency.

Reviewer 4:

The reviewer remarked that the DOE direction on what technologies provide best benefit for the cost will help guide industry in picking technologies to put on their production engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that the resources, $200,000 for one year, are insufficient to further develop the models.

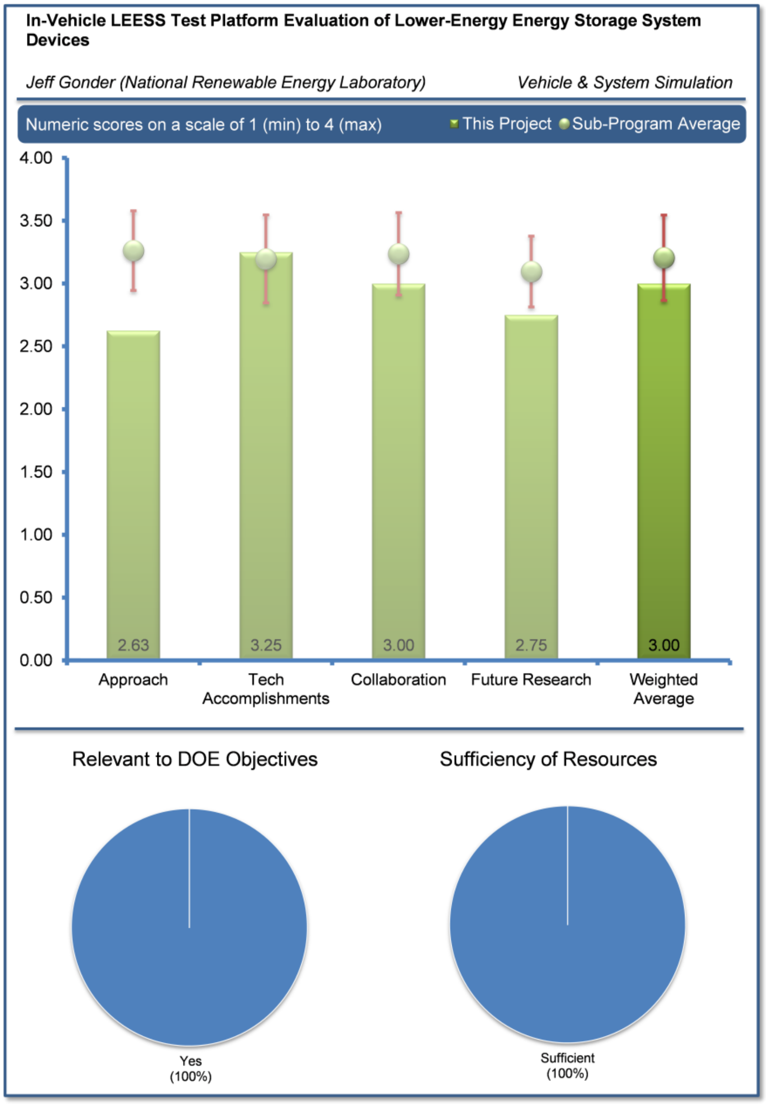
Reviewer 2:

The reviewer pointed out that in one year, with one quarter to go, the dollars allocated do not seem enough to get all the results even without correlating the model.

Reviewer 3:

The reviewer commented that resources are sufficient for project goals.

In-Vehicle LEESS Test Platform Evaluation of Lower-Energy Energy Storage System Devices: Jeff Gonder (National Renewable Energy Laboratory) - vss129



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the analysis and the approach were great. The reviewer added that all the testing was focused on quantifying the gains under relevant profiles. The reviewer noted that because the gains are incremental, it would be helpful to quantify the added cost for OEMs to implement this technology. This may show that the gains are not significant enough to offset the additional cost.

Reviewer 2:

The reviewer reported that the premise for the project is interesting, and the experimental approach is very good. A little more analytical work might have been a nice compliment to the experimental work. The reviewer added that while testing one alternative lower energy storage device is an excellent start, an analytical evaluation showing the impact of a range of different energy storage capabilities and the impact at the system level would have been interesting. This might have also helped to justify the choice of the particular energy storage device that was tested. The reviewer commented that because the premise is that lower energy storage will provide similar benefits at lower cost, it would have been nice to see some evaluation of costs for both the baseline system as well as the alternative. The reviewer noted that if costs had been considered, it would have been possible to create fuel consumption versus cost/energy storage capacity. Creating curves for both the nickel-metal hydride (NiMH) battery, as well as the alternative would show the trade-off between cost and fuel consumption for both technologies, and provide better understanding if lower energy storage really does provide a better cost/benefit trade-off.

Reviewer 3:

The reviewer stated that it appears that an evaluation of cost will be conducted near the end of the project, yet the purpose of the project is to evaluate a means to reduce the cost of a hybrid energy storage system. A more comprehensive approach to the USABC power assist hybrid goals could have been done to evaluate charge power and discharge power goals as well as the currently evaluated available energy goal. The reviewer added that it is not clear that a smaller device, but one with a significantly higher power to energy ratio will provide a cost savings, even if there is no performance degradation. Modeling could have been done to evaluate the impact of modifying USABC power assist hybrid goals. The reviewer commented that it is not clear that any upfront modeling was done as part of the coordination with the USABC.

Reviewer 4:

The reviewer indicated that the basic idea of attempting to replace existing battery energy storage systems in HEVs with lower cost energy storage system combinations is a good one. HEVs only account for about 3% of new vehicle sales, largely probably as a result of higher initial cost. If that cost differential could be driven down significantly or eliminated, it is likely HEV sales would take off with concomitant higher fuel economy and resulting energy savings. The reviewer's fundamental concern with regards to the approach surrounds the lack of modeling and back-end sequencing of cost studies. To date, the task has heavily emphasized the development of a full-HEV test bed for in vehicle lower-energy energy storage system (LEESS) device evaluation, and comparison, bench, and in-vehicle dyno testing. The reviewer said that it seems an alternative and probably more cost effective approach would be to conduct modeling studies upfront of technology combinations of particular interest (and having significant industrial support) to determine whether it is likely they would be able to meet the technical requirements of the vehicle. The reviewer added that if the particular LEESS technology of interest passed these criteria, an impartial economic assessment should then be conducted with industry to gauge whether the particular technology was really viable from a system, cost, and business standpoint. Then, if these two criteria were successfully met, HEV test bed and bench and dyno testing would be conducted. As the task is set up now, it is highly likely that significant resources will be expended testing technologies, which will likely fail from a commercial standpoint due to cost and business considerations which have not been adequately scoped out up front.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the listing of accomplishments for the project is reasonable given the task duration and funding levels. Bench testing has been completed on the first LEESS (lithium ion capacitor (LIC) form JSR Micro). The reviewer added that rated energy comparison for the LIC system compared to the stock NiMH has been determined. A 2012 Ford Fusion Hybrid has been modified to enable operation on alternative LEESS devices while maintaining stock operating capability using production NiMH cells. Also, the reviewer noted that 0-60 mph in-vehicle acceleration comparison testing has been conducted which illustrated comparable performance between production NiMH and LEESS LIC configurations. The reviewer added that in vehicle dynamometer testing compared the voltage range and fuel and energy use of a production NiMH versus three LIC configurations. The reviewer added that the results indicate small fuel use differences between the HEV configurations with all showing significant savings compared to a non-hybrid vehicle. The energy window of each ESS configuration was also measured for each cycle and summarized. The reviewer said a significantly reduced energy window resulted in negligible fuel use consumption difference on most cycles and only a small increase on the US06 test. Overall, the reviewer said the project had a respectable list of accomplishments.

Reviewer 2:

The reviewer said that a rigorous approach has been taken to the evaluation of the energy storage devices selected for evaluation. The reviewer added that the results for the LIC provide a strong technical foundation for the evaluation of the USABC power assist hybrid available energy goal.

Reviewer 3:

The reviewer stated that there was great experimental work in evaluating the different energy storage systems.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project seemed to benefit from strong collaboration with a range of outside partners including Ford, Maxwell, USABC, and etc.

Reviewer 2:

The reviewer reported that overall, the level of collaboration and coordination for the project is good. The reviewer noted that NREL has coordinated with the USABC (Chrysler, Ford, GM, and DOE/national laboratories) on the precursor analysis for LEESS performance targets for power-assist HEVs; Ford for a CRADA on the Fusion conversion; JSR Micro for the LIC modules for evaluation; Maxwell Technologies for electrochemical double-layer capacitors (EDLC) modules for upcoming testing; and cost share collaboration between VSST and Energy Storage for the project as a whole. The reviewer added that as alluded to under Approach, it would be good to include modeling activities upfront and possibly associated coordination therein with other national laboratories such as ANL and ORNL, as well as detailed communication with the OEMs and technology suppliers with regards to cost and business assessments of the various technology options.

Reviewer 3:

The reviewer said that it is too early in the project to share results with the USABC Energy Storage Tech Team; however, once work is complete, a comprehensive discussion with the Tech Team should occur, including the potential to evaluate charge and discharge power goals in future work.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the future plan also seems sound; however, there is not a whole lot of value in improving mild-hybrids. The reviewer commented that we need to make a push towards PHEVs and BEVs.

Reviewer 2:

The reviewer commented that evaluating additional alternatives for energy storage would be a good next step; however, at the top of the list should be to include cost considerations in the analysis. The reviewer added that including cost for the individual systems tested will allow some evaluation of cost versus benefit. However, these data points could also be used to anchor an analytical study showing a broader consideration of the impact of different size energy storage systems, the fuel consumption benefit each could provide at the system level, and the system level costs.

Reviewer 3:

The reviewer reported that consideration should be given to diversifying the next two evaluations to look at reduced power as well as reduced energy and perhaps increased energy and reduced power. The reviewer added that coordinating with modeling resources to provide guidance in this area would be useful.

Reviewer 4:

The reviewer said that modelling activities and rigorous cost and business case assessments should be added upfront to the project to assess and screen technologies before any further testing activities (not currently envisioned) commence.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project is definitely relevant given the potential of HEVs to reduce petroleum consumption if their penetration rates into the nation's fleet can be significantly increased.

Reviewer 2:

The reviewer said yes, to help improve understanding of the role of energy storage in helping to deliver fuel consumption improvement at the system level, and the project may help to drive lower cost hybrid solutions which will drive greater adoption.

Reviewer 3:

The reviewer stated that continued guidance on HEV design is useful, particularly for reduced power mild hybrids where there is currently no USABC guidance (somewhere between power assist and start-stop).

Reviewer 4:

The reviewer observed that the project is relevant; however, not significantly. The reviewer explained that mild hybrids have incremental gains and are mainly a way for major OEMs to stall progress towards PHEVS and BEVs, the technology for which is already out there.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the project appears to be on schedule and budget with existing resources.

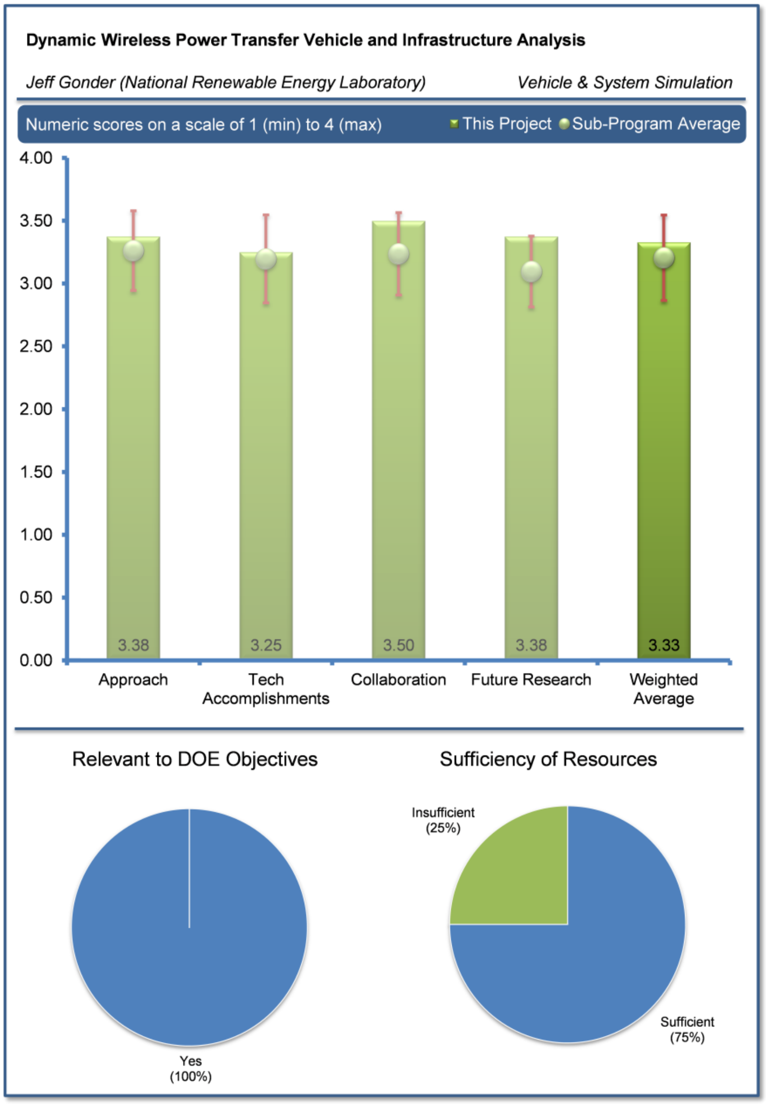
Reviewer 2:

The reviewer said that this researcher and his team seem very talented. The reviewer thought their efforts would be better spent on powertrain technologies that lead to larger petroleum displacement.

Reviewer 3:

The reviewer noted that the resources for the project are sufficient.

Dynamic Wireless Power Transfer Vehicle and Infrastructure Analysis: Jeff Gonder (National Renewable Energy Laboratory) - vss130



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that this looks good for the stage this project is currently; however, it is still highly speculative, characteristics and costs of vehicles as well as cost of service should be much more well-defined before using vehicle choice models. The reviewer added that at this stage this will tell you very little except that decreasing costs increases sales, which is already clear.

Reviewer 2:

The reviewer reported that the overall approach for making the case for light-duty and Class 8 trucks was excellent. The reviewer added that the plot that showed the percentage of distance traveled over the percentage of roadways was illuminating and a modest infrastructure investment could yield a significant benefit.

Reviewer 3:

The reviewer stated that the approach acknowledges uncertainty; assumes realistic limitations on the possibilities of the technology (e.g., 1% roadway penetration assumption).

Reviewer 4:

The reviewer observed that a lot of research is short-term and even medium-term focused, but research with a long-term focus is also crucial, and this project provides a significant contribution to exploring the future possibilities for wireless charging. The reviewer added that the analysis that revealed how a small fraction of overall roads having dynamic WPT installed would be sufficient for an outsized portion of electric driving was illuminating. The reviewer pointed out that the lack of a cost assessment at this stage of the project, given that the project ends September 30th, implies that insufficient effort has been directed in this area. The costs of dynamic charging (as opposed to quasi-stationary, which seems to make obvious sense for bus applications) appear to be a showstopper when the current state of infrastructure in the United States and how the funding is lacking for its improvement already is considered. The reviewer said that the cost-analysis should have been a larger portion of the project in this reviewer's opinion.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer claimed that the modeling efforts have shown good results and indicate the potential of dynamic WPT to have considerable impact in reducing petroleum consumption. The reviewer added that the analysis of the required amount of dynamic WPT infrastructure to satisfy the demands of a large proportion of driving is a considerable contribution.

Reviewer 2:
The reviewer indicated that this project appears to be meeting its objectives, and seems headed towards an interesting final result.

Reviewer 3:
The reviewer concluded that most of the analysis was centered on justification of the need, but there was not as much information about how much power (per mile or per unit distance) would be required and what the cost of that power would be. The reviewer said that perhaps this is the next step in the project, but it is a critical piece in the evaluation.

Reviewer 4:
The reviewer remarked that given the uncertainties involved, the "what if" aspect is well handled. The reviewer added that the EV penetration prediction assumptions should be reported with some kind of error-bars on the various scenarios (for example, the total EV penetration percentage is surely not a single value in year “202x,” but a possible range).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the level of collaboration looks appropriate for this stage of the project.

Reviewer 2:
The reviewer reported that collaborating with DOT on a complementary analysis is a positive addition to the project. The reviewer added that the collaboration with OEMs and another national laboratory appears to be productive and useful to the project. The reviewer suggested including academic researchers into the project to add to the modeling capabilities.

Reviewer 3:
The reviewer commented that the collaboration with one of the electric-power industry associations may be needed to weigh in on the practicality of implementation.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked that this project appears to have a well-defined plan.

Reviewer 2:
The reviewer stated that the future work addresses the questions raised by the study.

Reviewer 3:
The reviewer mentioned that more work is needed to get an understanding of the technical hurdles of electrifying roadways. The power required, how it would be distributed, interaction with grid and stationary storage, etc.

Reviewer 4:

The reviewer indicated that the proposed future research provides a strong framework for taking these future technologies forward and resulting in a deployment. The reviewer would suggest that focusing on quasi-stationary WPT, at least initially, might be the best approach.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that increasing sales of electrified vehicles will decrease petroleum use.

Reviewer 2:

The reviewer commented that this study is needed to determine potential petroleum displacement of dynamic charging technology.

Reviewer 3:

The reviewer reported that a dynamic and quasi-stationary WPT have the potential to dramatically increase the number of electrified vehicles in the transportation fleet, and this will certainly result in significant petroleum displacement. The reviewer added that this project identifies this potential, and provides an indication of how dynamic charging can be implemented.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that resources appeared adequate.

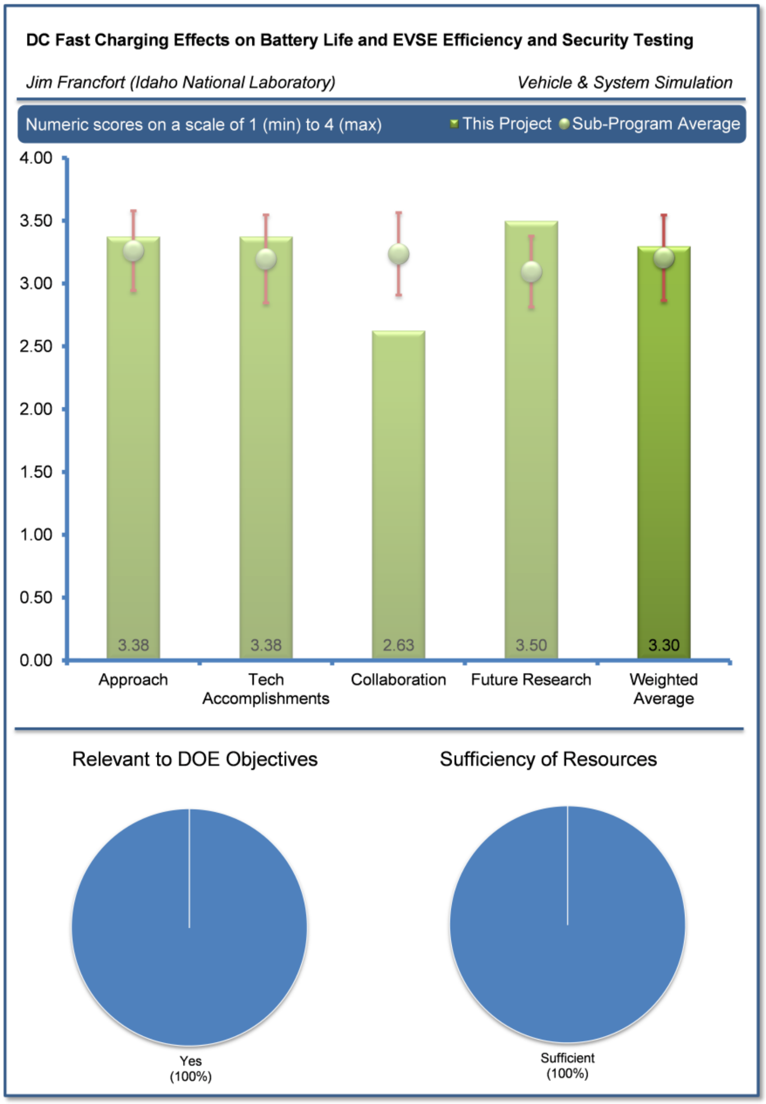
Reviewer 2:

The reviewer said that the level of funding is relatively modest and seems appropriate to support this effort.

Reviewer 3:

The reviewer stated that this was not addressed directly, but funding seems adequate.

DC Fast Charging Effects on Battery Life and EVSE Efficiency and Security Testing: Jim Francfort (Idaho National Laboratory) - vss131



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this is important work. The reviewer added that understanding the different types of charging and the effects on battery life is very important.

Reviewer 2:

The reviewer stated that the work seems great. The reviewer saw high value in the comparative testing of DC fast charging and L2 charging. The results are interesting so far, but releasing more data would increase value tremendously. The reviewer saw very low value, though, in cybersecurity testing with no output beyond the manufacturer. Unless this is funded by the manufacturer, this appears to be an inappropriate use of funding.

Reviewer 3:

The reviewer commented that the testing procedures (i.e., drive cycles, test setup, etc.) seem to be good, but more thought should be given to the types of situations that are simulated. The reviewer asked if the current driving patterns are representative of real-life driving. The fleet size and models are very limited though. The reviewer added that it may be more useful to extend this kind of testing to more models and manufacturers. Mixed charging cycles (slow and fast) should maybe be studied as well. Also, the reviewer said that it might be nice to see one vehicle pushed way beyond the manufacturers charge frequency specs to see what sort of degradation occurs. This will likely happen in real-life, so it should be tested.

Reviewer 4:

The reviewer reported that the approach is quite straightforward. The reviewer noted the approach was to design a test and conduct it that assure that multiple vehicles are tested as close to identically as possible to understand how different charging protocols affect long term battery capacity. The planned test methods are valid. The reviewer noted that what could be improved is the original plan for the test which should have included deeper dives to the causes and reasons for the capacity loss. This seems to be a focus now for the future. The reviewer cannot comment on the EVSE security issue as the reviewer did not understand what was presented in that area. So the reviewer will evaluate the capacity testing only.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that it looks great so far for the vehicles. The reviewer added that it is unclear what the concrete results are for the EVSE testing.

Reviewer 2:

The reviewer commented that the true value of this project rests in the ability to understand the trends and causes of the battery degradation. For example, need to relate the ambient temp profile to the degradation results on a more detailed basis. Also, the reviewer mentioned that the project team needs to understand the temperature condition of the battery after charge and as the vehicle goes on the next cycle. The reviewer asked if the battery went back to ambient temp before the next drive event. The reviewer also asked how the battery temperature profiles have related to the loss of capacity. Simply stated, the project team needs to look deeper for the things that affect the differences in the individual vehicles tested.

Reviewer 3:

The reviewer pointed out that the current accomplishments are good. They would be much better if more analysis were done on battery temperature, current, and voltage histories. The reviewer added that in order to make useful models of this data in the future these sorts of analyses need to be performed.

Reviewer 4:

The reviewer was concerned that the sample size was too small at four vehicles, but if this work can reduce the cost of testing it is very important. The reviewer also noted that the PI was very impressive.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer remarked that the collaboration partners look okay, but it is unclear what the nature of the collaboration is. It would be very valuable to release the data more widely, so that everyone could collaborate. The reviewer added that it is unclear why this data would be collected in the manner that it is being collected without intending it for public release.

Reviewer 2:

The reviewer stated that none were shown. The collaborations cited were not really collaborations; they were primarily internal groups and subcontractors. The reviewer suggested that the project team collaborate with the car manufacturer to verify that the findings are reasonable.

Reviewer 3:

The reviewer noted that very little collaboration seemed to be on-going. The reviewer added that this project should seek more collaborators. If OEMs are not interested in the results then the question should be asked if the data recorded from this testing is truly useful.

Reviewer 4:

The reviewer would like to see more OEM collaborators.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the future work appears to be on target to address many of the previously mentioned issues. The reviewer noted that the publication of this work and results should remain a main focus. This data is likely to be used by future researchers to build battery models, so dissemination of the work is critical.

Reviewer 2:
The reviewer commented that the project team had an excellent research plan.

Reviewer 3:
The reviewer reported that the future work is well planned. This reviewer noted that the activity, "Propose deep-dive of on-road data to examine more subtle changes beyond capacity, power capability (i.e., resistance growth)," stood out. The reviewer stated that this should be a top priority that will greatly increase the value of this project and also include investigation into the capacity causes.

Reviewer 4:
The reviewer encourages continuing the test, even after 70,000 miles, even if this has to be done on a simulator.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said yes, this provides more information that may support EV use in the future. The reviewer added that most electricity is produced from non-petroleum sources, so this project is in line with DOE objectives.

Reviewer 2:
The reviewer reported that it helps to understand the current battery technology limits and if expanded could outline an agenda for future technology improvements.

Reviewer 3:
The reviewer pointed out that reducing uncertainty for PEV battery life will increase sales and decrease petroleum displacement.

Reviewer 4:
The reviewer stated that we need to lower testing cost which is a goal of this project. The reviewer added that the project had an excellent work plan and very impressive work.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that funding is sufficient for the work as described.

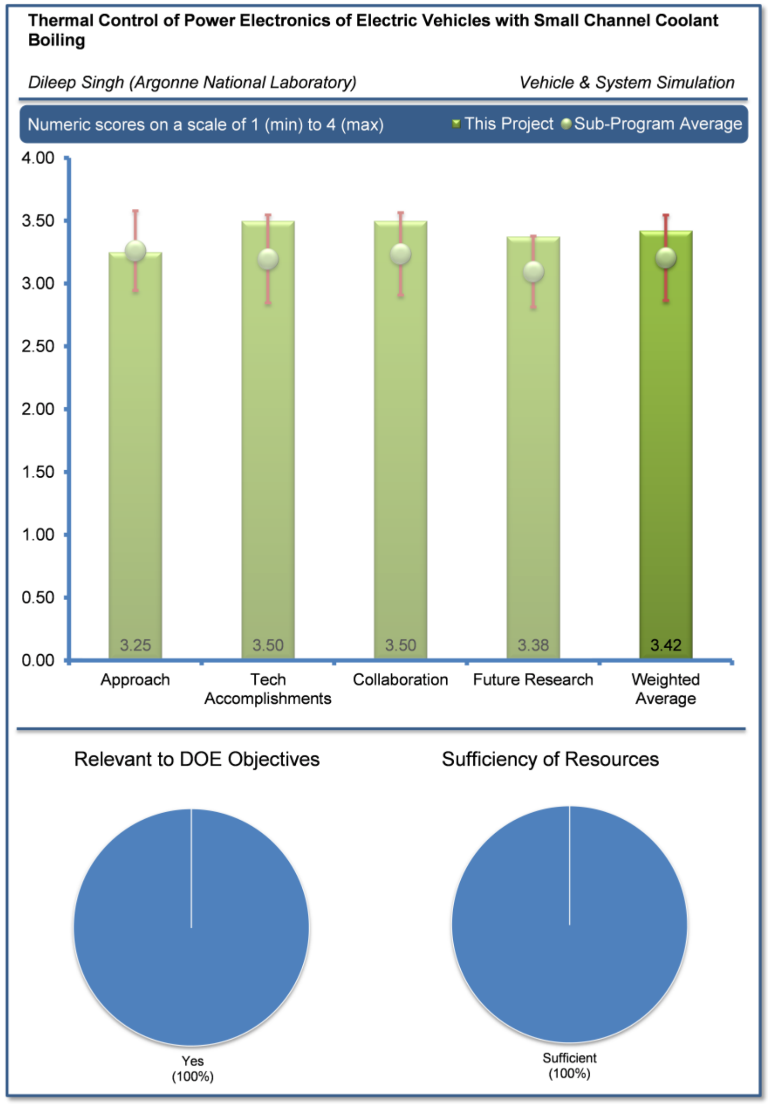
Reviewer 2:
The reviewer remarked that this seems sufficient, although the reviewer would defund the cybersecurity research if meaningful results could not be widely distributed.

Reviewer 3:
The reviewer noted that the team seems to have enough resources to achieve its goals, but the vehicles are a bit old and maybe some new ones should be added. The reviewer added that EV technology/batteries are evolving quickly, so systems from only a few years ago may be very out of date.

Reviewer 4:

The reviewer recommended increasing the sample size, which also increases cost, because this work is important.

Thermal Control of Power Electronics of Electric Vehicles with Small Channel Coolant Boiling: Dileep Singh (Argonne National Laboratory) - vss132



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said the project had an excellent PI, whom is published in the area.

Reviewer 2:

The reviewer commented that the project is intended to develop a small channel coolant boiling system that can eliminate the low temperature cooling systems for electronics in HEVs. The reviewer stated that the technical barriers are properly identified and the proposed approaches are well designed and reasonable. The reviewer added that the only concern relates to the general approach of combining the high temperature and low temperature systems into one cooling system with two loops, each rely on a different cooling mechanism. It may increase the system complexity, for example, the performance of one loop may impact the performance of another loop, and reliability.

Reviewer 3:

The reviewer reported that this appears to be a solid project with good potential benefits if it proves to be valid. The reviewer added that the effort is not highly funded and appears to be a one man effort, much like a post grad student project. The approach is good given the apparent constraints.

Reviewer 4:

The reviewer stated that the approach is not novel but is probably unique. The reviewer added that the use of the engine coolant instead of a separate circuit for the power electronics is a significant step towards cost reducing hybrid power trains.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that the project has progressed well and met its accomplishments.

Reviewer 2:

The reviewer commented that ANL invented nanofluids. The reviewer pointed out that working on better properties is the key.

Reviewer 3:
The reviewer indicated that the initial numerical thermal analysis has been completed, impacts of key variables have been analyzed and the potential capability of the system verified. The reviewer added that the project progressed as proposed.

Reviewer 4:
The reviewer mentioned that while some basic modelling had been done, it appears that much more design work on the system needs to be done to better guide the testing. The reviewer added that the PI could not answer what the reviewer thought was a pretty simple question about how much of the system cooling fluid has to be diverted to provide the expected cooling needs for the power electronics package. The reviewer said that it seemed like a pretty simple but very important question. The reviewer was concerned that it may be very difficult in practice to control the nucleate boiling regimen within the cooling channel and the surface temperatures may vary a lot in practice.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that NIST should also be a collaborator. The reviewer added that the project team needs to work with OEMs.

Reviewer 2:
The reviewer would like to see a Tier 1 express interest in this if only to evaluate the concept on production intent power electronics design.

Reviewer 3:
The reviewer noted that there was not a lot of collaboration shown, although some with NREL.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted an impressive research plan. The project team should consider shear thinning nanofluids which lowers the viscosity. The reviewer added that the project team should consider propylene glycol. The reviewer warned that ethylene glycol (EG) is a hazardous material.

Reviewer 2:
The reviewer said that the proposed future research is appropriate.

Reviewer 3:
The reviewer stated that the future work is well planned and straightforward. The reviewer added that one weakness is that no industry partner is involved for future technology transfer. More importantly, the reviewer commented that the project team should evaluate the technical and commercial feasibility of the general concept.

Reviewer 4:
The reviewer suggested that building a testing lab for this project would be a good next step, but the reviewer would suggest that more system design issues need to be answered to better guide the testing.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that nanofluids can save energy because they weigh less.

Reviewer 2:
The reviewer said yes this is relevant as it could lead to cost reduced hybrid solutions.

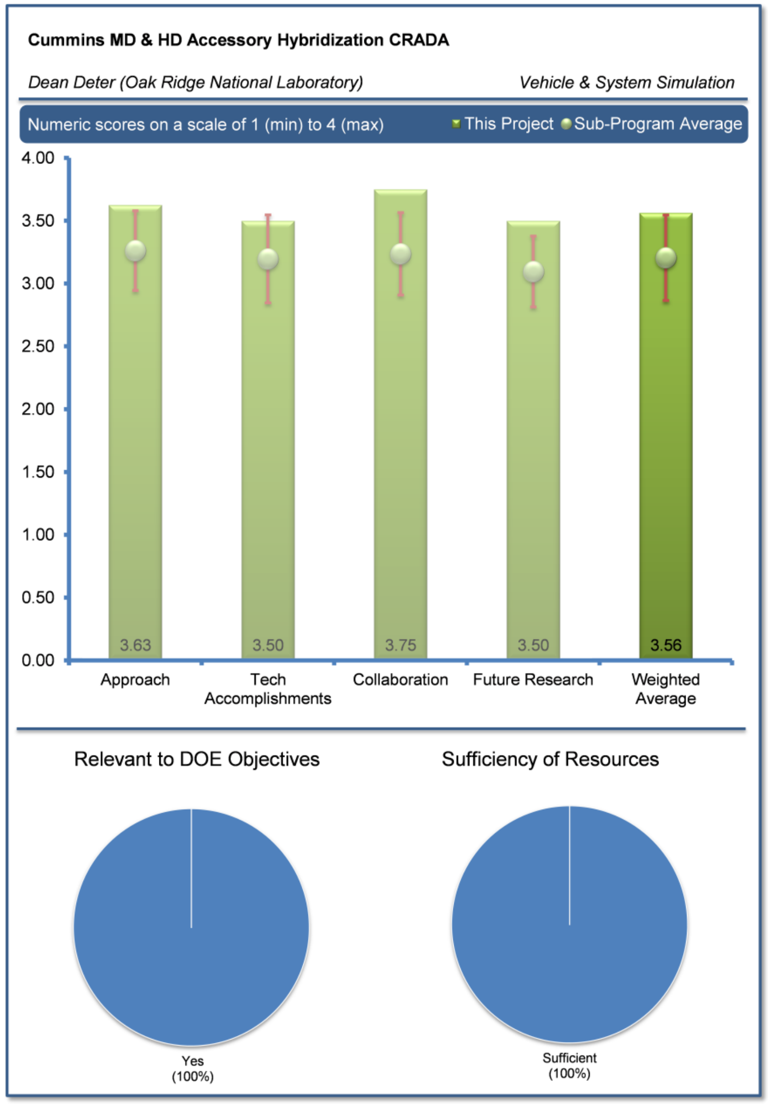
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that the project was excellent work and had some of the best researchers in the area.

Reviewer 2:
The reviewer stated that ANL has the thermal analysis and design capability, and ORNL provides expertise in power electronics design requirements.

Reviewer 3:
The reviewer commented that if further system design efforts could prove the viability of a full scale system, the reviewer would want to see more resources provided to the testing and design effort.

Cummins MD & HD Accessory Hybridization CRADA: Dean Deter (Oak Ridge National Laboratory) - vss133



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the physics based model approach is an excellent way to evaluate systems approaches to solving problems; however, there needs to be verified grounding of the assumptions. For instance, the bus alternating current (AC) load is about one third of what is required to provide the function of AC for a passenger bus. The reviewer suggested that the project effort also includes development of a table known maximum power levels to adequately power their relevant sub-system. The reviewer added that power levels affect the fuel saved and the sizing of systems. The project is very relevant.

Reviewer 2:

The reviewer pointed out that this project was a valuable CRADA and had a well thought-out research plan.

Reviewer 3:

The reviewer said that the approach with analytical investigation and then on a test stand is good. The reviewer added that most component manufacturers do not think about this part of the duty cycle. The reviewer noted that the project team is using three drive cycles to select one for deeper analysis. The reviewer also said that the project team selected a system for long haul sleeper cabs to be hybridized.

Reviewer 4:

The reviewer observed that a deeper study on the relevance should be completed on the component level.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that so far, still early in the project life. The reviewer commented that it was great to work so close with Cummins for prototypes. The project has a great chance of being a real world application, for example, using Cummins real time fleet test data. Truck HVAC focus is strong and needed. The reviewer added that the cooling fan needs better fidelity, the reviewer agreed and is excited to see more work done here.

Reviewer 2:
The reviewer remarked that validation is an important part of the project. The reviewer said that the better understanding of auxiliaries is the key. The reviewer added that NREL has done a high fidelity model for the HVAC system called COOLCAB. The reviewer suggested that this software should be included.

Reviewer 3:
The reviewer noted that the building of the models and choosing the direction of the evaluation are great first steps. The reviewer observed that evaluation needs grounding based on actual sizing needs. The reviewer added that the technical approach to using the Merritor Hybrid system is not relevant (the system is not commercial and it is not planned to be commercial). The reviewer suggested that a commercial transmission partner be used or a transmission that is a part of an active product development.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that Cummins and Meritor are an all-star team for this project's scope. The reviewer suggested taking as much advantage of their help as possible.

Reviewer 2:
The reviewer said that there was excellent partnership.

Reviewer 3:
The reviewer stated that Cummins is a great partner to have; however, it is not clear to what degree Cummins is participating in the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked that eliminating overnight idling is a worthy goal.

Reviewer 2:
The reviewer reported that the proposed future work of completion of the models, component testing, validating the sub-system models, integrating into a powertrain and evaluation of the powertrain is a complete approach. This is assuming that a baseline of the initial powertrain has been completed. The reviewer added that if not in the plan or already completed, the baseline of the powertrain needs to be added to the list.

Reviewer 3:
The reviewer observed that it is important to do electric APU, or what we call battery HVAC along with diesel APU. The reviewer added that the project team had a strong approach for 2014/15 work and that the work was excellent.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewers stated that there were excellent partnerships, but do not include air brakes for the type of vehicles the project is looking at.

Reviewer 2:
The reviewer remarked that the electrification of truck auxiliary systems (including idle reduction) is an excellent approach to improving truck petroleum usage.

Reviewer 3:

The reviewer pointed out that idling is an important piece of the duty cycle that needs more study. This gives us good data for understanding. The reviewer added that components do not typically get analyzed in this speed/situation and need this work.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that laws for eliminating idling are a driving force.

Reviewer 2:

The reviewer commented that it looks like a very robust plan.

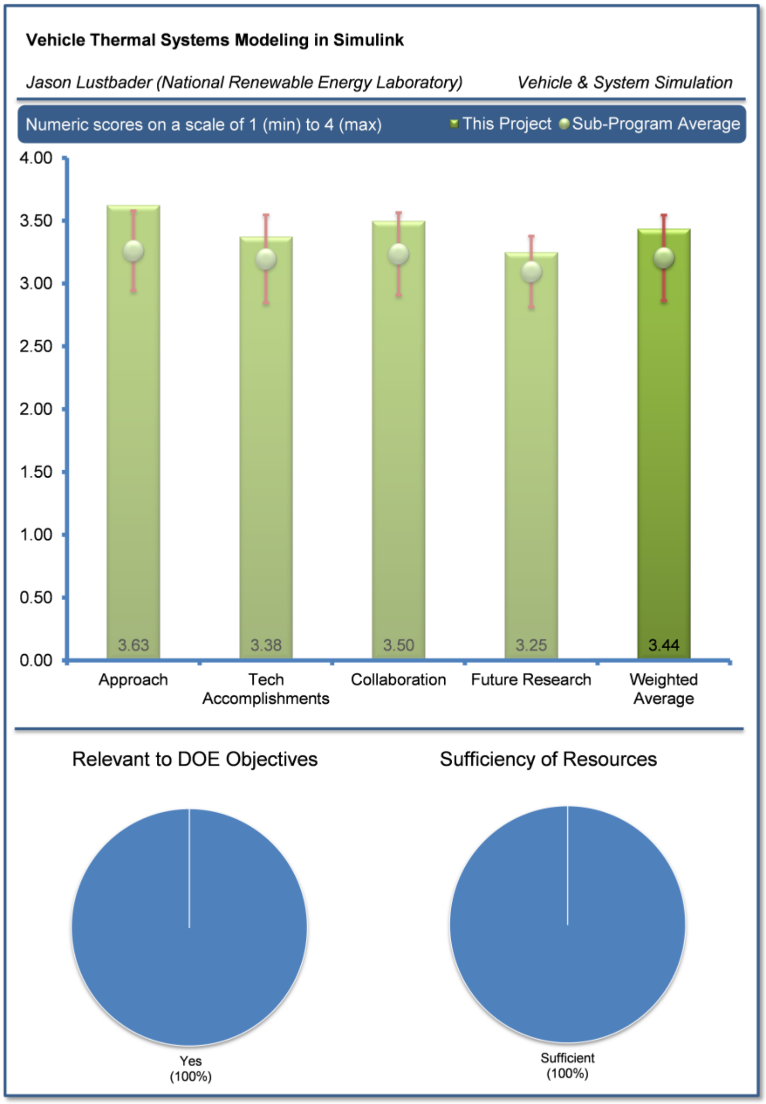
Reviewer 3:

The reviewer stated that more research is required to validate models. The reviewer said that there was good work over all.

Reviewer 4:

The reviewer indicated that the resources seem to be sufficient for the modeling work. In the next steps that require electric vehicle auxiliary systems will require additional resources if the components are not available. The reviewer added that the resourcing briefed is not forward looking, so no comment on the funding required doing the next steps.

Vehicle Thermal Systems Modeling in Simulink: Jason Lustbader (National Renewable Energy Laboratory) - vss134



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this is the second year the reviewer has reviewed this work. The reviewer greatly appreciates the approach and content. The reviewer added that the PI has taken a logical approach to modeling a system that is well known to industry but not necessarily evaluated to this point. He is now moving to the systems level modeling after a year of tools development. The reviewer looks forward to his review next year.

Reviewer 2:

The reviewer commented that the project and the approach are innovative and timely.

Reviewer 3:

The reviewer stated that the heating and cooling of EVs impacts EV range significantly and directly effects range anxiety which retards market adoption. The reviewer added that developing modeling tools that enable designers to optimize systems is valuable.

Reviewer 4:

The reviewer noted that the overall approach of developing an open-source framework that can co-simulate with Autonomie is sound. Autonomie is lacking a dedicated module for thermal system modeling, and this project serves to fill this void. The reviewer stated that with quantification of the loss of fidelity from the model being 1-D as opposed to 3-D would be useful here. Also, the M1 milestone was completed and the results of the model are said to have "reasonable trend." This reviewer asserted that a discussion of how this was judged is warranted. The reviewer asked how much of an improvement has been made over existing models. The reviewer added that the objective is stated to develop models from the first principles but several of the components are said to have lookup tables. The reviewer wanted to know if these tables are derived from the first principles or experimental data.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that there was good progress to date. The reviewer added that the baseline tool set appears to be strong and fairly complete.

Reviewer 2:

The reviewer indicated that the PI presents a very viable account of the project progress.

Reviewer 3:

The reviewer stated that the modeling of the thermal system has been demonstrated and provides capability for development of advanced and optimized systems in EVs, hybrids, or conventional vehicles that can reduce petroleum consumption.

Reviewer 4:

The reviewer said that the project appears to be on track with the first milestone achieved and the bulk of the work still to come; however, because the details of the go/no-go decision are unclear, it is difficult to judge the current status of the progress. The reviewer said that the milestones are well laid out for the remaining work.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that there was an excellent list of collaboration partners and their participation scope is provided. The reviewer said that a collaboration partner listed (Daimler) with listed scope of "Assisting with SuperTruck project" does not make sense.

Reviewer 2:

The reviewer commented that the project team had a solid collaboration group.

Reviewer 3:

The reviewer noted that the investigator has been in contact with persons from the reviewer’s agency who have been inspired by this project.

Reviewer 4:

The reviewer remarked that there appeared to be significant collaboration with a variety of institutions and organizations; however, collaboration with some universities might be beneficial.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed future work is a good listing of work that can be completed; however, it is not clear of the timing of the proposed future work. The reviewer suggested that the proposed future work also includes some kind of timing.

Reviewer 2:

The reviewer indicated that the technical progression is logical and achievable. The reviewer added that the support group appears to be an excellent advisory group.

Reviewer 3:

The reviewer reported that the plan to achieve the remainder of the project objectives appears sound. The reviewer stated that a validation of the overall model and the development of the open-source tool will be a significant accomplishment.

Reviewer 4:

The reviewer stated that the investigator did not discuss this item.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that modeling of all parts of the vehicle is essential for vehicle design. The reviewer added that this project focuses on an often overlooked aspect of model development, but it can have significant impact on increasing the efficiency of thermal regulating systems onboard vehicles. The reviewer said that this can lead to a significant contribution towards petroleum displacement.

Reviewer 2:

The reviewer remarked that this is a good set of tools and system modelling for a broad industry base.

Reviewer 3:

The reviewer commented that HVAC is a large consumer of petroleum and improving HVAC performance will reduce petroleum consumption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources dedicated to this project appear to be sufficient and of appropriate scope.

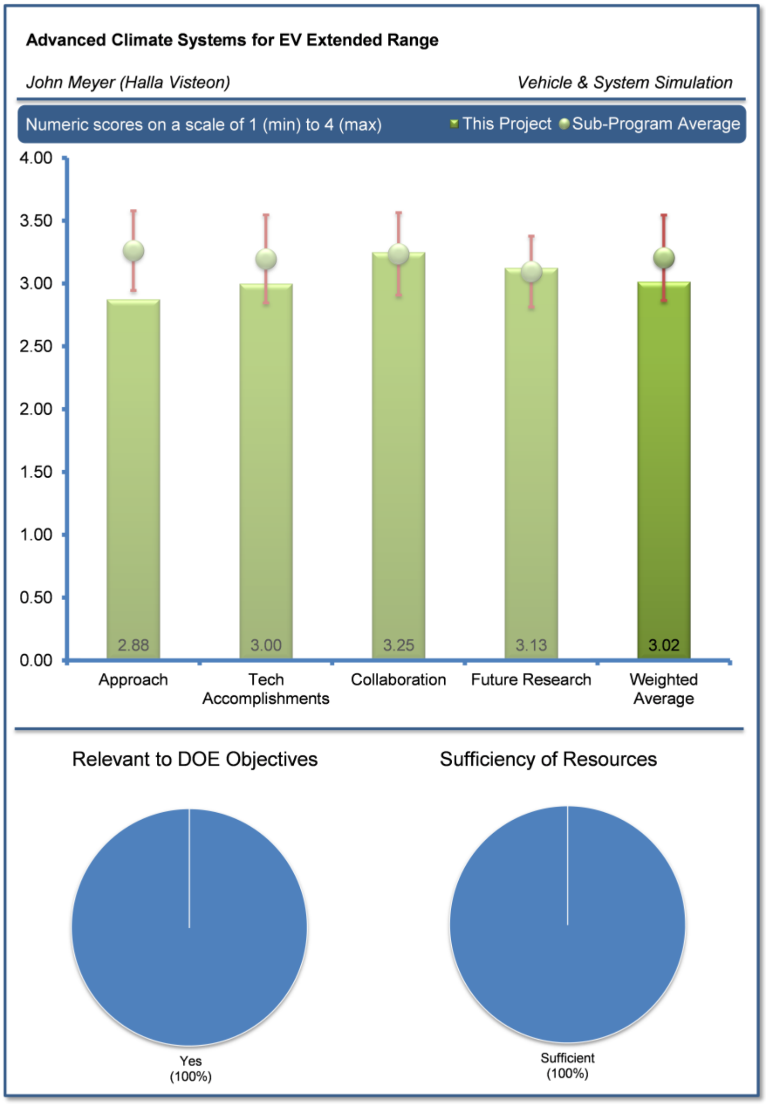
Reviewer 2:

The reviewer commented that progress is steady and the reviewer did not see blatant holes in the research plan. The reviewer emphasized that this was a nice project.

Reviewer 3:

The reviewer explained that the resource rating of sufficient assumes that this project is in support of other projects that are developing the components and subsystems. The reviewer added that if this project does not have the support of other projects, a rating of insufficient is appropriate.

Advanced Climate Systems for EV Extended Range: John Meyer (Halla Visteon) - vss135



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the approach is good and mentions improvements in components and subsystems. The reviewer asked if the project is going to develop a better overall (possibly different) system design or just improve the parts in the existing HVAC system. The reviewer was unable to attend the live presentation, so maybe this question was answered.

Reviewer 2:

The reviewer stated that it would help if the approach includes expected benefits in terms of percentage improvement in driving range, etc., the reviewer added that, of course, it is understood that this would depend on the chosen drive cycle, but some rough estimate would be helpful.

Reviewer 3:

The reviewer stated that this project demonstrates well laid out plans and good use of CAE tools to understand the baseline thermal loads. The reviewer added that some more thought could have been put into laying out project targets and metrics.

Reviewer 4:

The reviewer commented that the objectives lack the specificity necessary for the project to achieve its intended goal. The reviewer said that the project fails to specify objectives that will deliver advanced load reduction, advanced HVAC, and preconditioning systems that will make the EV viable in the very cold and hot temperature operating environments that are characteristic for large portions of the U.S. market. The reviewer added that this lack of specificity allows the performer to weigh the design requirements analysis to the moderate temperatures of the California market.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the work to date is crucial to executing the project goals and seemed to be progressing very well.

Reviewer 2:
The reviewer stated that based upon the level of funding received in FY 2014, the accomplishments were good. Perhaps, more funding could have helped to move this project along a bit better.

Reviewer 3:
The reviewer stated that the project is still in its infancy.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that there was excellent collaboration with OEM and leveraging of DOE national laboratory expertise.

Reviewer 2:
The reviewer commented that collaboration with partners NREL and Hyundai appeared to be strong.

Reviewer 3:
The reviewer indicated that the relevant stakeholders were present to make the project successful.

Reviewer 4:
The reviewer stated that one of the 2014 tasks is to build and validate a CFD model. It seemed to this reviewer that the experience that NREL has gained in developing and validating CoolCab and CoolCalc should be leveraged here. The reviewer added that not only will NREL benefit when the tool is used for a purpose other than for simulating truck cabs, but Halle Visteon should benefit from all the experience that NREL has already gained.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the work elements proposed should produce good results.

Reviewer 2:
The reviewer observed that the long term plans for project are well laid out. The reviewer wanted to see a bit more on estimated gains in petroleum consumption reduction from the work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that any improvement in EV driving range would increase the acceptance of these vehicles among the general public, and contribute to a reduction in petroleum usage.

Reviewer 2:
The reviewer indicated that the project improves efficiency of EV HVAC subsystems, which enables improved overall vehicle energy efficiency and improved EV range. The reviewer added that this will help make EVs more practical as alternative to ICE-based transport.

Reviewer 3:
The reviewer noted that by reducing auxiliary loads the project has the potential to extend EV range and displace petroleum consumption.

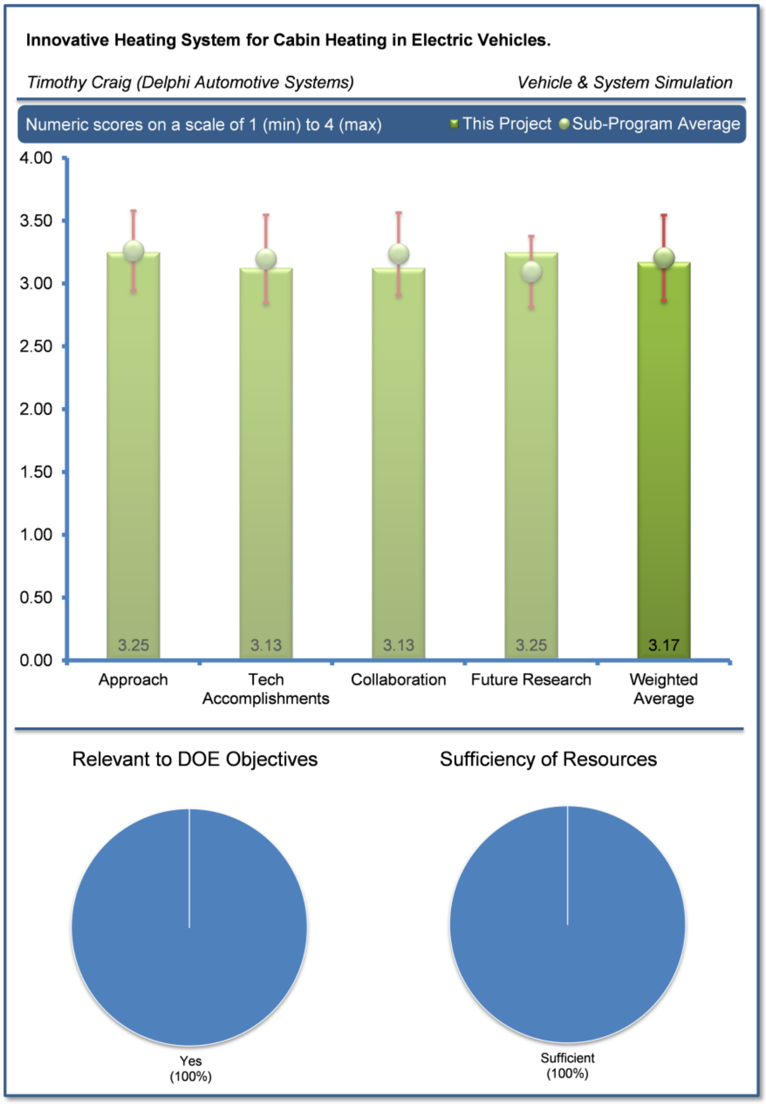
Reviewer 4:
The reviewer stated that the project directly supports the DOE objectives of petroleum displacement through minimizing air conditioning (A/C) loads for electric vehicles and increasing useful range.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the resources appeared adequate.

Reviewer 2:
The reviewer stated that the resources are sufficient for this task.

Innovative Heating System for Cabin Heating in Electric Vehicles.: Timothy Craig (Delphi Automotive) - vss136



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer pointed out that the project team had an excellent approach that incorporates practical requirements and test of the technology in real world conditions.

Reviewer 2:

The reviewer commented that the overall approach is laid out logically. While the component development technical approach is strong, it was not clear if the system performance requirements have been adequately determined. The reviewer added that up-front analysis is needed to determine the required system performance in order to improve over current solutions, namely adding more batteries. An argument needs to be made about the required system density, weight, and cost that if achieved, would make a compelling case over adding more battery capacity. The reviewer recommended that this analysis consider both heating and cooling, even if cooling is only sensible thermal storage. The reviewer also said that in the question and answer session, it sounded like some thought may have gone into this, but a more clear and complete augment was needed.

Reviewer 3:

The reviewer reported that, while understanding that the scope of this project is to develop a thermal heating system using phase change material (PCM), the cost and weight trade-off of this system when compared to increasing battery capacity should be highlighted, along with the fact that increasing battery size provides a positive benefit during the summer months through increased range, while this proposed system increases the weight. This does not, in the reviewers mind, reduce the technical merit of this approach. The reviewer added that this is another alternate solution to an existing problem that has to be weighed along with all the other solutions. The reviewer commented that the choice of extending grid-connected electric-drive vehicle (GCEV) range by greater than 20% at -10°C, is somewhat arbitrary, and has a direct influence on the benefit of this system over other competing systems as well. Perhaps, the analyses and tests should be carried over based on the duty cycles experienced by the current GCEVs in use to truly understand the trade-offs involved.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that given that this project was started in October and is only 5% complete, good progress has been made on the component development. Identifying a possible PCM that approaches the target goals is an important step in the component design. The reviewer added that providing a more accurate schematic that includes the required bypass and controls would be helpful to understanding the system behavior. The reviewer asked if there are two valves in the system. The reviewer also noted that there was some discussion about how this control would be performed to minimize impacts on transient response, especially during cold weather startup would be helpful. The reviewer stated that the preliminary modeling is also a good initial accomplishment and shows some thought is being put into the component design.

Reviewer 2:

The reviewer commented that there was excellent progress on system requirements development. The reviewer added that it is not clear from accomplishments if tradeoff of added mass of ePATH has been considered in the energy savings projected.

Reviewer 3:

The reviewer said that the project still in its infancy.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that there is an excellent team composition including an OEM, HVAC supplier, PCM company, and national laboratory. The reviewer added that it seemed that the right companies were involved for successful development and eventual commercialization.

Reviewer 2:

The reviewer stated that appropriate collaborations for success are in place.

Reviewer 3:

The reviewer noted that the presenters indicated that the project is planning to use a grid connection that bypasses the on-board energy storage and likely will not use the J1772 connector. The latter statement indicates that the project team needs to collaborate more with DOE and their partners for design review and feedback. The reviewer added that one cannot fulfill the requirement to integrate the device into grid connected vehicle if it does not use the standard grid connection interface. That being said, it is desirable to bypass the energy storage system from the standpoint of maximizing the life of the battery pack. The reviewer stated that the project should use the standard connector and bypass the energy storage system in the design to provide power to the phase change material energy storage device.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the necessary plans are in place, and looked forward to the results.

Reviewer 2:

The reviewer indicated that the proposed plan is logical, starting with design, development, then bench level testing, and finally integration as well as validation. The reviewer added that the plan would be improved by up-front feasibility and target analyses, even if simple, to set the correct performance goals and assess the feasibility of achieving the target.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the project improves range performance of EVs by reducing impact of HVAC loads on vehicle energy usage.

Reviewer 2:
The reviewer reported that this device has strong potential to extend EV range in while operating in cold temperatures.

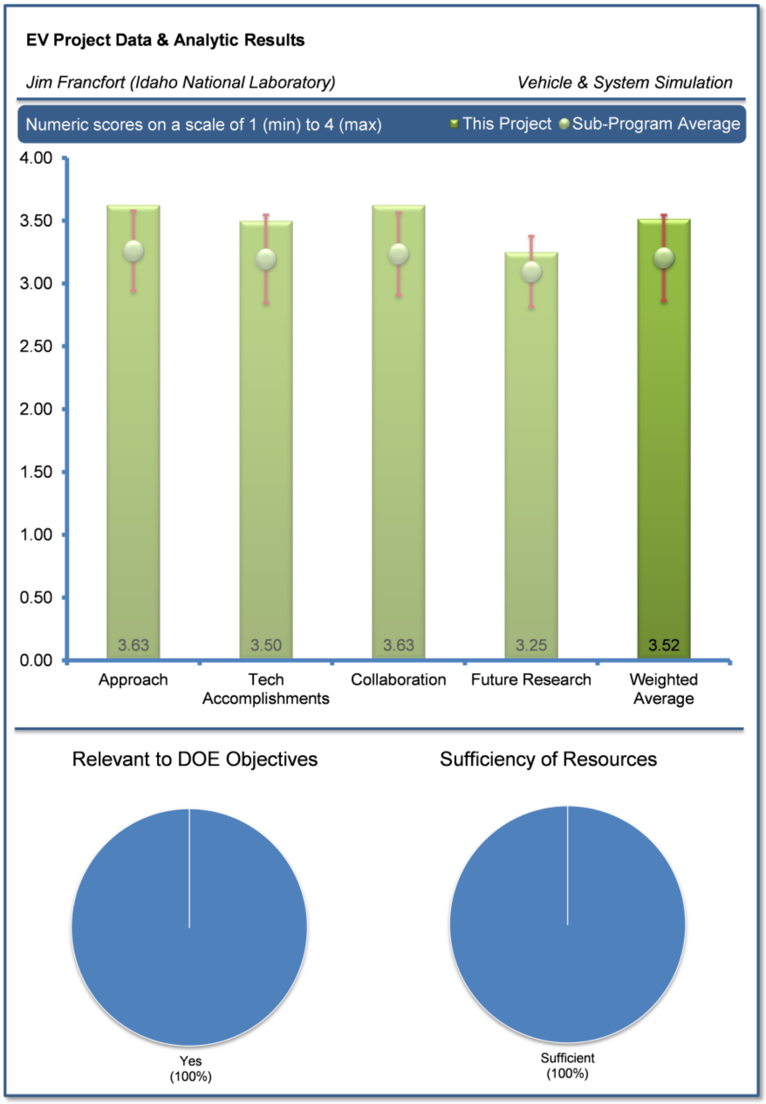
Reviewer 3:
The reviewer mentioned that as in the first comment above, this approach provides one solution to the problem of reduced driving range due to auxiliary heating loads.

Reviewer 4:
The reviewer commented that the presenter did a good job addressing DOE goals. Reducing the impact of cabin heating on EDV's is critical to their long term acceptance and wider adoption. The reviewer added that the goal to extend GCEV range by more than 20% by reducing or eliminating the auxiliary heating load from the vehicle battery at -10°C would be a significant accomplishment and is very relevant to DOE goals. Additionally, the reviewer said that decreasing the impact of HVAC system on EDV range is critical to reducing range uncertainty and therefore their widespread adoption. The reviewer remarked that it would be helpful to make an argument for the feasibility of a successful system design achieving this goal in the future.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that resources are good.

EV Project Data & Analytic Results: Jim Francfort (Idaho National Laboratory) - vss137



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed that this is a giant project, a huge investment, and is collecting a tremendous amount of valuable data that highlights barriers for mass adoption and can be used to address barriers to EV adoption. The reviewer added that this is an awesome investment by the government.

Reviewer 2:

The reviewer reported that the project was a huge undertaking that was performed very well. The reviewer cannot wait to see the actual report with details. The reviewer added that the anecdotal references to issues are well appreciated, but moreover were successfully handled.

Reviewer 3:

The reviewer stated that the project plan and design has covered several important factors that will help the future deployment of the plug-in EV; however, in regard to diverse geographies there is less deployment in the Midwest area, which can have useful environmental and other factors to study.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer pointed out that the investment and data collection are complete, the project is data rich. The reviewer added that the path forward is straightforward, and recommended to draw out as much knowledge as possible from the data collected, so that the project can become knowledge rich.

Reviewer 2:

The reviewer said that the project has a large collection of interesting data from all the work that was done. The reviewer added that this data has a wealth of information to analyze. The reviewer stated that more data analysis is needed for the maximum use of the project results.

Reviewer 3:

The reviewer stated that this overview in 20 minutes cannot describe what is apparent in the report.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the project has excellent collaboration with diverse groups of government, laboratories, utility providers, general public, manufacturers, and others.

Reviewer 2:
The reviewer commented that a great deal of collaboration was completed with vehicle manufactures, charging suppliers and vehicle operators/users.

Reviewer 3:
The reviewer stated that all appropriate stakeholders were seemingly involved.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the project is winding down and analysis of the data is underway. The reviewer added that it is not clear whether the analysis will move into FY 2015.

Reviewer 2:
The reviewer commented that data loggers must be used to account for all energy use and performance.

Reviewer 3:
The reviewer reported that the project presented a future work plan that emphasized the use of the large collection of data generated from previous work. The project also identified several barriers mainly relate to managerial or consumer issues; however, more emphasis on technical barriers need to be identified and addressed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer indicated that the project provides a huge amount of information and emerging knowledge on how to best address the needs of vehicles and charging systems to meet the user needs. The reviewer added that this will be invaluable in the path forward.

Reviewer 2:
The reviewer stated that EVs will support the DOE objectives of petroleum displacement. The reviewer added that this project will provide the needed data for improving the EV technologies, consumer acceptance, and other EV related issues.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

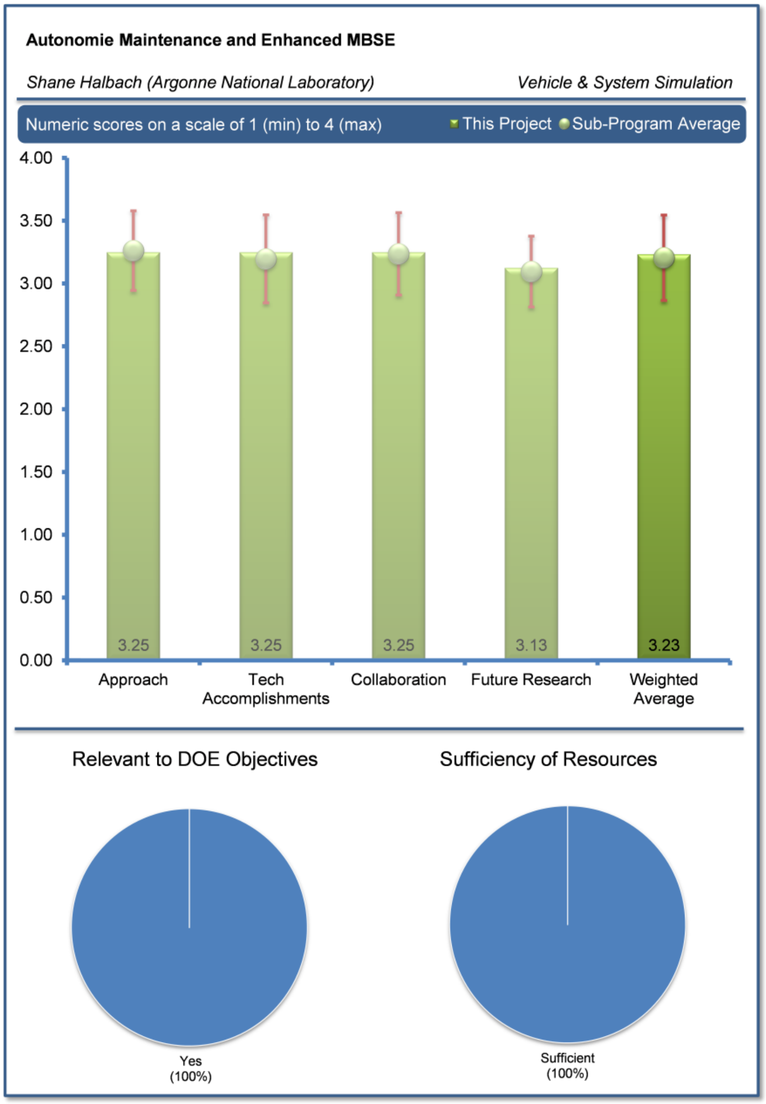
Reviewer 1:
The reviewer said that the project was very good overall.

Reviewer 2:
The reviewer commented that it appears that the project has sufficient funding to cover all of its milestones.

Reviewer 3:
The reviewer emphasized what a budget.

Reviewer 4:
The reviewer indicated that the project is winding down.

Autonomie Maintenance and Enhanced MBSE: Shane Halbach (Argonne National Laboratory) - vss139



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that using a virtual engineering approach to accelerate the vehicle development process is an excellent practice. By using this approach the barriers of accelerating technology evaluation and bringing technologies to market faster are addressed in this project.

Reviewer 2:

The reviewer stated that Autonomie vehicle simulation tool has a large user base and is highly integrated with the R&D efforts of industry. The reviewer indicated that universities and national laboratories are to conduct R&D on vehicle efficiency improvements. The reviewer added that maintaining the simulation tool and adding features are vital to enable this user base to continue their R&D efforts and is highly aligned to the DOE's efforts to displace petroleum. Also, the reviewer said that some of this workload is a result on the dependency to Matlab/Simulink tool. The reviewer said that an alternative approach to consider is the creation of a stand-alone tool.

Reviewer 3:

The reviewer commented that since they come from industry, where they have already performed many vehicle simulations,, the reviewer was not just juiced on this presentation. The commenter criticized that this work has already been done and that parts of industry are already great at this. The commenter suggested that instead of doing a "me-too" simulation; that the researchers work on those vehicles / powertrains / configurations that are not being done in the industry.

Reviewer 4:

The reviewer reported that the initiative to make Autonomie more accessible through the FMI is a significant achievement and improvement, as are the connections to BatPac as well as the MOO addition. The reviewer added that Autonomie is widely used in the industry, and this project serves to maintain the position as the preeminent modeling software. One small suggestion the reviewer had would be to have a trial version of the software to give potential users a feel for what the capabilities of the software are.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer indicated that technical accomplishments and progress of this project has been excellent. The reviewer pointed out that several new models, tool integration and software have been developed which will lead to added capabilities of Autonomie.

Reviewer 2:
The reviewer commented that there is a significant workload of accomplishments completed, including upgrades of features to make Autonomie more compatible with a larger user base (Functional Mockup Interface, BatPac, and co-simulation). Additional component models (dual clutch transmissions, PHEV 2-mode configuration) and general upgrades are to be compatible with newer Matlab versions.

Reviewer 3:
The reviewer remarked that the milestones page does not contain enough information to judge the progress of this project. The reviewer added that a more comprehensive presentation of specific milestones, including their date and past results should be included in subsequent years.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer reported that collaboration and coordination is very good. The reviewer added that ANL has worked closely with national laboratories and OEMs such as GM and Ford to get feedback to help enhance Autonomie.

Reviewer 2:
The reviewer observed that there appears to be considerable collaboration with other institutions and organizations. The reviewer suggested that more collaboration with universities would be a good idea.

Reviewer 3:
The reviewer said that a large user base depends on the use of Autonomie for their research efforts.

Reviewer 4:
The reviewer criticized that this is already being done in industry. The commenter asked what the far-reach on this type of modeling and simulation is.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the future work is well defined and will continue to enhance Autonomie to provide support to VTO activities by gathering new requirements from industry.

Reviewer 2:
The reviewer remarked that the proposed work to continue maintenance and upgrades to Autonomie is needed to support the larger R&D community. The reviewer noted that one alternative approach for the future is to investigate Autonomie as a stand-alone tool and wean the tool off its dependency on Matlab/Simulink. The reviewer said that this would make the tool accessible to a larger user community without having to purchase Matlab/Simulink licenses and avoid having to perform maintenance updated based on Matlab/Simulink changes.

Reviewer 3:

The reviewer mentioned that outside of the plans for large-scale simulation, the plans for future work on the project are relatively modest; however, the maintenance work required to keep Autonomie current is very important in its own right.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that Autonomie is a relevant research tool for evaluation the effectiveness of fuel savings technologies and is highly aligned with DOE's mission.

Reviewer 2:

The reviewer said that Autonomie is a very relevant tool used by DOE to evaluate benefits of advanced technology and industry to help with market introduction of new technologies.

Reviewer 3:

The reviewer pointed out that Autonomie is a very important tool to a variety of stakeholders in the automotive industry. The reviewer added that this project is an important DOE venture to reduce petroleum consumption by allowing design of advanced vehicles to proceed more quickly and efficiently.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer reported that the funding of this project appears appropriate and is relatively low, meaning that the DOE is receiving good value for its investment.

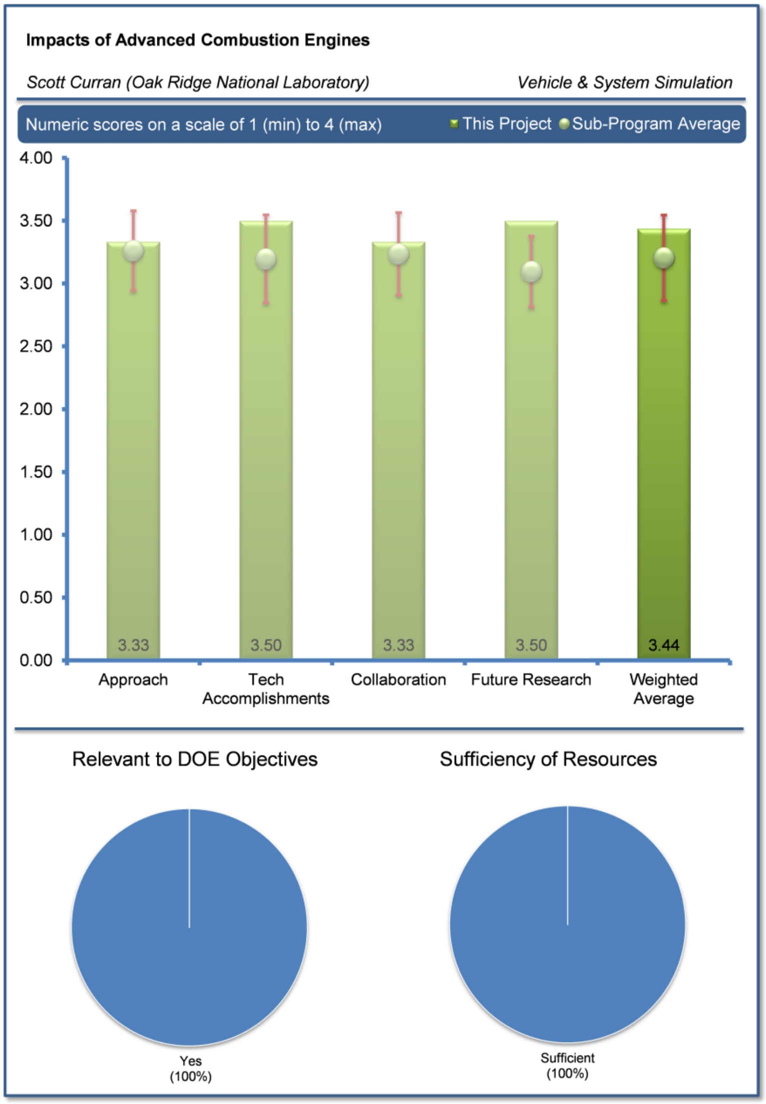
Reviewer 2:

The reviewer remarked that funding appears to be sufficient to implement this project successfully.

Reviewer 3:

The reviewer said that funding appears to be sufficient.

Impacts of Advanced Combustion Engines: Scott Curran (Oak Ridge National Laboratory) - vss140



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that there was a strong technical approach and growth strategy. The reviewer added that the project had good relevance to industry with cooperative relationship through crosscut committee. Also, the reviewer said that there was an excellent cross relationship with other ORNL related projects.

Reviewer 2:

The reviewer stated that this task is focused on examining the fuel economy potential and resulting emissions and mitigation schemes for reactivity controlled compression ignition (RCCI) combustion. This multi-mode approach involves a RCCI operating regime and a conventional diesel operating mode. The RCCI regime may be fueled by gasoline or biofuel, while the conventional diesel combustion mode is fueled by diesel or a biodiesel blend. RCCI offers significant potential to increase fuel economy, even above diesel engines, in both conventional and hybrid vehicle applications. Oxides of nitrogen (NO_x) are significantly reduced; however, hydrocarbons (HC) and carbon monoxide (CO) increase considerably. The reviewer added that this activity is being conducted to support U.S. automakers in meeting 2025 Corporate Average Fuel Economy (CAFE) standards and EPA Tier III emissions regulations. The reviewer commented that the ORNL approach to this task appears sound: development of advanced steady state combustion maps from dynamometer measurements with exhaust species; evaluation of the fuel economy potential of RCCI advanced combustion in conventional and hybrid light duty powertrains; evaluation of the complete drive cycle implications on emissions /after treatment requirements; and evaluation of the effect of fuels on multi-mode operation. Also, the reviewer stated that multi-cylinder advanced combustion engine experiments are conducted, followed by aftertreatment model integration, and subsequently vehicle systems level modelling. The reviewer said that updating and refining after treatment component models depends upon timely acquisition of the latest available data on device physics and chemistry.

The commenter suggested that the concept of using two fuels may lead to a customer acceptance issue, but the commenter noted that the approach of developing a blended fuel that can be used that broadens the RCCI operating domain has good value. The reviewer asked if there is any data that has investigated adoption of dual fuel vehicles by consumers. If the project is successful, the project evaluator indicated that the modeling capability will be very helpful to system designers to make substantive system level changes and have a high degree of confidence that fuel and emissions targets will be met prior to building product. The reviewer suggested that there should be more parallel validation of the model against advanced systems under test at OEMs or at DOE labs to gain confidence in modelling capability. The commenter also commented that the briefing should have shown the predicted versus actual for fuel economy, performance, and emissions.

Reviewer 3:

The reviewer stated that they were stuck on the acronym FLT, asking what it stands for. The commenter recommended that an acronym listing be given because it was not properly introduced in a manner that the reviewer could find. The commenter noted that there are many more acronyms in this briefing that are not introduced. The project evaluator offered that this made the presentation hard to follow. The reviewer explained that the relevance of the work is excellent and the result integrates with Autonomie.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the project had impressive results so far; even though it is early in the program, an excellent data set was presented.

Reviewer 2:

The reviewer recognized that excellent progress has been made to date for the funding level of the project.

Reviewer 3:

The reviewer reported that the project has made significant technical progress including updating and refining RCCI multi-mode engine maps and transient combustion models for dual-mode combustion engines. These efforts have identified opportunities including a multi-mode strategy for high load transition with potential fuel efficiency gains, as well as a multi-mode strategy for low-load transition which has identified emissions concerns including the presence of sub 200°C exhaust temperatures with high HC and CO, which represent challenges for current oxidation catalysts. The reviewer added that accomplishment number two expanded range enabled by biofuels and RCCI drive cycle coverage over city and highway cycles, and further noted that 100% coverage of LTC is necessary to avoid mode switching and resulting FE and emission control penalties. This task has identified expanded low and high load operating range due to higher port fuel injection to direct injection ratio for a 20% biodiesel blend and gasoline. Using diesel and a 30% ethanol blend, an expanded high load was observed due to higher octane and charge cooling, while a reduced low load was observed due to stability issues. Also, the reviewer indicated that accomplishment number three utilized vehicle systems simulations to enable drive cycle coverage comparisons of renewable fuels. Modeling results show greater than 75% drive cycle coverage with RCCI over Urban Dynamometer Driving Schedule (UDDS) and Highway Fuel Economy Test (HWFET) cycles with B20 and gasoline. A 41% improvement in combined city/highway MPG was demonstrated compared to port fuel injection baseline and a 6% improvement over the combined cycles compared to conventional diesel combustion. Accomplishment four has successfully simulated the fuel economy of several RCCI enabled HEVs. Initial modeling shows significant improvement with RCCI-enabled HEV configurations over PFI and even diesel HEVs. A similar increase is seen with RCCI in both conventional and HEV powertrains. The reviewer added that accomplishment five is an initial simulation comparison among port fuel injection (PFI), gasoline direct injection (GDI), conventional diesel combustion (CDC), and RCCI in a power-split mid-sized hybrid sedan including cold start cycles. Results indicate RCCI achieves higher fuel economy than CDC and GDI with significantly lower NO_x, but higher CO and HC. The reviewer said that, overall, the project had an impressive list of accomplishments for the project, especially given a project start date of October 2013.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the collaboration group is impressive especially within ORNL. The reviewer would like to see some specific participants from engine manufacturing group if possible.

Reviewer 2:

The reviewer observed that this project demonstrates excellent coordination and collaboration with VTO between Advanced Combustion Engine, Fuels/Lubricants, and VSST. VTO Advanced Combustion has and is providing funding for development of combustion maps while Fuels and Lubricants technologies is providing funding to evaluate the effects of drive cycle coverage as related to fuels. VSST is providing funding to conduct simulations at the vehicle level including fuel economy simulations of RCCI-enabled HEVs and conventional vehicles. The reviewer added that it also appears to be well coordinated with industry, suppliers, universities, and national laboratories through U.S. DRIVE tech team participation and involvement in Cross-Cut Lean Exhaust Emissions Reduction Simulation (CLEERS). The reviewer said that the project is well coordinated within ORNL itself indicating several ORNL projects with which it is being coordinated. It is important to keep up this strong collaboration especially with industry and suppliers to be sure research and modelling activities continue to track with industry needs and business realities.

Reviewer 3:

The reviewer suggested that there should be one or more OEM/powertrain suppliers as partners in this project to enable modeling verification and validation of correlation of the model against real vehicles/powertrains. The commenter noted that currently all of the collaborators are with the DOE/DOE laboratories.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that this was a good startup plan and logical plan for the remainder of the program.

Reviewer 2:

The reviewer stated that the proposed future work seems reasonable and in line with activities needed to further explore and validate the potential of RCCI enabled conventional and hybrid electric vehicles. The reviewer added that efforts to examine/model potential after treatment scenarios and potential mitigation schemes to address higher HC and CO emissions, as well as continued vehicle level simulations seem particularly relevant. Also, the reviewer said little mention at this point is made of looking at potential vibration, harshness, and durability issues, may be something to consider in the not too distant future.

Reviewer 3:

The reviewer proposed that a plan with timing and collaborators/resources would be helpful in understanding what will be done and when and how the project collaborators contribute to the completion of the project. The commenter agreed with the proposed research. The reviewer suggested that in addition to the proposed future work should be collaboration with one or more vehicle OEMs/powertrain providers. The project evaluator indicated that the proposed research level is excellent for the funding level.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer claimed that the modeling capability will help system designers to meet CAFE and emissions requirements with a higher degree of confidence before pouring metal and making chips.

Reviewer 2:

The reviewer stated that the ideal activity for a national laboratory is to explore and define advanced technology and transfer to industry.

Reviewer 3:

The reviewer stated that 2025 CAFE requirements and EPA Tier 3 emission requirements are very challenging and will require substantial increases in vehicular fuel economy with concomitant reductions in emissions. The reviewer added that while significant progress may be achieved with various forms of electrification, vehicle weight reduction, auxiliary load mitigation, etc., significant further improvements in the fuel efficiency and emissions characteristics of heat engines will likely be required. This person explained that RCCI-enabled engines are showing promise in this regard and may be a key enabling technology to meet future requirements.

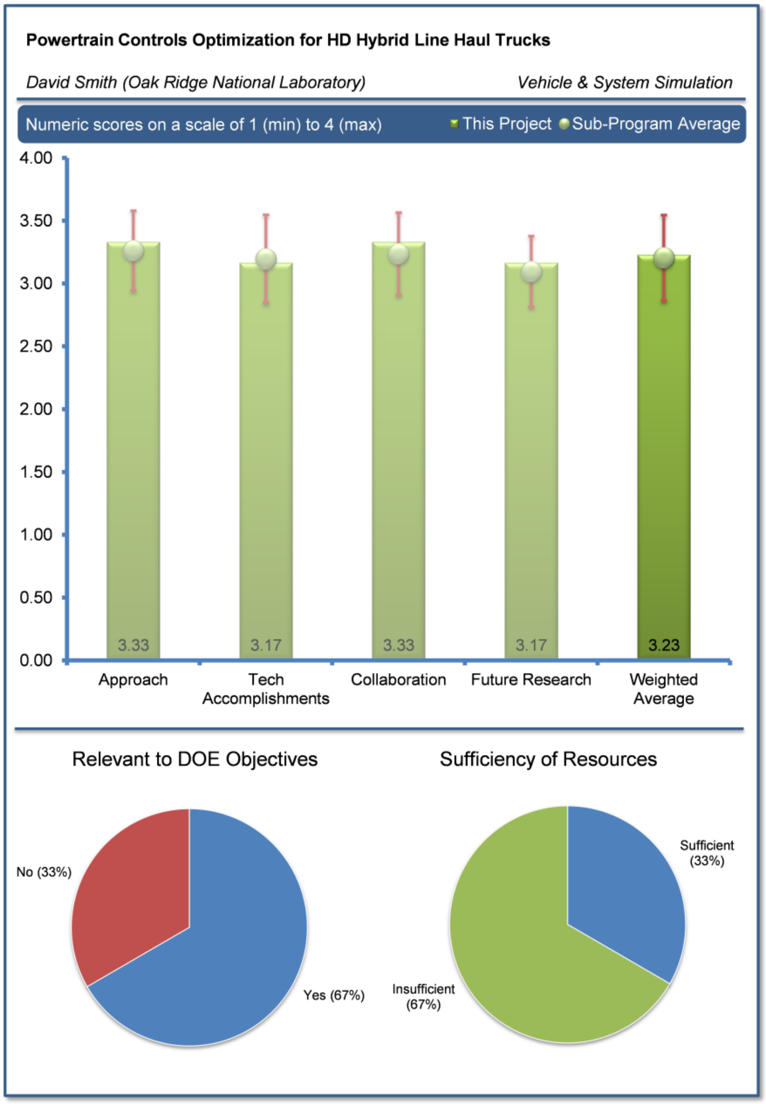
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that funding is probably bordering on insufficient, but no specific holes in research plan were identified.

Reviewer 2:
The reviewer reported that presented resources are sufficient for the presently outlined tasks.

Reviewer 3:
The reviewer agreed that the funding may be sufficient to support the analytical/modelling effort. However, the reviewer added that the funding does not seem to be sufficient to complete the level of dynamometer testing on engines as discussed in the future work.

Powertrain Controls Optimization for HD Hybrid Line Haul Trucks: David Smith (Oak Ridge National Laboratory) - vss141



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer really liked this project; it takes on a good role for an industry that does not invest much in this area. The reviewer added that the strategy is sound with strong partners.

Reviewer 2:

The reviewer stated that the approach leverages previous work regarding Ultra Caps in LD vehicles.

Reviewer 3:

The reviewer described that they support the approach of RCCI with the engine; however, they cautioned that series hybrid electric powertrains are very expensive and their adoption versus a parallel system is going to be highly-challenged because of the cost versus additional benefit (if any) is not justified. The project evaluator suggested the researchers look for a hybrid concept that has a higher likelihood of being relevant. The reviewer explained that unless the capability of ultracapacitors has improved, the size, weight, and cost of ultracapacitors are not a good candidate as a part of the solution. The commenter asserted that the size of the system to capture the regenerative energy of a loaded Class 8 truck is enormous; way bigger than for Li-ion batteries. The Meritor hybrid seems to require a large energy storage system, but regenerative braking should not overtax the batteries. The reviewer also remarked that the Meritor hybrid system has been discontinued, so using it as a basis for design may be flawed as well. The commenter believes that the cost of the system is prohibitive to user adoption.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the project had a strong start for the fiscal year. The reviewer added that there were good steps in the technology plan, appears to be an aggressive, heavily reliant on related programs at ORNL.

Reviewer 2:

The reviewer suggested that the concept of the system architecture be re-investigated. The goal is to lead to substantive reduction in petroleum reduction, so if nothing is adopted, then there will be no net impact. The reviewer did indicate that the milestone of achieving RCCI operation with the engine is good.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that there were excellent supporting organization inside and industrial.

Reviewer 2:
The reviewer acknowledged that the collaboration partner of Cummins is good. The reviewer, however, asserted that the collaboration of Meritor is poor, given that they have discontinued development of the system and have disbanded their hybrid group as the reviewer understood.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer mentioned that the presenter indicated that a component of the experimental hardware had reached end-of-life, for example, Meritor Inverter Power Electronics. This indicates that the validation phase of the design work will be unable to use that hardware for validation and will likely reduce the evidence to support project conclusions.

Reviewer 2:
The reviewer commented that there was a good program plan and aggressive schedule for the year. The reviewer added that technical areas are complete and of high interest. The reviewer would have liked to see a broader set of technologies evaluated in a follow on program.

Reviewer 3:
The reviewer criticized that the hybrid energy storage approach is flawed because it is too heavy and too big. The reviewer explained that Li-ion batteries alone are a better value per pound, cost, performance, and size.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said absolutely. The reviewer explained that the heavy industry is highly segmented unlike the autos. This type of evaluation is needed, which requires the participation of engine and transmission manufacturers. The reviewer added that the addition of another transmission manufacturer would be impressive (e.g., possibly Allison and possibly one of the chassis OEMs).

Reviewer 2:
The reviewer stated that the vision for the project is aimed at supporting the DOE objectives but the game plan to achieve the vision is seriously flawed.

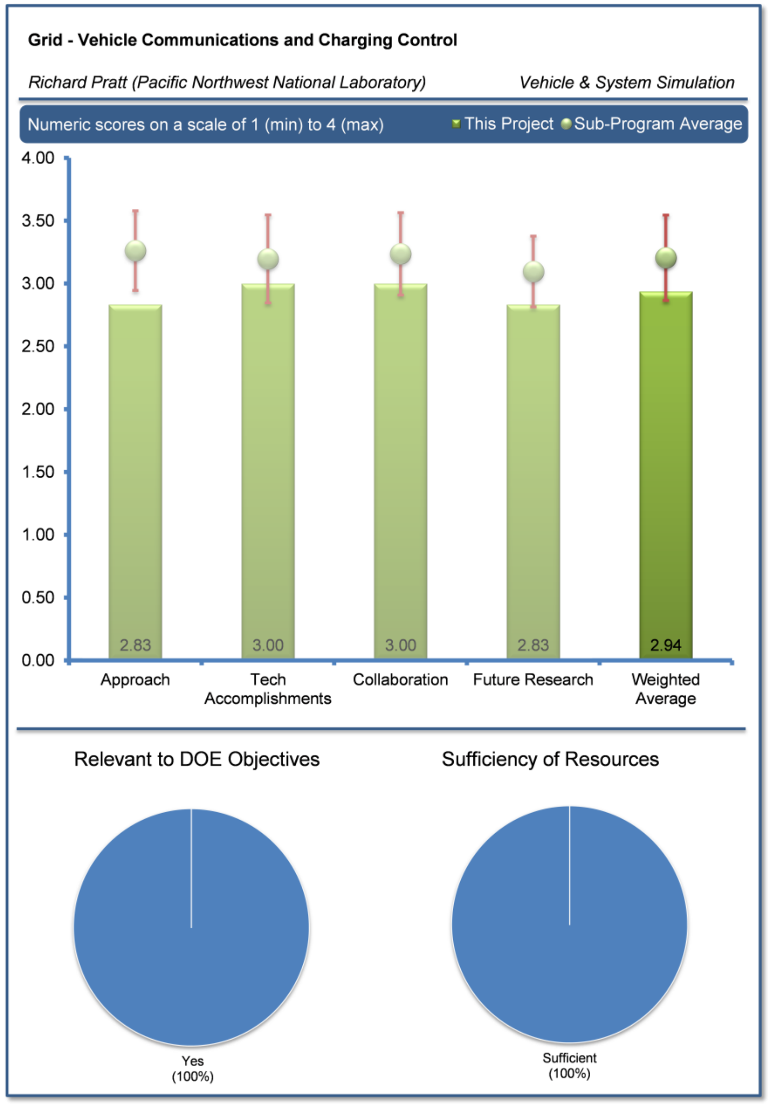
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that this project needs more resources to ensure that experimental equipment can be maintained and rebuilt to enable validation of optimization strategies.

Reviewer 2:
The reviewer stated that the project had a good start and should expand after this year's run for the project trial. The reviewer said the team should look to expand on truck industry partners.

Reviewer 3:
The reviewer suggested that the project be revisited for scope/plan.

Grid - Vehicle Communications and Charging Control: Richard Pratt (Pacific Northwest National Laboratory) - vss142



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the overall project has merit with the potential to reduce grid loads and energy storage requirements, transformer upgrades, and increase renewable energy utilization. The project consists of two basic activities. The first is exploration of advanced control strategies needed to optimize performance and efficiency of EV charging with associated hardware-in-the-loop testing of charging systems. The second is to support SAE standards committees for EV charging and grid connection, as well as the Smart Grid Interoperability Panel. The reviewer added that the approach to exploration of advanced control strategies is basically sound utilizing PNNL's powered and metered manufactured home and three employee-driven EVs. It is not clear, however, why three EVs would be hooked up to the same home as it is not likely any family will have more than one EV. In short, the reviewer said it would be good to develop a limited portfolio of additional potential use case scenarios, test them, and then draw more robust conclusions. Nonetheless, incorporating two customer preferences into charging including energy required and charge completion time seems to be accurate and likely predictive of customers' behavior. A maximum power goal reduction of 25% also seems on target. The reviewer also reported that with regards to support to the SAE standards committees and the Smart Grid Interoperability Panel (SGIP), it is hard to evaluate the approach here outside of the obvious committee participation and input process.

Reviewer 2:

The reviewer stated that it is not clear what the overall goal of the standards development portion of the project is. The reviewer added that standards development seems to be one of the objectives, but the SAE standards work is not being led by this project, and it is unclear what the impact of this project has been on the standards' development. The reviewer commented that the charge rate reduction portion of the project seems promising but without the connection with the building loads, remains too theoretical. It is too late because the project is ending in September 2014, but the reviewer believed this should have been part of the project from its inception. The reviewer would get customer preferences for range, not energy. The reviewer also said that not enough people will be able to express how much energy they want, but most will be know how much range that they prefer.

Reviewer 3:

The reviewer observed that the PI’s coordinated charging strategy is based on historical grid load profiles and lookup tables based on ambient temperature. The reviewer suggested that the PI consider using grid synchrophasor data and other inputs as additional feedback variables to support faster real-time control of the J1772 control signal duty cycle. The reviewer stated that in addition to local peak power thresholds and time of use targets, this could support utility company objectives to reduce demand at specific times.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the PI has made good progress. Last year, the PI was working to understand the J1772 standard and charge rate control. This year, the PI has taken measurements of real-time electrical consumption data in residential applications and active control of the PHEV chargers has been achieved to demonstrate a local coordinated charging strategy. The reviewer added that the PI was able to reduce peak loading by 26% using this strategy.

Reviewer 2:

The reviewer stated that the overall accomplishments for the task are reasonable given the current task duration and funding levels. For the scenario identified above under approach, the project has demonstrated the ability to reduce peak load by 26% using charging rate control for one use case scenario. Additionally, the reviewer said that three identical prototype charging rate control modules were developed and tested on EVSEs from three different manufacturers. The reviewer stated that with regards to standards support accomplishments, it is more difficult to gauge accomplishments although it is clear progress has and is being made on a number of SAE standards with regards to EVs and charging, as well as leadership support provided to the SGIP to accelerate development and harmonization of V2G codes and standards.

Reviewer 3:

The reviewer reported that the SAE standards have been updated and the work towards V2G standards is said to be ongoing; however, it is unclear what the status is of the latter, and how the work on these standards will reduce barriers to petroleum displacement. The reviewer added that the HIL study, if the connection with the house loads was not intended to be part of the project, appears to be on schedule

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the level of collaboration and coordination for the project is acceptable including interactions with SAE, NIST, University of Vermont, and one industry partner, AeroVironment. The reviewer added that it seemed the project should have more extensive collaboration, including utilities, as well as additional EVSE manufacturers and potentially home energy control systems partners such as Johnson Controls. It is mentioned under Gaps that utility incentives for coordinated charging are beginning to appear in several regions.

Reviewer 2:

The reviewer remarked that more industry partners would be useful here. The reviewer asked if AeroVironment is the only EVSE OEM that was willing to participate. The reviewer added that the collaboration on the standards development appears sound.

Reviewer 3:

The reviewer commented that the PI is collaborating with Aerovironment to integrate the coordinated charging features into their EV chargers. The PI is also working with Professor Steve Letendre from the University of Vermont as well as the standards committees SAE and NIST.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed work for the balance of FY 2014 is a logical extension of the current activities with field testing of coordinated charging (HIL) including examining static energy use goals, variable energy use goals, and determining vehicle response to external control. Additionally, activities will develop control strategies needed to optimize performance and efficiency of EV charging. The reviewer added that the final product is to prepare a report summarizing tested and projected technology options that can be exercised for automotive applications. One concern the reviewer had is whether enough collaboration and communication is being undertaken with those entities which would ultimately have to accept and implement recommended control strategies. It is important that the final report has a very clearly defined audience and that recommendations are not developed somewhat in a vacuum. Additionally, it seems that having a few additional use cases would be beneficial instead of relying on one case with three EVs and a single determination of when each one would be back ready to charge, before drawing peak load reduction conclusions.

Reviewer 2:

The reviewer stated that with the project ending in September, the proposed future work on the HIL study appears to be within reason for completion. It is unclear what remains for the standards development portion.

Reviewer 3:

The reviewer observed that the PI would benefit from a more comprehensive future research strategy. Presently, he has investigated frequency regulation and coordinated charging. The reviewer added that future research efforts involve further coordination with the utilities; however, limited details were provided.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that the project has relevance in that it offers advantages for reducing grid loads, delaying transformer upgrades, and potentially improving renewable energy utilization and lowering energy storage requirements. The reviewer added that Intelligent Vehicle Charging Infrastructure can offer substantial economic benefits and help reduce the cost of the overall EV infrastructure ecosystem.

Reviewer 2:

The reviewer reported that controlling the loads from PEV charging will impact utilities' acceptance of PEVs, for example, preventing local transformer overload. It can also increase customer acceptance, especially commercial customers who are subject to demand charges. The reviewer added that this project is a step towards increasing the viability of PEVs when it comes to reducing charging costs and eventually V2G infrastructure and this has the potential to reduce petroleum consumption.

Reviewer 3:

The reviewer pointed out that the developed methods can be used to maximize the use of vehicle chargers during periods of peak availability of renewable sources, for example, wind and solar. The reviewer added that the methods can also be used to reduce the need to bring less efficient generation capacity online.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources are sufficient for current and projected activities.

Reviewer 2:

The reviewer commented that the funds allocated for this project were relatively modest, and appeared to be sufficient.

Reviewer 3:

The reviewer stated that the project was on track with the current level of resourcing.

Acronyms and Abbreviations

Acronym	Definition
AC	Alternating Current
A/C	Air-Conditioning
ACEC	Advanced Combustion & Emissions Control
AER	All-electric range
AEV	All electric vehicle
AHD	Advanced Hybrid Drives
AMR	Annual Merit Review
AMT	Air maintenance technology
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
APEEM	Advanced Power Electronics and Electric Machines Program
AQMD	Air Quality Management Districts
ARPA-E	Advanced Research Projects Agency - Energy
APRF	Advanced Powertrain Research Facility (ANL)
APU	Auxiliary Power Unit
ARRA	American Recovery and Reinvestment Act
AVTA	Advanced Vehicle Testing Activity
BARTA	Berks Area Regional Transport Authority
BEV	Battery Electric Vehicle
BMS	Battery Management System
CAE	Computer aided engineering
CAFE	Corporate Average Fuel Economy
CAN	Controller Area Network
CARB	California Air Resources Board
CD	Charge Depleting
CDC	Conventional diesel combustion
CFD	Computational Fluid Dynamics
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPUC	California Public Utilities Commission
CRADA	Cooperative Research and Development Agreement
CS	Charge Sustaining
D3	Downloadable Dynamometer Database
DC	Direct Current
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DQA	Data Quality Act
DSRC	Dedicated Short-Range Communications

Acronym	Definition
DWTP	Dynamic wireless power transfer
ECU	Engine control unit
EDLC	Electrochemical double-layer capacitors
EG	Ethylene glycol
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
EREV	Extended Range Electric Vehicle
ESS	Energy Storage Systems
EV	Electric Vehicle
EVSE	Electric Vehicle Supplemental (Supply) Equipment
FHWA	Federal Highway Administration
FOA	Funding Opportunity Announcement
FTMPG	Freight-ton-miles per gallon
FTP	Federal Test Procedure
FY	Fiscal Year
FOT	Field operational test
GCEV	Grid-connected electric-drive vehicle
GDI	Gasoline direct injection
GM	General Motors Corporation
GnP	Graphite nano-Platelets
GSF	Generic Speed Form
GPS	Global Positioning System
GHG	Greenhouse Gas
H_2	Hydrogen
HC	Hydrocarbons
HD	Heavy-Duty
HEV	Hybrid electric vehicle
HFET	Highway Fuel Economy Test
HHDDT	Heavy heavy-duty diesel truck
HHV	Hydraulic hybrid vehicle
HIL	Hardware in the Loop
HMI	Human-machine interface
HPD	High power density
HV	High voltage
HVAC	Heating Ventilating and Air Conditioning
HWFET	Highway Fuel Economy Driving Schedule
IAV	Ingenieurgesellschaft Auto und Verkehr
ICE	Internal Combustion Engine
INL	Idaho National Laboratory
ISO	International Organization for Standardization
ITS JPO	Intelligent Transportation Systems Joint Program Office
JARI	Japan Automotive Research Institute
kW	Kilowatt

Acronym	Definition
kWh	Kilowatt-hour
Li-ion	Lithium Ion
LD	Light-Duty
LEESS	Lower-energy energy storage system
LIC	Lithium ion capacitor
MD	Medium-Duty
MOVES	Motor Vehicle Emissions Simulator
MPG	Miles per gallon
MPGe	Miles per gallon equivalent
MTNW	Measurement Technology Northwest
NA	Naturally aspirated
NHTSA	National Highway Traffic Safety Administration
NiMH	Nickel-metal hydride
NIST	National Institute of Standards and Technology
NO_x	Oxides of Nitrogen
NREL	National Renewable Energy Laboratory
O_2	Oxygen
OBD	On-board diagnostics
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PCM	Phase change material
PEV	Plug-in Electric Vehicle
PFI	Port Fuel Injection
PHEV	Plug-In Hybrid Electric Vehicle
PI	Principal Investigator
PM	Permanent magnet
PMP	Pontryagin Minimization Principle
PTO	Power take-off
R&D	Research and Development
RCCI	Reactivity controlled compression ignition
ROI	Return on Investment
SAE	Society of Automotive Engineers
SCAQMD	South Coast Air Quality Management District
SDO	Standards definition organizations
SGIP	Smart Grid Interoperability Panel
SI	Spark Ignition
SOC	State Of Charge
TIM	Thermal interface materials
TRACC	Transportation Research and Analysis Commuting Center
UDDS	Urban Dynamometer Driving Schedule
UMTRI	University of Michigan Transportation Research Institute
U.S. DRIVE	U.S. Driving Research and Innovation for Vehicle efficiency and Energy sustainability
V2G	Vehicle-to-Grid

Acronym	Definition
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VSS	Vehicle & System Simulation
VSST	Vehicle and Systems Simulation and Testing
VTMS	Vehicle thermal management system
VTO	Vehicle Technologies Office
WHR	Waste Heat Recovery
WPT	Wireless Power Transfer

2. Energy Storage Technologies

Improving the batteries for electric drive vehicles, including hybrid electric (HEV) and plug-in electric (PEV) vehicles, is key to improving vehicles' economic, social, and environmental sustainability. In fact, transitioning to a light-duty fleet of HEVs and PEVs could reduce U.S. foreign oil dependence by 30-60% and greenhouse gas emissions by 30-45%, depending on the exact mix of technologies. While a number of electric drive vehicles are available on the market, further improvements in batteries could make them more affordable and convenient to consumers. In addition to light-duty vehicles, some heavy-duty manufacturers are also pursuing hybridization of medium and heavy-duty vehicles to improve fuel economy and reduce idling.

The Vehicle Technologies Office focuses on reducing the cost, volume, and weight of batteries, while simultaneously improving the vehicle batteries' performance (power, energy, and durability) and ability to tolerate abuse conditions. Reaching the Office's goals in these areas and commercializing advanced energy storage technologies will allow more people to purchase and use electric drive vehicles. It will also help the Department of Energy meet the EV Everywhere Grand Challenge of making the United States become the first nation in the world to produce plug-in electric vehicles that are as affordable for the average American family as today's gasoline-powered vehicles within the next 10 years.

The VTO pursues three major areas of research in batteries:

- Exploratory Battery Materials Research: Addresses fundamental issues of materials and electrochemical interactions associated with lithium and beyond-lithium batteries. This research attempts to develop new and promising materials, use advanced material models to predict the modes in which batteries fail, and employ scientific diagnostic tools and techniques to gain insight into why materials and systems fail. Building on these findings, it works to develop ways to mitigate those failures.
- Applied Battery Research: Focuses on optimizing next generation, high-energy lithium ion cells that incorporate new battery materials. The activity emphasizes identifying, diagnosing, and mitigating issues that negatively impact the performance and life of cells using advanced materials.
- Advanced Battery Development, System Analysis, and Testing: Focuses on the development of robust battery cells and modules to significantly reduce battery cost, increase life, and improve performance. This research aims to ensure these systems meet specific goals for particular vehicle applications.

This research builds upon decades of work that the Department of Energy has conducted in batteries and energy storage. Research supported by the Vehicle Technologies Office led to today's modern nickel metal hydride batteries, which nearly all first generation hybrid electric vehicles used. Similarly, the Office's research also helped develop the lithium-ion battery technology used in the Chevrolet Volt, the first commercially available plug-in hybrid electric vehicle. This technology is now being used in a variety of hybrid and plug-in electric vehicles coming on the market now and in the next few years, including the Ford Focus EV.

As described in the EV Everywhere Blueprint, the major goals of the Batteries and Energy Storage subprogram are by 2022 to:

- Reduce the production cost of an electric vehicle battery to a quarter of its current cost
- Halve the size of an electric vehicle battery
- Halve the weight of an electric vehicle battery

Achieving these goals would result in:

- Lowering battery cost from $500/kwh to $125/kwh
- Increasing density from 100 Wh/kg to 250 Wh/kg, 200 Wh/l to 400 Wh/l, and 400 W/kg to 2000 W/kg

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: David Howell (U.S. Department of Energy) – es000

Question 1: *Was the program area, including overall strategy, adequately covered?*

Reviewer 1:
The reviewer observed a very well-organized presentation that gives the audience an excellent overview of the U.S. Department of Energy's (DOE) overall strategy and the projects being worked on.

Reviewer 2:
The reviewer remarked that the program is directed at developing a new paradigm in transportation in the United States. The program is well funded to carry out the process and develop the new technology to assist U.S. car companies successfully compete in vehicle transportation market. The management is excellent and the plans and direction is superior. The reviewer added that given a little time, it will be a terrific advantage for the United States.

Reviewer 3:
The reviewer said yes, and found a comprehensive but detailed explanation of boundary conditions and program strategy.

Reviewer 4:
The reviewer remarked yes, although 30 minutes is obviously not enough to do anything but give a brief overview. The reviewer commented that the presentation was a bit low key. The reviewer wishes the program would do more to toot its horn. In particular, the reviewer thinks the knowledge gained in understanding the layered cathode material is outstanding, even if the answer is not what we would like, as it may be hard to fix the manganese (Mn) migration issue. This was, in this reviewer's view, a huge technical accomplishment and is really one of the great strengths of the national laboratories and the team approach taken.

The reviewer noted a good comparison of funding outlay versus gasoline saved; the 16:1 payback was impressive, as this reviewer was not actually expecting any payback until the technology was adopted more wildly (2025 time-frame).

Reviewer 5:
The reviewer commented that while critical areas in battery systems were well covered, the reviewer strongly emphasized that the strategy was not clear, unless the areas studied constitute a strategy. In this reviewer's view, study materials, electrodes, cells and batteries are a list of areas, and not a strategy.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer observed that there is excellent balance in the program. All aspects of vehicle technology relating to electric vehicles is being addressed and funding is at appropriate levels.

Reviewer 2:
The reviewer commented that the program is well structured and aligned to reasonable mid-term and long-term targets.

Reviewer 3:
The reviewer observed that the program was pretty well balanced based on the $85 million dollar budget in the Office of Energy Efficiency and Renewable Energy (EERE). According to the reviewer, in a later talk it became clear there is program flow-through from the materials to the cell to the battery programs (e.g., Amprius).

Reviewer 4:
While the reviewer thought the overall distribution of funds is well aligned with overall objectives, the reviewer personally believed that further readjustment is possible. This reviewer thinks the biggest so-called bang for the buck will come out of the Exploratory Materials group. Advanced cell development should not get more than half the money that the Materials group gets. Thus, this reviewer's

suggestion is to lower both Advanced Cell Development and Battery Development work and redirect that money to the Materials group that will ultimately make the leapfrog we are all waiting for.

Reviewer 5:

This reviewer believed that there is an appropriate balance. The reviewer thought that most of the program seems directed at short- to mid-term goals in that while some goals are still very challenging, there is at least a clearly identified set of paths to success. It made sense to this reviewer to let programs such as Advanced Research Projects Agency - Energy (ARPA-E) and the Joint Center for Energy Storage Research (JCESR) handle some of the longer term quantum leaps in performance that may or may not ever pan out. The reviewer observed that some longer term work on lithium metal nodes is included in this program. While this reviewer is personally very skeptical that lithium metal batteries can ever be made safe enough for vehicle use (might be okay for utility applications), the program recognizes that this is the high risk/big reward part of this program. The reviewer observed a good target cost plus performance, although the reviewer expressed a little concern about the apparent short shrift given to safety. The reviewer pondered that maybe safety is viewed as not great but good enough, like consumer lithium-ion (Li-Ion). The reviewer was glad to see some work beyond Li-Ion, although the reviewer remains deeply skeptical about Li/O_2 and agreed that Li/air is a non-starter.

Question 3: Were important issues and challenges identified?

Reviewer 1:

This reviewer agreed that important issues and challenges were identified.

Reviewer 2:

For this reviewer, the key issues of battery technology and the transfer of technology to appropriate automotive customers are being addressed. Both batteries and fuel cell technologies are supported. The reviewer remarked that it is clear that with the development of these new technologies, the corporate average fuel economy (CAFE) standard can be met in a timely fashion.

Reviewer 3:

The reviewer agreed yes, as a part of many of the accomplishments and the early material in the talk, the challenges were apparent.

Reviewer 4:

The reviewer noted that the key issue of increasing energy density and reducing costs were clearly addressed.

Reviewer 5:

The reviewer said yes. However, this reviewer thought there was too much emphasis on the battery pack and reducing manufacturing costs. The reviewer preferred that reducing manufacturing cost is best left to industry experts, as they are far better at this. The reviewer considered that maybe DOE has some unique game-changer approaches that might justify attention, but otherwise this reviewer would not expect the DOE program to address this. The reviewer guessed this gets back to whether the program is held accountable for cost goals or for advancing the state of the art so others can make a commercial success. The reviewer preferred the latter, but it seems the DOE programs are being judged by the former.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:

The reviewer thought that plans were identified, in general.

Reviewer 2:

The reviewer observed that cost reduction is a driver for choosing program areas for part of future plans. This is a good way to pick areas because cost will decide in the end.

Reviewer 3:

The reviewer observed a comprehensive explanation of topics, projects and teams to address challenges.

Reviewer 4:
The reviewer found that the plans were clear and transparent. All of the needs are being addressed. For this reviewer, a viable, cost effective technology is essentially available today and with refinements will meet future needs. The only unanswered question is the cost of the new technologies. According to the reviewer, this ultimately will determine success or failure.

Reviewer 5:
The reviewer commented yes, although details were necessarily sparse as the time did not permit much detail. Most of the talk focused on what happened, which this reviewer thinks is appropriate for a Merit Review.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer commented yes, and elaborated it is clear that all areas are benchmarked for their timeliness and importance. Nothing has been left to chance.

Reviewer 2:
The reviewer concluded that the main achievements and progresses were demonstrated in different examples.

Reviewer 3:
The reviewer found that progress this year was well defined and last year's work was not "claimed" again; the new progress was the main focus of the talk.

Reviewer 4:
The reviewer commented that it was hard to do this in 30 minutes. The reviewer noted that the presentation mentioned some highlights and some metrics by year.

Reviewer 5:
Benchmarking of progress was not that apparent to this reviewer, in case it is the appropriate question for this presentation.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:
The reviewer commented yes, and noted a broad attack on the major problems of durability, cost, and power or energy density.

Reviewer 2:
The reviewer agreed that projects are addressing broad problems and barriers.

Reviewer 3:
The reviewer commented that essential issues of electric transportation technology needs are being addressed and solutions developed. The reviewer observed that batteries seemed to be ahead of fuel cells today, but both are likely to be included in the transportation mix.

Reviewer 4:
The reviewer commented that projects are focused on main challenges.

Reviewer 5:
The reviewer commented yes.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:

The reviewer found that due to good and effective project management, and by respectively directing the projects, the outcome is very good and addresses the Vehicle Technologies Office's (VTO) needs.

Reviewer 2:

The reviewer emphasized that yes, the program is focused on the objectives for electrified transportations and the program is versatile and complete. The only problem the reviewer observed is that U.S. car makers are slow to shift from gas powered engines to electrification.

Reviewer 3:

The reviewer commented yes, and referenced suggestions made in question two concerning a readjustment of funds.

Reviewer 4:

The reviewer commented that the program was certainly focused and well managed. What would help get DOE-origin batteries in vehicles is a plan where funds are focused where they are most needed, and particularly a quick refocus of resources to preferentially fund the areas where advancement is needed or where big progress is imminent. The reviewer thought the program has a plan and just did not express it as such.

Reviewer 5:

The reviewer commented yes, although this reviewer really got a better feel for what was actually being funded by looking at the other presentation rather than this presentation. The reviewer found that there was not enough time for the presenter to go over what is actually being funded in any detail.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:

For this reviewer, a key strength in this area is the strong effort to link different competence centers and make sure that there are common standards and testing protocols to make results comparable.

Reviewer 2:

The reviewer found that the program today is in a position to supply the needed technology to auto producers for them to produce a competitive electric vehicle for the marketplace. The advanced technology developed in the past five years places the electric car technology at the front worldwide. The U.S. automobile producers are holding back as they perceive a lack of interest in the part of general public. The reviewer commented that automobile producers also do not want to make the investment in new technology that overseas producers have recognized and are beginning to introduce. The reviewer cited Focused National Laboratory Project: Voltage Fade Mitigation of High Capacity Manganese Rich Layered-Layered Cathode Material as an outstanding project addressing both approach and results.

Reviewer 3:

The reviewer observed realism and honesty and appreciated that most solutions have their own set of challenges and that one can rarely get the full benefits of a new material/design indicated by test cells in a full cell. The reviewer noted the presentation avoided making many of the ridiculous claims that this reviewer often reads in technical and lay press. The reviewer acknowledged that the program team is using an extensive true team approach. For example, the work done to explain voltage fade of Argonne's layered-layered material involved a degree of teamwork often claimed but not usually realized in national laboratories or elsewhere. The reviewer noted a good selection of potential candidates, e.g., early recognition that Li/air was never going to meet goals even if we get it to work. The reviewer notes that basically, the program team has gone through the intellectual exercise of deciding ahead of time if we had it, would we really want it.

Reviewer 4:
The reviewer found that high capacity cathode and Si anode work are the program's strengths. The reviewer recommended that cell development, and focusing too much on cost reduction from processing points of view should be left primarily to manufacturers.

Reviewer 5:
The reviewer identified as strengths the wide range of programs and chemistries, so there are many chances to meet program goals. The reviewer observed knowledgeable staff and consultants, and good teams doing the work in most cases. The reviewer identified that a weakness is how some programs are carried after it is clear these programs are not going to make progress. The reviewer thought that the Energy Storage program would be more efficient if the program had an ability similar to Defense Advanced Research Projects Agency (DARPA) to end projects that are not going to make the progress needed or expected.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes and noted cutting edge techniques, analytical techniques, significant advances in modeling, and the program is working on a good selection of new approaches to boosting usable energy density.

Reviewer 3:
The reviewer said that in general, these projects do. While multiple projects with the same high risk/high payoff are okay, this reviewer's recommendation is to avoid redundancies as much as possible. The reviewer perceived that several projects appeared to have quite a bit of overlap and that one needs to justify such projects on very strong grounds.

Reviewer 4:
The reviewer said that the electrification of transportation is not a primary issue for the general public. The primary barriers are in the mind of the general public. The general public needs a comfort factor in choosing an EV over the traditional gas engine cars. The reviewer pointed out Tesla as a good example of the technology directed at the well-to-do public. According to the reviewer, the primary issue for the general public is cost. Today, the U.S. car manufacturers could produce an electric car for the general public at reasonable cost given an incentive. The reviewer noted that in the past the general public has insisted that EVs are expensive and ignored a smaller car that is common in most other countries.

Reviewer 5:
The reviewer commented that many projects were fairly advanced, or were innovations on well-known approaches. The reviewer said that appropriate techniques were used; one does not have to be truly novel to perform good work or use the right approach.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer was very satisfied with partnership engagement.

Reviewer 2:
The reviewer observed that the program direction has covered all bases. Funding is available and the needs are being addressed. This reviewer does not know of any area that has not been addressed in an appropriate fashion.

Reviewer 3:
The reviewer observed that the project involves a number of worldwide recognized national laboratories or universities as well as technology leaders from industry.

Reviewer 4:
The reviewer responded yes. The reviewer observed that the program appeared to have a very good link to Vehicle Systems and Simulation (VSS) in terms of targets and metrics. This is a critical linkage in ensuring that if and when the program meets its targets, they actually are useful and will make a difference. The reviewer noted that it has always been hard to get meaningful partnerships with battery companies as these entities are so secretive and concerned about intellectual property (IP), and that this is not likely to change. The reviewer observed that the program managers seemed to do a lot of talking with interested parties up and down the supply chain, and this reviewer thought the program team put together a very reasonable program focused on near term must-have issues while also funding some longer term support projects. The reviewer noted good links to VTO and JCESR goals.

Reviewer 5:
The reviewer thought the mix of academia, labs, and companies seemed pretty good. The reviewer recommended that the program would benefit from collaboration with other programs in other countries.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer remarked that everyone in the field was satisfied that the program was well directed and willingly contributes their time and effort on this important technology for the future.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer said that projects with effective collaborations were established in each program sub-area.

Reviewer 4:
The reviewer said that collaboration was the best that one could hope for.

Reviewer 5:
The reviewer said that the question’s intent was unclear. However, according to this reviewer, the DOE staff works well with the contacted teams. If that was the question’s intent, then this reviewer was in agreement.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer saw no obvious gaps.

Reviewer 2:
In this reviewer’s opinion, there are no gaps in the program portfolio.

Reviewer 3:
The reviewer commented that all relevant research areas are addressed.

Reviewer 4:
The reviewer observed no gaps, but had some concerns about dilution of effort. This reviewer was concerned about work directed at lowering costs that specifically includes advanced processing and battery manufacturing techniques. If this reviewer understood the scope of this work, it would seem to play much better into the strengths of industrial partners, equipment makers and engineering expertise. This reviewer thought the DOE national laboratories’ strengths are significantly more in the chemistry area and cell analysis, battery data analysis, and determining failure modes. These are the areas where there are still major unknowns and obstacles, so this reviewer would think these people should remain focused on this area. The reviewer believed that it is a better fit and frankly a more important problem. In this reviewer’s view, while the program team stated that the battery development work was often done with

partners, too much money was targeted at battery development. This reviewer would focus on materials and the 0.5-1 ampere-hour (Ah) cell. The reviewer opined that this is where the DOE national laboratories could really shine, especially in terms of understanding problems and evaluating new solutions. The reviewer stated that optimizing battery design for cost/performance is essential, but this reviewer did not believe the DOE programs needed to pay for this to get done. This reviewer recognizes that of course if given a directive, the program managers have little recourse but to follow them, but the reviewer perceives this is redirecting truly critical assets away from areas where assets can have the greatest impact.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:

The reviewer concluded that all topics were being addressed. This reviewer was satisfied the program was complete and would be of great benefit to U.S. car companies and public buyers and users of electric propulsion.

Reviewer 2:

The reviewer would like to know under which portfolio non-lithium topics such as aqueous systems (sodium (Na)-based, for example) were addressed.

Reviewer 3:

The reviewer said moving from DOE to production in industry is not adequately addressed. The reviewer would like to know how to get U.S. automakers to pick it up and use it.

Reviewer 4:

This reviewer was not sure about next steps to stop Mn migration in layered-layered cathode. Hopefully, according to this reviewer, the other talks would cover this. The reviewer asked whether the layered-layered material, with coatings and other approaches to restrain fade issues other than voltage fade, was good enough for consumer applications where 150-500 high capacity cycles are fine. The reviewer said this might be a significantly easier and valuable entry point for this material than trying to jump straight into EVs.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

This reviewer would like to see more basic research devoted to new class of electrolytes, especially from a non-flammability perspective.

Reviewer 2:

This reviewer indicated that safety seemed unrepresented and could not think of any others beyond this.

Reviewer 3:

The reviewer noted a barrier in that there are few filling stations for EVs as well as acknowledgement on the part of the general public that global warming is a key issue in the overall picture. Another problem is that EVs are more expensive than gas powered cars. The reviewer suggested that DOE may want to consider supporting electrification by initiating a $5,000 instant payback on EVs.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer commented that the program seems to be covering a wide range of opportunities.

Reviewer 2:

The reviewer commented that voltage fade is a hot issue and it has not been resolved to a satisfactory level despite elevated levels of funding. The reviewer observed that one aspect of the work that got low attention is doping. This reviewer was curious to know how a comprehensive approach affects the voltage fade.

Reviewer 3:

The reviewer commented that the main barrier to EVs is cost and range. The reviewer perceived that the program is mainly directed at the technology with cost the second. Today, this is the correct situation as the technology is just now reaching the point where cost can be addressed as well as technology. The reviewer commented that this is mainly a matter of educating the people on the advantages of EVs. The reviewer believed that a start would be making the public notice by establishing convenient charging stations at appropriate locations.

Reviewer 4:

The reviewer recommended advanced conceptual methods for controlling or designing batteries or electric powertrain systems, and battery control models.

Reviewer 5:

The reviewer suggested that the approach of a deep dive, such as the voltage fade project, can be transferred to other specific problems within the battery material research area.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer found that overall, the program areas were well balanced requiring slight tweaking here and there as suggested above.

Reviewer 2:

The reviewer recommended setting up criteria for graduating from material programs to cell, to battery, and then to make them known to help researchers see where they should be aiming.

Reviewer 3:

The reviewer stated that the public needs to see visible evidence of the tremendous work that is being carried out and the world class capability of our scientists and engineers.

Reviewer 4:

The reviewer suggested focusing on cell chemistry and unit cell design. While scaling up large unit cells is okay, this reviewer did not think DOE should be expending so much energy on battery pack designs; the reviewer asked if others can do this (such as battery companies). The reviewer suggested that the focus should be on materials and cell design and understanding issues. Interfaces as usual are key, and DOE has some unique tools to study these. From talks later in the week, this reviewer was left unhappy about the status of the safety program and the cell tear down and analysis efforts. Based on what this reviewer had seen, both seemed pretty empirical and this reviewer questioned the usefulness of evaluating safety and doing tear downs without (in this reviewer’s view) really understanding it. The reviewer recommended that both needed a shake up and a shift to a more fundamental approach.

Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Cell Analysis, Modeling, and Prototyping (CAMP) Facility Product	Andrew Jansen (Argonne National Laboratory)	2-16	3.67	3.50	3.83	3.08	3.53
Impact of Materials on Abuse Response	Christopher Orendorff (Sandia National Laboratories)	2-20	2.90	3.10	3.40	2.70	3.04
† High Capacity Composite Cathode Materials: New Synthesis Routes and Structures	Michael Thackeray (Argonne National Laboratory)	2-24	3.63	3.63	3.38	3.38	3.56
† High capacity, High-voltage Cathode Materials for Lithium-ion Batteries	Arumugam Manthiram (University of Texas at Austin)	2-27	3.25	3.25	3.50	3.13	3.27
† Design of High Performance, High Energy Cathode Materials	Marca Doeff (Lawrence Berkeley National Laboratory)	2-30	3.38	3.25	3.50	3.38	3.33
† First Principles Calculations of Existing and Novel Electrode Materials	Gerbrand Ceder (Massachusetts Institute of Technology)	2-33	3.67	3.33	3.00	3.17	3.35
† First Principles Calculations and NMR Spectroscopy of Electrode Materials	Clare Grey (University of Cambridge)	2-36	3.50	3.50	3.67	3.33	3.50
† Development of High Energy Cathode Materials	Jason Zhang (Pacific Northwest National Laboratory)	2-38	3.17	3.17	3.33	3.33	3.21
† Advanced in-situ Diagnostic Techniques for Battery Materials	Xiao-Qing Yang (Brookhaven National Laboratory)	2-41	3.33	3.17	3.17	3.00	3.19
† Nanoscale Heterostructures and Thermoplastic Resin Binders: Novel Li-ion Anode Systems	Prashant Kumta (University of Pittsburgh)	2-44	3.67	3.17	3.33	3.00	3.29
† Metal-based High Capacity Li-ion Anodes	Stanley Whittingham (Binghampton University-SUNY)	2-47	3.83	3.17	3.67	3.17	3.40
† Development of Electrolytes for Lithium-ion Batteries	Brett Lucht (University of Rhode Island)	2-49	3.30	3.20	3.50	3.20	3.26
† New Electrode Design for Ultrahigh Energy Density	Yet-Ming Chiang (Massachusetts Institute of Technology)	2-53	3.38	3.25	2.63	3.13	3.19
† Interfacial Processes in EES Systems Advanced Diagnostics	Robert Kostecki (Lawrence Berkeley National Laboratory)	2-56	2.83	2.83	3.00	3.00	2.88
† Predicting and Understanding Novel Electrode Materials From First-Principles	Kristin Persson (Lawrence Berkeley National Laboratory)	2-58	3.38	3.38	3.13	3.25	3.33
† Studies on High Energy Density Lithium Ion Electrodes	Jagjit Nanda (Oak Ridge National Laboratory)	2-61	3.38	3.25	3.50	3.25	3.31
Development of Computer-Aided Design Tools for Automotive Batteries	Steven Hartridge (CD-Adapco)	2-64	3.17	3.33	3.33	3.17	3.27

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Development of Computer-Aided Design Tools for Automotive Batteries	Taeyoung Han (General Motors LLC)	2-67	3.17	3.17	3.00	3.50	3.19
Development of Cell/Pack Level Models for Automotive Li-Ion Batteries with Experimental Validation	Christian Shaffer (EC-Power)	2-69	3.33	3.33	3.17	3.17	3.29
Open Architecture Software for CAEBAT	Sreekanth Pannala (Oak Ridge National Laboratory)	2-71	3.50	3.33	3.50	3.33	3.40
† Development of High Energy Density Lithium-Sulfur Cells	Donghai Wang (Pennsylvania State University)	2-74	3.20	3.00	2.80	3.00	3.03
† Silicon Nanostructure-based Technology for Next Generation Energy Storage	Ionel Stefan (Amprius)	2-78	3.20	3.40	2.70	2.90	3.20
† Development of Large Format Lithium Ion Cells with Higher Energy Density	Fabio Albano (XALT Energy)	2-82	2.80	2.70	3.00	2.90	2.79
† Modular Process Equipment for Low Cost Manufacturing of High Capacity Prismatic Li-Ion Cell Alloy Anodes	Sergey Lopatin (Applied Materials)	2-85	3.00	3.30	2.90	2.60	3.09
† High-Voltage Solid Polymer Batteries for Electric Drive Vehicles	Hany Eitouni (Seeo)	2-89	2.80	2.60	3.10	2.80	2.74
† Innovative Cell Materials and Designs for 300 Mile Range EVs	Yimin Zhu (Nanosys)	2-93	3.00	3.10	3.10	2.90	3.05
† High Energy Novel Cathode / Alloy Automotive Cell	Jagat Singh (3M)	2-96	3.30	3.40	3.20	3.20	3.33
† Utilization of UV or EB Curing Technology to Significantly Reduce Costs and VOCs in the Manufacture of Lithium-Ion Battery Electrodes	Gary Voelker (Miltec UV International)	2-99	3.25	2.75	3.75	3.25	3.06
† Significant Cost Improvement of Li-Ion Cells Through Non-NMP Electrode Coating, Direct Separator Coating, and Fast Formation Technologies	YK Son (Johnson Controls)	2-101	3.75	3.25	3.50	3.25	3.41
† Dry Process Electrode Fabrication	Mike Wixom (Navitas Systems)	2-103	3.00	2.75	3.00	3.00	2.88
† Stand-Alone Battery Thermal Management System	Brad Brodie (DENSO International America)	2-105	3.00	3.00	3.00	3.00	3.00
† Innovative Manufacturing and Materials for Low-Cost Lithium-Ion Batteries	Steve Carlson (Optodot Corporation)	2-107	2.83	2.83	3.17	3.00	2.90
† Novel Anode Materials	Jack Vaughey (Argonne National Laboratory)	2-110	3.50	2.83	3.33	2.67	3.04
† Development of High Capacity Anode Materials	Jason Zhang (Pacific Northwest National Laboratory)	2-112	3.67	3.33	3.50	3.17	3.42
† Atomic Layer Deposition for Stabilization of Amorphous Silicon Anodes	Chunmei Ban (National Renewable Energy Laboratory)	2-114	3.67	3.17	3.50	3.17	3.33
† Synthesis and Characterization of Polymer-Coated Layered SiOx-Graphene Nanocomposite Anodes	Donghai Wang (Pennsylvania State University)	2-116	3.67	3.17	3.33	3.17	3.31
† Wiring up Silicon Nanoparticles for High Performance Lithium-ion Battery Anodes	Yi Cui (Stanford University)	2-118	3.50	3.17	3.33	2.83	3.23

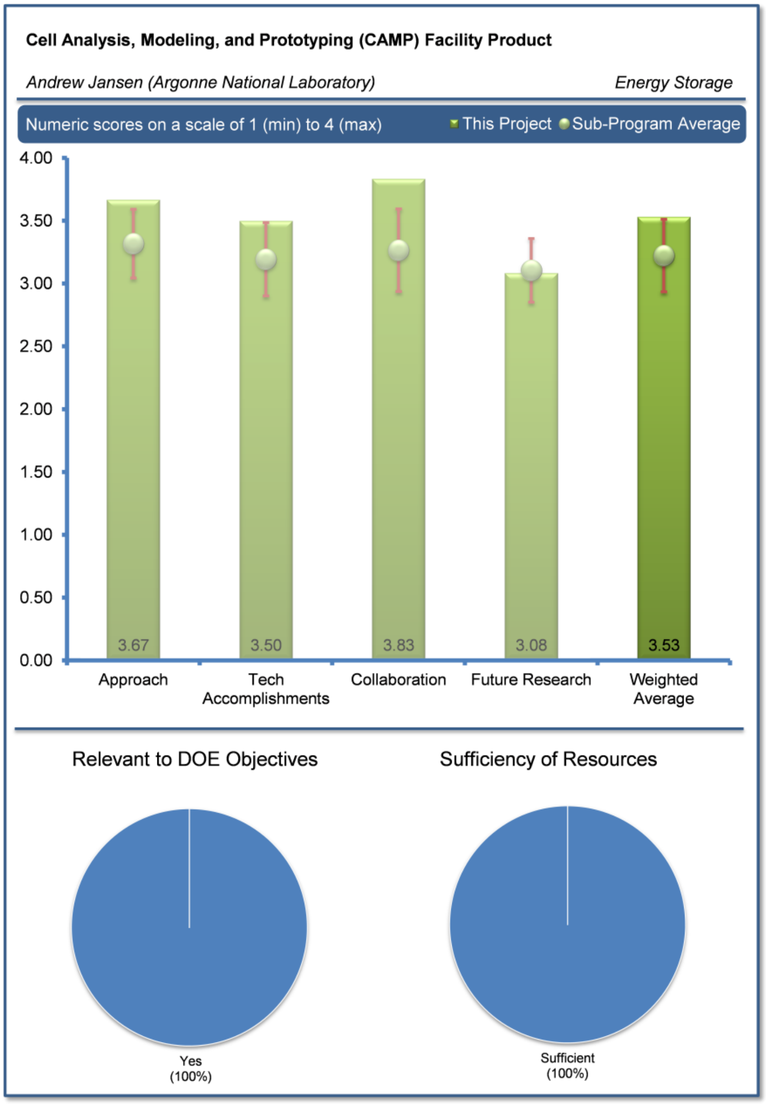
Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Voltage Fade, an ABR Deep Dive Project: Status and Outcomes	Anthony Burrell (Argonne National Laboratory)	2-120	3.70	3.60	3.70	3.10	3.58
Overcoming Processing Cost Barriers of High-Performance Lithium-Ion Battery Electrodes	David Wood (Oak Ridge National Laboratory)	2-125	3.10	3.20	3.00	3.10	3.14
Roll-to-Roll Electrode Processing and Materials NDE for Advanced Lithium Secondary Batteries	David Wood (Oak Ridge National Laboratory)	2-129	2.92	2.83	3.00	2.92	2.89
Post-Test Analysis of Lithium-Ion Battery Materials at Argonne National Laboratory	Ira Bloom (Argonne National Laboratory)	2-133	2.83	2.50	3.17	1.83	2.58
Process Development and Scale-up of Advanced Cathode Materials	Greg Krumdick (Argonne National Laboratory)	2-137	3.50	3.40	3.60	3.10	3.41
Process Development and Scale-up of Advanced Electrolyte Materials	Greg Krumdick (Argonne National Laboratory)	2-141	3.25	3.50	3.50	3.25	3.41
† In situ Solvothermal Synthesis of Novel High Capacity Cathodes	Feng Wang (Brookhaven National Laboratory)	2-145	3.38	3.25	3.63	3.25	3.33
† Lithium Bearing Mixed Polyanion Glasses as Cathode Materials	Andrew Kercher (Oak Ridge National Laboratory)	2-148	3.25	2.88	3.63	3.13	3.09
NMR as A Tool for Understanding Voltage Fade in LMR-NMC	Baris Key (Argonne National Laboratory)	2-151	3.40	3.60	3.20	3.20	3.45
Electrochemical Characterization of Voltage Fade in LMR-NMC cells	Daniel Abraham (Argonne National Laboratory)	2-155	3.70	3.40	3.60	3.20	3.48
Electrochemical Modeling of LMR-NMC Electrodes	Anthony Burrell (Argonne National Laboratory)	2-159	3.00	2.80	3.40	3.00	2.95
Synthetic Approaches to Correcting Voltage Fade in LMR-NMC	Christopher Johnson (Argonne National Laboratory)	2-163	3.50	3.50	3.40	3.00	3.43
Atomic-Scale Models of LMR-NMC Materials	Hakim Iddir (Argonne National Laboratory)	2-166	3.30	3.30	3.30	3.10	3.28
Understanding Structural Changes in LMR-NMC Materials	Jason Croy (Argonne National Laboratory)	2-170	3.50	3.63	3.30	3.13	3.49
Significant Enhancement of Computational Efficiency in Nonlinear Multiscale Battery Model for Computer Aided Engineering	Gi-Heon Kim (National Renewable Energy Laboratory)	2-174	3.33	3.00	3.00	3.17	3.10
Coupled Hierarchical Models for Thermal, Mechanical, Electrical and Electrochemical Processes	Harry Moffat (Sandia National Laboratories)	2-177	3.00	2.83	2.83	2.83	2.88
Coupling of Mechanical Behavior of Cell Components to Electrochemical-Thermal Models for Computer Aided Engineering of Batteries Under Abuse	Ahmad Pesaran (National Renewable Energy Laboratory)	2-180	3.17	2.83	2.83	3.00	2.94
Efficient Safety and Degradation Modeling of Automotive Li-ion Cells and Pack	Christian Shaffer (EC-Power)	2-183	3.00	3.33	3.17	3.17	3.21
† Electrochemical Performance Testing	Ira Bloom (Argonne National Laboratory)	2-186	3.33	3.17	3.33	3.00	3.21
† INL Electrochemical Performance Testing	Jon Christophersen (Idaho National Laboratory)	2-189	3.50	3.33	3.67	3.33	3.42

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† Battery Safety Testing	Christopher Orendorff (Sandia National Laboratories)	2-191	3.67	3.33	3.67	3.33	3.46
†Battery Thermal Characterization	Matthew Keyser (National Renewable Energy Laboratory)	2-194	3.75	3.25	3.75	3.25	3.44
†Advanced Battery Recycling	Steven Sloop (OnTo Technology)	2-196	3.50	3.50	3.50	3.25	3.47
† Real-time Metrology for Li-ion Battery R&D and Manufacturing	Jong Yoo (Applied Spectra)	2-198	3.00	2.50	3.00	3.00	2.75
Manufacturability Study and Scale-Up	Claus Daniel (Oak Ridge National Laboratory)	2-200	3.13	3.38	3.25	2.88	3.23
New High-Energy Electrochemical Couple for Automotive Applications	Khalil Amine (Argonne National Laboratory)	2-203	3.36	3.43	3.50	3.29	3.40
High Energy High Power Battery Exceeding PHEV-40 Requirements	Jane Rempel (TIAX)	2-207	2.67	2.58	2.25	2.58	2.56
Advanced High Energy Li-ion Cell for PHEV and EV Applications	Jagat Singh (3M)	2-211	3.21	3.14	3.50	2.93	3.18
High Energy Lithium Batteries for PHEVs	Subramanian Venkatachala (Envia)	2-215	3.20	3.00	3.30	3.10	3.10
High Energy, Long Cycle Life Lithium-ion Batteries for PHEV Applications	Donghai Wang (Pennsylvania State University)	2-219	3.13	2.88	3.13	3.00	2.98
High Energy Density Li-ion Cells for EVs Based on Novel, High Voltage Cathode Material Systems	Keith Kepler (Farasis)	2-222	3.30	3.00	3.40	3.10	3.14
† First Principles Modeling of SEI Formation on Bare and Surface/Additive Modified Silicon Anodes	Perla Balbuena (Texas A&M University)	2-225	3.38	3.50	2.75	3.13	3.33
† Analysis of Film Formation Chemistry on Silicon Anodes by Advanced In Situ and Operando Vibrational Spectroscopy	Gabor Somorajai (University of California, Berkeley)	2-228	3.00	2.63	2.25	2.75	2.69
† Optimization of Ion Transport in High-Energy Composite Cathodes	Shirley Meng (University of California, San Diego)	2-231	3.33	3.00	2.67	3.00	3.04
† Daikin Advanced Lithium Ion Battery Technology —High Voltage Electrolyte	Ron Hendershot (Daikin America)	2-234	3.30	3.30	2.80	3.30	3.24
† Fluorinated Electrolyte for 5-V Li-Ion Chemistry	John Zhang (Argonne National Laboratory)	2-238	3.38	3.50	3.50	3.25	3.44
† Novel Non-Carbonate Based Electrolytes for Silicon Anodes	Dee Strand (Wildcat Discovery)	2-241	3.40	3.40	3.20	3.50	3.39
† Predicting Microstructure and Performance for Optimal Cell Fabrication	Dean Wheeler (Brigham Young University)	2-244	3.67	3.75	3.50	3.58	3.68
† A Combined Experimental and Modeling Approach for the Design of High Coulombic Efficiency Si Electrodes	Xingcheng Xiao (General Motors LLC)	2-248	3.17	3.33	3.33	3.17	3.27
† Electrode Architecture-Assembly of Battery Materials and Electrodes	Karim Zaghib (Hydro-Quebec)	2-250	3.70	3.50	3.60	3.50	3.56
† Advanced Binder for Electrode Materials	Gao Liu (Lawrence Berkeley National Laboratory)	2-253	3.75	3.63	3.75	3.50	3.66

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† Fundamental Studies of Lithium-Sulfur Cell Chemistry	Nitash Balsara (Lawrence Berkeley National Laboratory)	2-256	3.60	3.70	3.60	3.60	3.65
† Design and Synthesis of Advanced High-Energy Cathode Materials	Guoying Chen (Lawrence Berkeley National Laboratory)	2-259	3.63	3.50	3.38	3.38	3.50
Microscopy Investigation on the Fading Mechanism of Electrode Materials	Chongmin Wang (Pacific Northwest National Laboratory)	2-262	3.38	3.13	3.00	3.00	3.16
Overall Average			**3.32**	**3.20**	**3.27**	**3.11**	**3.22**

Note: † denotes poster presentation.

Cell Analysis, Modeling, and Prototyping (CAMP) Facility Product: Andrew Jansen (Argonne National Laboratory) - es030



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer emphasized that the CAMP facility is critical to the battery research and development (R&D) community. The reviewer asserted that the facility plays an important and unique role among the national laboratory, industry, and academia for providing independent and critical validation analysis of newly developed battery materials.

Reviewer 2:

The reviewer highlighted that this research is critically-positioned between small lab-scale coin cells and large format production quantities. The reviewer voiced that, by positioning its significant capabilities in the valley of death (for scale-up), Argonne National Laboratory (ANL) is helping to accelerate the deployment of advanced battery materials.

Reviewer 3:

The reviewer reported that the ability to evaluate promising leads in larger format batteries is critical for establishing an effective commercialization roadmap for these concepts. The reviewer explained that this must be balanced with the difficulty of sufficiently large quantities of these new materials for further testing. The reviewer recognized that through a series of important examples, this work clearly demonstrated that the project facilities and staffing have struck an excellent balance between these issues and have addressed the barriers.

Reviewer 4:

The reviewer explained that the program is designed to provide a “pilot level” bridge manufacturing capability in the overall process of developing lithium-ion (Li-ion) cells with advanced designs. The reviewer stated that this is a critical step in the overall process of cell development, and if it is not available commercially, then this provides that capability. The reviewer cautioned that care should be taken as to determining the specific activity goals within this program. The reviewer also noted that cell concepts that have shown significant promise at smaller scale formats would be the candidate formats for development in this part of the development flow.

Reviewer 5:

The reviewer pointed out that the researchers have done an excellent job of getting as much expertise from industry and equipment makers (and maybe consultants) as one can to build a working system.

Reviewer 6:

The reviewer stated that the approach was useful and that it appeared to have met the objectives. However, the reviewer suggested that the formulation and material of choice was limited and could be more inclusive so that cause and effect could be established for mode of failure in silicon (Si) anodes.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer explained that it was well-demonstrated that this laboratory could contribute substantially to the materials program by developing more effective formulation, better electrode manufacturing practices, and cell fabrication, which in-turn could facilitate proper and more realistic evaluation of new material including active materials, Si-anode, new electrolytes, and additives.

Reviewer 2:

The reviewer offered that the CAMP electrode library was a key accomplishment of this program. This reviewer also noted that the standardization effort was critical to moving the whole field forward. The reviewer also noted that the number of electrodes provided was significant. The reviewer would have appreciated greater metrics of the impact of this program upon other battery researchers. This reviewer described that the facility is best viewed as an enabler and not so much the pinnacle itself; recognition of this would better speak to its technical accomplishments and progress.

Reviewer 3:

The reviewer applauded that building a battery facility and getting "good" cells is quite a feat and the Principal Investigator (PI) deserves a lot of credit for this important task, even though it may be viewed as less glamorous than coming up with new "stuff." The reviewer was also very impressed with the reproducibility they showed. The reviewer explained that the fact that the project is providing "standard" reproducible electrodes to other developers is extremely valuable for two reasons: 1) it enables anode, cathode and electrolyte developers to work on real, relevant systems without having to become experts in all aspects of cell design, and 2) by having standard materials, it can enable comparison between competing technologies on an "apples to apples" basis. For example, one could use this to rank Si/C approaches without the comparisons being plagued by issues related to the cathodes or electrolytes used. The reviewer summarized that this work helped one to pick real winners for future development.

Reviewer 4:

The reviewer stated that the technical accomplishments were focused on results related to scaling Si anode technology to this format level. It would have been helpful to the reviewer to review a summary of the coin cell work that occurred in this area, which would allow for a more informed review capability as to the additional knowledge that the larger format work provided.

Reviewer 5:

The reviewer described that the evaluations were focused on the U.S. Department of Energy (DOE) goals for high energy density, long cycle life, and cost reductions to enable further market penetration of battery-powered vehicles. The reviewer also explained that this work evaluated leading alternatives in Si anodes, and pointed to key performance issues that must be overcome with each candidate. The researchers characterized the role of electrolyte selection in addressing voltage fade in lithium (Li) and manganese (Mn) rich transition metal oxide (LMR-NCM), along with several other technologies. The reviewer commented that this work also shows that this team is versatile, and that they can accomplish outcomes in a wide variety of technologies that impact the development of better industrially-relevant battery performance and production.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer claimed that the collaborations were outstanding from their view. The reviewer especially liked the fact that in addition to get materials from others, that they also supply samples and even cross-check against other electrode manufacturers. The reviewer exclaimed that it would be hard to see how this could be improved.

Reviewer 2:

The reviewer reported that the collaborations within the laboratory and with external customers were very good.

Reviewer 3:

The reviewer indicated that the researchers have become an integral member of the battery research community working with a number of collaborators. The reviewer noted that the project team has also begun supplying a large number of electrodes to interested parties. The reviewer also explained that critical support of other DOE Office of Energy Efficiency and Renewable Energy-funded efforts as evidenced on Slide 17.

Reviewer 4:

The reviewer remarked that the program team has demonstrated a strong willingness to collaborate with a large number of universities, companies, and other national laboratories.

Reviewer 5:

The reviewer commented in the particular case of Si anode technology, that there are a wide range of materials under evaluation from a wide range of commercial developers. The reviewer stated that the collaboration presented was quite competent. The reviewer explained that it is simply a fact of the field that there will be a wide range of materials under development that may not represent the slice of technology provided by any one entity.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer suggested that as the project comes to an end, it would be valuable to document and publish the findings in open literature to benefit the battery R&D community.

Reviewer 2:

The reviewer noted that the plans to look at changes that can be made to get Si/C to work are critical. The reviewer cautioned, however, that this needs a very thorough and disciplined approach and needs a grand plan for this agreed upon by the major stakeholders. The reviewer warned, however, that the group must avoid just picking a few hot candidates and testing them one at a time, which far too often is the case in academic and government lab work, for various, somewhat understandable reasons. The reviewer observed that several of the approaches are likely to have very strong interactions; both positive and negative. The reviewer proposed that the team has to plan some designed experiments to look at interactions/synergies among stabilization efforts being pursued by the various groups and not treat it as a straight A versus B competition; this applies to both anode and cathode improvements and interactions between anode and cathode stabilizations are likely. The reviewer offered that planning such work is not trivial, but often this is where the most value can be added.

Reviewer 3:

The reviewer remarked that there seemed to be a large number of milestones still to be completed before the end of Fiscal Year (FY) 2014. The reviewer also pointed out that there does not seem to be a pathway to keep this unique and important facility working. The reviewer was very interested in the results of the work breaking down the three major contributors to energy fade (i.e., voltage fade, impedance rise, and capacity fade).

Reviewer 4:

The reviewer acknowledged that the capability demonstrated by the group is quite good, and quite valuable. The reviewer suggested that the process for defining what the high priority programs could be more transparent, which may or may not be in the purview of this specific group.

Reviewer 5:
The reviewer observed that the scope of objectives was very broad and criticized that they could not see any clear decision-making plan or critical-path analysis. The reviewer indicated that both should help with streamlining of activities toward obtaining desired results.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that this program is critical to generate reliable data on new materials and approaches and provides an invaluable service to the community. The reviewer specified that this work forms a solid foundation on which the rest of the community can build.

Reviewer 2:
The reviewer stated that this project would help the domestic industry to quickly streamline their processes for making better and more cost-competitive materials for Li-ion batteries.

Reviewer 3:
The reviewer affirmed that scale-up activities were important for ensuring that advanced battery materials make it from the bench to the consumer and ultimately displace petroleum.

Reviewer 4:
The reviewer indicated that this was a necessary capability in the overall development of advanced battery chemistries.

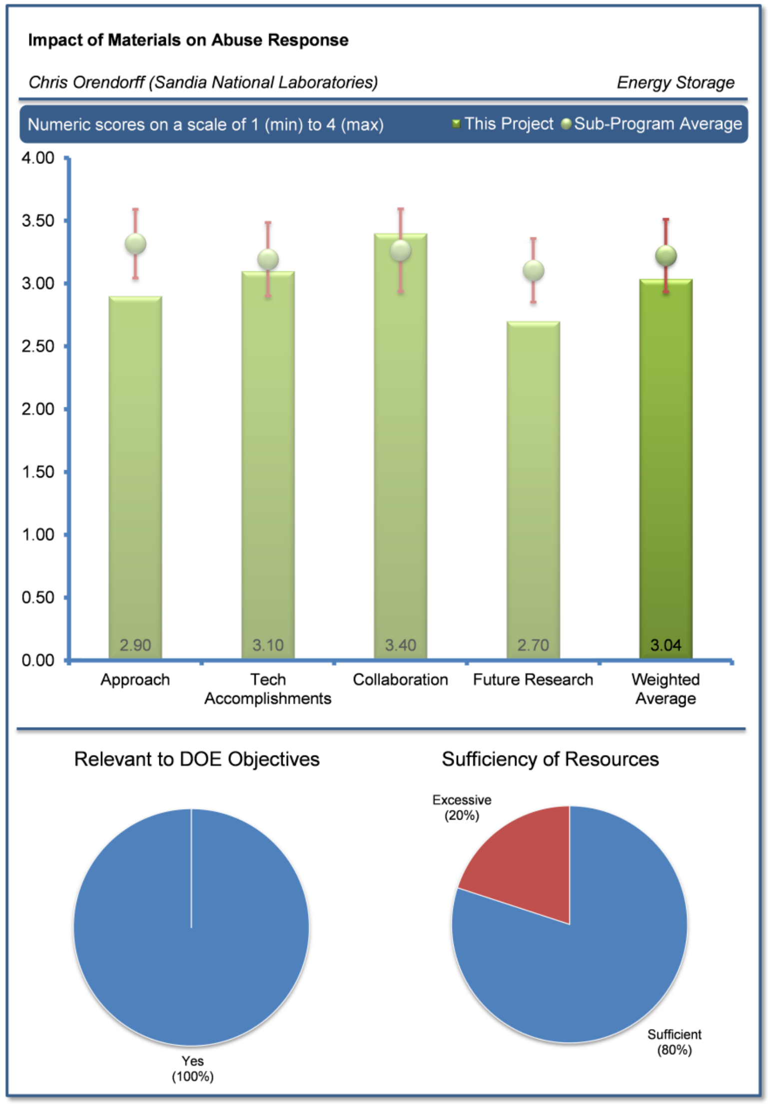
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said the allocation of resources appeared to be adequate, although the details were not discussed. The reviewer stated that it would be interesting to know where the bottleneck is, and how it can be resolved.

Reviewer 2:
It was unclear to the reviewer if the large amount of funds were spent on setting up this facility (funds considered sufficient), or not (funds considered excessive). The reviewer also would have liked to see a longer-term plan for this core funded facility.

Reviewer 3:
The reviewer stated that no information was presented to indicate that project areas would go unaddressed because resources were limited.

Impact of Materials on Abuse Response: Chris Orendorff (Sandia National Laboratories) - es036



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that the global objectives were in line with other efforts and approaches. However, the reviewer suggested that the detailed objectives can be refined to identify the chain-of-events that could result in cell failure or compromised safety. The reviewer proposed that it might be possible, at least in theory, that safety concerns could be alleviated by interrupting the chain-of-events rather than changing active materials.

Reviewer 2:

The reviewer agreed that the production of more robust batteries will accelerate their commercial deployment. The goal of this team was to alter existing chemistries to improve safety without compromising performance. There was a strong desire by the reviewer for more quantitative metrics on abuse tolerance. If not, the reviewer asked what the key thresholds are that represent a robust battery system. The reviewer agreed that this project is made up of good science, it just needs to be better applied to relate directly back to batteries, especially as they are used in vehicles.

Reviewer 3:

The reviewer stated that the program demonstrated methods to characterize abuse with both quantitative and qualitative outcomes. The reviewer explained that the methods tended to be more materials-based, with limited chemical insight developed thus far.

Reviewer 4:

The reviewer stated that the overall approach was okay, but this person was a little concerned about the low capacity of the project team’s 18650 cells – presumably these cells had a much higher electrolyte to solids ratio than “real” cells and burning electrolyte was apparently the biggest source of heat in these events. The reviewer thought that the researchers were looking at the right variables, but the reviewer remained concerned about the relevance of the 18650 test vehicle to actual vehicle batteries. Typically, in such cells, the role of the vent in ensuring safety can be very important and the project had not really addressed this level of complexity yet. The reviewer would like to know whether venting really helped cell safety, or if it actually made it worse (may depend on whether the expelled electrolyte catches fire which may in turn depend on spark/ignition sources). The reviewer recognized that this was not easy.

Reviewer 5:

The reviewer said that it seems that only thermal runaway is addressed in this project. It was unclear to the reviewer whether industry-accepted standard test procedures were used for the thermal runaway tests. It was also unclear whether the results from the project could be used to help develop Li-ion cells and batteries that are abuse-tolerant under more realistic conditions, such as under the influence of multiple factors (e.g., mechanical damage, air exposure, and thermal runaway) that may occur simultaneously. The reviewer also voiced that the project does not address aged battery cells that may have completely different abuse tolerance. It was unclear to the reviewer how statistical analysis was used for abuse failures that are usually random and low-probability events.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that it was well-demonstrated that this laboratory could contribute substantially to the materials selection program to address battery safety. However, the reviewer proposed that a more systematic approach to establishing a clear and unambiguous chain of events that could lead to battery failure would benefit this program.

Reviewer 2:

The reviewer commented that there is only one journal publication listed together with four conference presentations (Slide 18). The project person offered that it would be valuable to the R&D community if the results from the project can be found in archival journals.

Reviewer 3:

The reviewer stated that the PI showed a number of key successes in raising autoignition and thermal runaway temperatures and lowering the corresponding enthalpy. However, without a clear baseline it was difficult to put this research into context. The reviewer indicated that the key takeaways did not translate back well to the overall project objectives.

Reviewer 4:

The reviewer stated that this program described the challenges in assessing the contribution of Si anode to thermal abuse, but has yet to clarify the causes of the variation, nor the significance of any additional concerns over graphite. In contrast, the reviewer highlighted the significant improvements demonstrated for LiMPO4-coated NMC show the soundness of this program's approach and its ability to deliver important accomplishments. Similarly, the evaluation of novel electrolyte components that brings FRION effectiveness into question and qualifies the safety benefits of the LiF/ABA against battery performance trade-offs are significant accomplishments. The reviewer commented that these examples demonstrate the promise and perhaps some limitations to characterizing abuse.

Reviewer 5:

The reviewer affirmed that the researchers have added to some of the fundamental knowledge on Si anodes; however the reviewer did not think the lower onset temperatures was a very positive feature for this system.

It remained unclear to this person whether it was more important to delay thermal runaway or to have less heat produced if it goes off. Delaying thermal runaway may render a cell more abuse tolerant, but may not stop propagation or the scale of any thermal runaway that does occur. Having a lower heat output may help tame the violence of a runaway (and propagation), but may not reduce the tendency of cells to cook off in the first place. The reviewer supposed that both are important, but thought that TIAX’s modeling work presented a while back suggested that once the onset temperature of the anode is reached, thermal runaway in large cells can proceed very quickly regardless of cathode material. If true, more emphasis may be warranted for avoiding the start of an event rather than trying to tame it once it has started (i.e., onset temperature may be more important than energy).

The reviewer also proposed that the role of cell vents seemed to warrant more consideration. The reviewer asked if the venting of a cell early enough caused the cell to shut down enough to stop thermal runaway. If so, the very high pressures seen by some of the Si anodes could actually be an advantage. Also, the reviewer wanted to know if venting was inherently going to cause a fire in the absence of ignition sources, and explained that Sandia’s use of a sparking station to set electrolyte vapors alight is a worst-case scenario. The reviewer asked if standard electrolyte vapors will always tend to ignite in a real thermal runaway for a car battery pack. Pouch cells would also have very low vent/burst pressure and may pose different, not necessarily better, safety characteristics.

The reviewer asserted that the link between what SNL was measuring and safety in electric vehicles (EV), hybrid- electric vehicles (HEV), and plug-in hybrid- electric vehicles (PHEV) cells seemed weak. The reviewer explained that size and scale ere so critical to this runaway issue that more work on larger cells was needed. The reviewer agreed that these were hard questions to answer, but this person thought that it should be attacked; it gets at the whole validity of the project team's work. Finally, the reviewer criticized that the amount of work done does not in the reviewer's view seem to be very large. The reviewer asked if the researchers could not pick up the pace a bit.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer reinforced that the partnering to get commercial materials and the collaboration had been a critical element of the work in this project. The reviewer reported that there had been a number of successfully coordinated efforts with project successes. The reviewer was encouraged by the substantial industry engagement.

Reviewer 2:

The reviewer affirmed that collaborations within the laboratory and with external customers were very good. The reviewer proposed that collaboration also can be extended to development of new materials based on identifying the weak link in the battery.

Reviewer 3:

The reviewer explained that although a limited number of collaborations were described, they were well-chosen to address the goals of this program. The reviewer claimed that the accomplished of the program are likely to attract additional collaborations with programs that are targeting new concepts for improving battery safety.

Reviewer 4:

The reviewer described that the researchers were getting samples and presumably giving feedback on results to partners, which seemed to be okay.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed that the overall objectives were in line with the needs of industry. The reviewer suggested that it would be beneficial also to establish the chain of events that could lead to the failure and to identify the weak link in Li-ion battery safety. The reviewer summarized elements from the summary: 1) fielding the most inherently safe chemistries and designs can help address the challenges in scaling-up Li-ion, and 2) materials choices can be made to improve the inherent safety of Li-ion cells. Based on this logic one can conclude that gasoline should not be used in automobiles; however, proper engineering design and suitable material of choice made it possible.

Reviewer 2:

The reviewer remarked that most of the proposed future work, which seems to be a continuation of the current course, is sufficient. The reviewer indicated that the modeling/statistical analysis of the data will be key to generating usable information on how to improve abuse tolerances. This person expected there to be a greater focus on developing recommendations/guidelines for other researchers.

Reviewer 3:

The reviewer simply stated that the future work was focused on continuing current activities.

Reviewer 4:

The reviewer thought that the researchers' plans were fine as far as they go, but would have also liked to see more work done to ensure the work was truly relevant. The reviewer also commented that there was little actual chemistry in the presentation, so the reviewer was glad to see some analysis of the vented gases included in the future work.

Reviewer 5:
It was unclear to the reviewer whether the large number of tasks listed under proposed future work could be accomplished in the remaining few months of the project.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that this project would help the domestic industry to quickly streamline their processes for making safer and more cost-competitive materials for Li-ion batteries.

Reviewer 2:
The reviewer asserted that consumer fear of catastrophic battery failure was a drawback. Inherently safer battery designs limit this risk and accelerate deployment.

Reviewer 3:
The reviewer remarked that battery safety was an important and highly-publicized concern for the use of batteries in transportation. Therefore, methods to characterize safety, and search for improvements were very relevant to transition the consumer away from petroleum-based transportation.

Reviewer 4:
The reviewer reported that safety was obviously critical for Li-ion batteries, and appeared to be especially troublesome for large, high-energy and high-power battery packs needed to meet DOE goals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

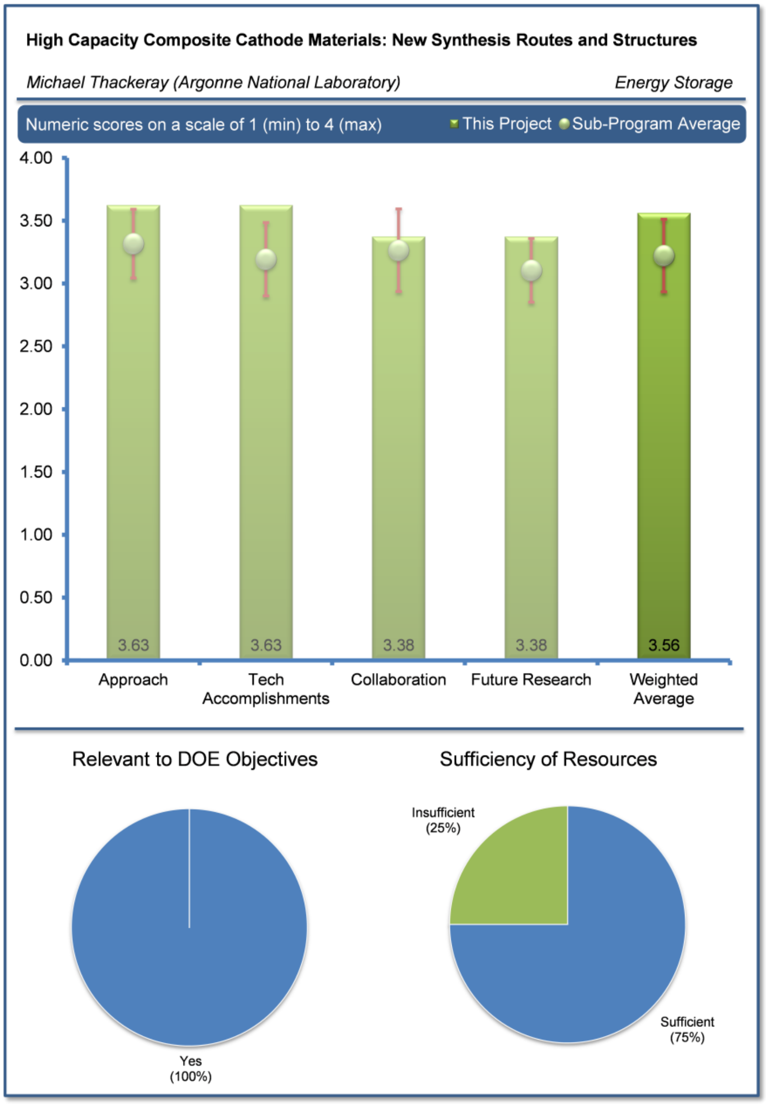
Reviewer 1:
The reviewer agreed that the allocation of resources appeared to be adequate, although the details were not discussed. It would be interesting to this person to know where the bottleneck was and how it could be resolved.

Reviewer 2:
The reviewer indicated that the program did not describe work that could not be completed due to insufficient resources.

Reviewer 3:
The reviewer commented that the resources seemed to be sufficient, but criticized that the amount of work done seemed to be rather modest. Currently, the bang for the buck was not there for this person.

Reviewer 4:
The reviewer warned that the invested funds, particularly on the abuse evaluation side, seemed to be quite high for the quantity and quality of research data generated.

High Capacity Composite Cathode Materials: New Synthesis Routes and Structures: Michael Thackeray (Argonne National Laboratory) - es049



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that among the approaches pursued that entailing tailoring of the bulk structure, the integration of stabilizing spinel, etc., appeared to be of the most benefit. The reviewer, however, was doubtful about the efficacy of approaches using surface modification to yield any fundamental breakthroughs to resolve the issues of life and voltage fade.

Reviewer 2:

The reviewer applauded the excellent approach, also indicating that the availability of a battery with high energy is essential to the success of the program.

Reviewer 3:

The reviewer explained that the project objective is to stabilize the nanocomposite structures of Li_2MnO_3 and $LiMO_2$ layered structures from the formation of the pseudo-spinel phase that contributes to its voltage fade upon cycling. The reviewer explained that the adopted approach includes developing integrated structures incorporating a spinel phase (for a layered-layered spinel composite [LLC]) with improved processing methods and further stabilizing these materials with suitable surface coatings. The reviewer confirmed that this project thus addresses one of the key performance barriers of the LMR-LLC cathodes, by adopting a viable approach and is well-integrated with the other efforts in understanding/mitigating the voltage fade. One question remained in the reviewer's mind, however, with the incorporation of the low-capacity (and low-voltage) spinel phase, if the LMR-LLC materials with spinel components compete well with simple surface-treated nickel (Ni)-rich layered cathodes operating at higher voltages.

Reviewer 4:

The reviewer commented that this is a good fundamental research to understand the phase transition mechanisms.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer confirmed that the approach to identify and develop a suitable battery for EVs is key. The reviewer explained that Dr. Thackary has a long history of success in developing battery systems, from those for EVs as well as to power portable electronics. The reviewer recognized that the PI has been a key performer at ANL for many years.

Reviewer 2:

The reviewer described that impressive progress had been made in understanding the processes contributing to the voltage fade of LMR-LLC materials and in the design and verification of new layered-layered-spinel composite structures. The reviewer highlighted that some of the significant findings included the following: stabilization of the Li_2MnO_3 with the incorporation of Ni^{2+} incorporation, even with high Li_2MnO_3 proportions; and development of synthetic technique for the structurally integrated layered-layered-spinel composites, which were confirmed through X-ray diffraction (XRD), high-resolution transmission electron microscopy (HRTEM), and electrochemical cycling. Further, the reviewer mentioned that some good publications had emerged from this project.

Reviewer 3:

The reviewer explained that the research has focused on understanding of what leads the degradation of Li_2MnO_3 and $LiMnNiO_4$ cathode using conventional electrochemical and XRD methods.

Reviewer 4:

The reviewer noted that the data showing the effect of stabilization of the Li_2MnO_3 structure looks promising. However, the reviewer cautioned that there are only little data to support the hypothesis that this approach will eliminate all the major issues that plague this LMR cathode (e.g., life especially at high temperatures, voltage fade, and gassing).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that all of the pertinent laboratories were involved in this collaboration.

Reviewer 2:

The reviewer observed that there are good collaborations with several researchers from the “voltage fade” team. The reviewer stated that it was probably the appropriate time to collaborate closely with industry (i.e., BASF, Toda, LG, and Envia) for further verification of the layered-layered spinel composite material in the industrial environment.

Reviewer 3:

The reviewer acknowledged that Dr. Thackeray is a leading proponent for battery-powered transportation. The reviewer indicated that the cathode materials, developed for portable electronics, are being used in most portable computers. The person recognized that Dr. Thackeray is a team performer and shares thoughts willingly and spontaneously. The PI’s stature in the industry makes it easy for him to cooperate with anyone in the industry and is always ready to cooperate.

Reviewer 4:

The reviewer was unsure if there was any evidence of collaboration outside of ANL so far.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed that the work was definitely focused on resolving the key issues, but suggested to bring about bulk stability of the material in the course of life.

Reviewer 2:

The reviewer reported that the approach used by Dr. Thackeray was based on sound ground. The reviewer pointed out that the PI had claimed several awards for work including the Technology Award from the International Battery Association. The reviewer also commented that the materials will find use in advanced vehicle propulsion.

Reviewer 3:

The reviewer explained that the proposed future research will continue the development of LMR-LLC cathodes to achieve high capacities combined with adequate stability on cycling. Composite structures with low Li_2MnO_3-content composite structures, with and without stabilizing spinel components, look promising. The reviewer agreed that basic studies related to the charge ordering and magnesium (Mg) mobility are useful in designing stable composite compositions which may be further protected with surface coatings to mitigate voltage fade and realize high energies. The reviewer emphasized that it is, however, important to demonstrate that these approaches also address the other limitations of the LMR-LLC compounds, which are yet to be successful in an industrial environment (e.g., with high cathode loadings and in full cells) due to their poor power characteristics and cycle life. The reviewer concluded by stating that voltage fade appears to be a minor component of the energy fade upon cycling.

Reviewer 4:

The reviewer commented that the proposed future research is relatively focused, but this person was unsure of how the coating on the particles could stabilize the phase transition inside particles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that this project was highly-relevant to DOE's overall objective of petroleum displacement by advancing the next generation high capacity cathode chemistry for low-cost and long-life batteries.

Reviewer 2:

The reviewer stated that the development of batteries to service electric vehicles was an essential part of the DOE assignment.

Reviewer 3:

The reviewer explained that the low specific energies and high costs of Li-ion batteries were serious impediments to their widespread adoption in vehicles. The reviewer suggested that LMR-LLC cathode materials were promising, both from an energy and cost perspective, but were hampered by issues such as voltage fade and hysteresis. According to the reviewer, it is essential to have a fundamental understanding of these phenomena to mitigate these issues and to develop stable structures, as was being done in the present project.

Reviewer 4:

The reviewer commented that the project would develop high capacity high-voltage cathode for Li-ion batteries.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

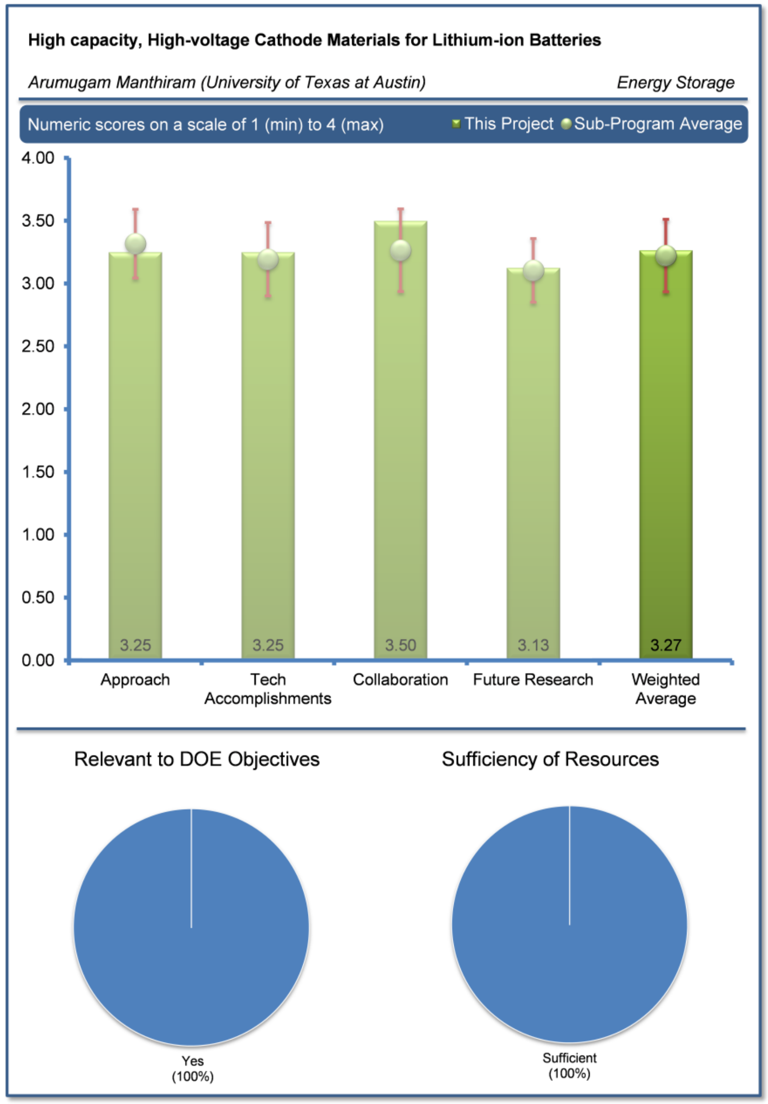
Reviewer 1:

The reviewer simply stated that the funding was appropriate.

Reviewer 2:

The reviewer indicated that the resources were adequate for the scope of the project.

High capacity, High-voltage Cathode Materials for Lithium-ion Batteries: Arumugam Manthiram (University of Texas at Austin) - es051



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the approach is very sound and that the work has developed high-performance spinels and polyanion cathode materials such as phosphates and silicates. The reviewer also reported that a fundamental understanding of the structure and performance with good performance and high-voltage was developed. The reviewer also explained that low temperature synthesis of these materials was developed as the use of graphene as a conductive diluent. The reviewer reported that solid-state, high-energy ball milling, and solution-based synthesis approaches were used along with advanced chemical, structural, and surface characterizations. The researchers also performed an in-depth electrochemical evaluation including impedance analysis to develop an understanding of the structure-property-performance relationships.

Reviewer 2:

The reviewer described that the project objective here is to develop new polyanion cathodes with high specific energy for Li-ion batteries, specifically based on high-energy density phosphate and silicate cathodes exhibiting multi-electron redox process, and to gain and a fundamental understanding of their structure- composition-performance relationships. The reviewer reported that three types of cathodes were being developed including the three polymorphs of $LiVOPO_4$ wherein two Li ions can intercalate, andnanostructured phosphate and silicate cathodes with either graphene inclusions of aliovalent metal dopings for enhanced conductivities and performance. The project person also described that low-temperature synthesis methods are being developed for these cathodes ionic and electronic transport. Using detailed chemical, structural and surface characterization; the electrochemical performance was correlated with the materials' structure and property. The reviewer indicated that this approach was proving to be feasible for the development of new cathode materials.

Reviewer 3:

The reviewer reported that microwave-assisted synthesis was used to synthesize $LiVOPO_4$, and chemical and electrochemical lithiation methods were used to insert additional Li into the cathode structure.

Reviewer 4:

The reviewer agreed that the approaches will definitely lead to a better understanding of these classes of (potentially) stable cathode materials. The reviewer, however, was not sure though whether any of them would be practically useful.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the work established a new method for identifying new cathode materials for vehicle applications.

Reviewer 2:
The reviewer described that several cathode materials with multi-electron redox processes were being developed and that the initial results were encouraging. For example, high capacities of approximately 220 mAh/g were demonstrated in the three polymorphs of $LiVOPO_4$. High capacities of 155 mAh/g were realized with aliovalent substitution of V^{3+} for Mn^{2+} in $LiMnPO_4$. Finally, the reviewer noted that the nanostructured Li_2MnSiO_4-carbon composite cathodes synthesized with a hard-template approach exhibit stable cycling at high rates (1C rate) with a capacity of 100 mAh/g. The reviewer cautioned that even though a good understanding of these materials was gathered through detailed structural characterization, the performance characteristics of these materials were not quite appealing yet.

Reviewer 3:
The reviewer confirmed that the results certainly helped the research community to understand the limitations/opportunities with these compounds. The reviewer suggested that using mAh/g might not be the best metric to report the capacity of these compounds since the voltages are around 2 V or below, thus reporting a 200 mAh/g capacity does not tell the true story.

Reviewer 4:
The reviewer asserted that the insertion of Li into $LiVOPO_4$ has caused a significant potential reduction to the level that it becomes not practically useful. The reviewer recommended that the electrical conductivity of synthesized $LiVOPO_4$ should be measured.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer affirmed that a number of key, and well-known, laboratories were involved in the consortium.

Reviewer 2:
The reviewer simply noted that Dr. Manthran was always willing and able to assist.

Reviewer 3:
The reviewer said that there is no formal collaboration yet for this project. Though exploratory in nature, some collaboration with a national laboratory or industry in terms of assessing the performance of the cathode materials will help in prioritizing these materials and focusing on the promising candidates for further development.

Reviewer 4:
The reviewer noted collaboration with Lawrence Berkeley National Laboratory (LBNL) on x-ray absorption and Oak Ridge National Laboratory (ORNL) on XRD has been developed.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer offered that the future work is focused well to advance the battery research community’s understanding of these classes of cathode materials. The reviewer was curious to see how nanoparticles affect the capacity as well as how the proposed dopants modulate the cell voltages.

Reviewer 2:

The reviewer remarked that the future work on the use of graphene as a conductive diluent was very interesting and a promising method for maintaining contact to the particles of active materials.

Reviewer 3:

The reviewer explained that the proposed future research is to continue the development and study of the three polymorphs of $LiVOPO_4$ cathode and to downselect one for further study on the synthesis of $LiVOPO_4$/graphene nanocomposites to improve conductivity and thus increase the capacity to approximately 250 mAh/g. Likewise, the aliovalent doping of M (in $LiMPO_4$; M=Fe, Mn, or Co) as well as Li_2MSiO_4 and $Li_2MP_2O_7$ (M = Mn, Fe, Co, and Ni) with V^{3+} or Ti^{4+} will be explored to improve their ionic and electronic conductivities. The reviewer reinforced that the proposed materials look interesting, but this person noted that the approach seems to be truly exploratory and non-specific. The expected improvements did not appear to be significant to the reviewer compared to some of the known layered mixed metal oxide materials (Ni-rich or LMR-LLC). The reviewer suggested that the materials need to be prioritized, or ruled out, based on their performance to make this effort beneficial to the DOE Applied Battery Research for Transportation program.

Reviewer 4:

The reviewer suggested that the PI should investigate how to improve the cyclability and charge/discharge rate of $LiVOPO_4$. The reviewer also requested that the PI should also make an extensive literature search for previous works on the doping of $LiFePO_4$ and $LiMnPO_4$.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer explained that low specific energies and high costs of Li-ion batteries are serious impediments to their widespread adoption in vehicles. Thus, improvements in the specific energy of electrode materials will result in increased range for the vehicle as well as reduced overall cost for the battery. The reviewer stated that state-of-the-art cathode materials have low capacities due to their inability to intercalate with more than one Li ion per transition metal. The reviewer proposed that the researcher community needed to explore new cathode materials that can intercalate multiple Li-ions and or provide higher capacity than the state-of-the-art materials, which the present project is duly addressing.

Reviewer 2:

The reviewer agreed that a high capacity, stable cathode was critical for developing an efficient, low-cost battery.

Reviewer 3:

The reviewer affirmed that the work directly supported the DOE VTO program and provided a new look/method for improving contact between the cathode materials and the current collector.

Reviewer 4:

The reviewer stated that the project was developing a high capacity high-voltage cathode for Li-ion batteries.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

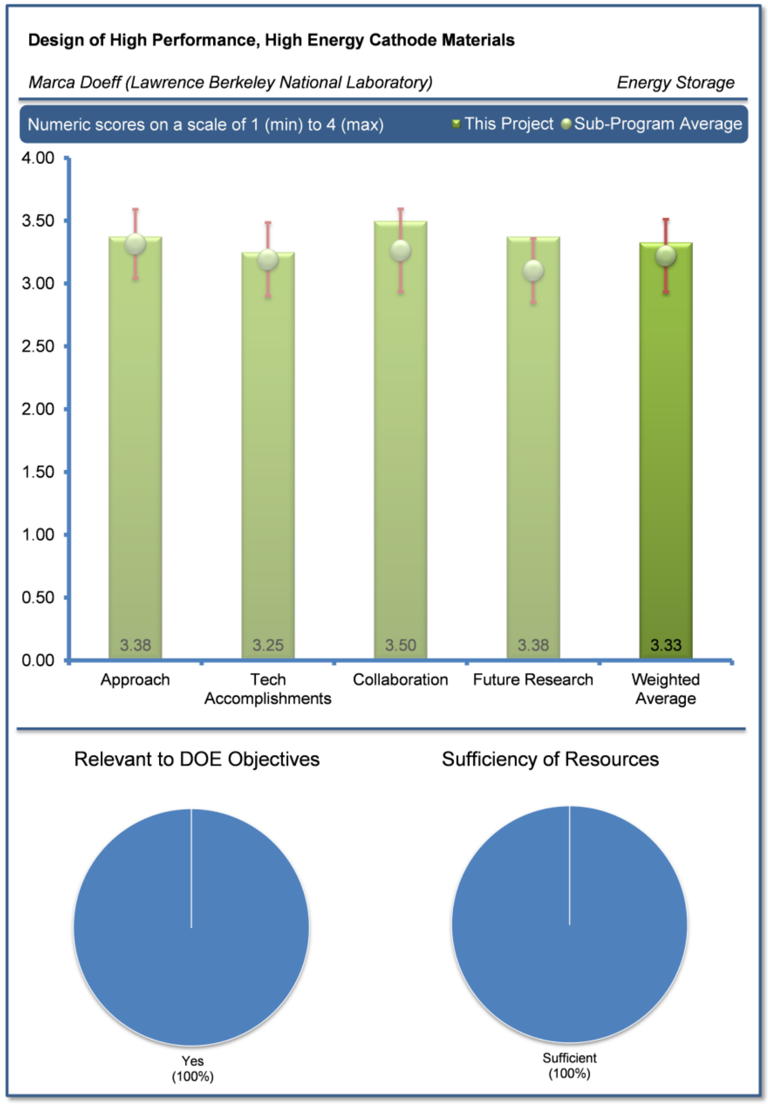
Reviewer 1:

The reviewer simply stated that the support was adequate.

Reviewer 2:

The reviewer agreed that the resources were adequate for the scope of the project.

Design of High Performance, High Energy Cathode Materials: Marca Doeff (Lawrence Berkeley National Laboratory) - es052



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach is in keeping with the traditional method for developing new cathode materials for Li-ion cells. The reviewer complimented that the PI is a careful worker and a fountain of knowledge of the past work at LBL.

Reviewer 2:

The reviewer affirmed that soft XAS and HRTEM have been effectively used to study the surface properties of aging cathodes.

Reviewer 3:

The reviewer explained that the project objective is to develop high-energy cathode materials with layered composites, with particular emphasis on modified NMCs, and to optimize their synthesis using a low-cost spray pyrolysis method. The reviewer noted that the spray pyrolysis method is a one-step process yielding the desired morphology, and also allows simultaneous doping and subsequent surface coating. The reviewer indicated that although titanium substitution into NMC is not new, its substitution for Co^{3+} here (instead of Mn^{4+}) is mainly responsible for the improved performance. Detailed analytical studies, using soft X-ray absorption spectroscopy (XAS) and other synchrotron techniques are being carried out to understand the mechanism underlying the improvements from titanium (Ti)-doping. The project person agreed that the approach overall is effective, and that the spray-pyrolysis method is proving to be feasible for the development new cathode materials. However, the reviewer noted that the cycle life data shown with the Ti-doped MNC materials, though better than the pristine materials at higher voltages, is not promising with rapid capacity fade within 20-30 cycles. The reviewer commented that proper trades are to be made to establish the merit of these materials in comparison to the other mature options (e.g., conventional coated cathodes).

Reviewer 4:

The reviewer remembered seeing people make attempts to use spray pyrolysis for spinel synthesis a long time ago. The reason was forgotten, but this reviewer recalled that it never caught on and the large difference in melting/decomposition the authors refer to might further complicate the scenario. The reviewer cautioned that even the data are not too supportive that this will be a right approach to solve the life issues. The reviewer also suggested that such a process might not be the one that is commercially-attractive.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that good progress had been made and the project goals were met.

Reviewer 2:
The reviewer remarked that the diagnostic data are quite impressive. The reviewer thought that the authors were capable of doing a much better job in that regard, than on the synthesis/processing part.

Reviewer 3:
The reviewer explained that impressive fundamental analytical studies were carried out to understand the capacity degradation in NMC cathodes during cycling at high voltages. It was shown that the NMC particles are covered with a rock salt layer comprised of reduced Ni, Co, and Mn, which may be primarily responsible for the capacity loss. The reviewer reported that Ti-substitution is speculated to be modifying the composition of this surface layer to make it more conductive (perhaps being inferred from electrochemical impedance spectroscopy). The reviewer suggested that spray pyrolysis appeared to be a simpler and lower-cost method compared to the standard co-precipitation/calcination, but the (hollow) morphology is not optimum for high tap densities. Even though the cyclic stability is improved with Ti compared to pristine materials, the cycle life data with Ti-doped NMC is not impressive yet, with rapid capacity fade within 20 cycles. The reviewer summarized that even though a good understanding of these materials was gathered through detailed structural characterization (which resulted in good publications), the performance characteristics of the Ti-doped NMC materials are not quite appealing yet.

Reviewer 4:
The reviewer commented that the project has been focused on the surface reconstruction and valance change of surface element. The reviewer stated that HRTEM with SAED can be used to study the microstructural and crystalline change inside the aging cathode particles.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer confirmed that the collaboration with other institutions and the work program was coordinated with others in the DOE network.

Reviewer 2:
The reviewer commented that there were useful collaborations within LBNL and with external laboratories to carry out the soft XAS and other synchrotron studies.

Reviewer 3:
The reviewer recognized that the PI has established a wide collaboration with several institutions including the Stanford Synchrotron Radiation Lightsource for XAS, Brookhaven National Laboratory (BNL) for transmission electron microscope, and the University of California, Berkeley for computer modeling.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the proposed work is in keeping with the program goals and should make significant contributions.

Reviewer 2:

The reviewer described that the proposed future research is to continue the study of the rock salt formation in the NMC cathodes, using additional synchrotron, X-ray Raman measurements. The spray pyrolysis/infiltration method will be extended to other classes of cathodes such as $LiNi_{0.5}Mn_{0.5}O_2$, $LiNi_{0.5}Mn_{1.5}O_4$, and NMCs with higher Ni content. Further, the reviewer explained that these cathodes will be coated with surface coatings for stability at high charge voltages, with the coatings powders (Al_2O_3, ZnO) made by spray pyrolysis. The reviewer explained that even though the long-term cyclic stability of Ti-doped NMC is questionable (or not demonstrated yet), the spray pyrolysis method is promising and merits further study with other potential cathode materials.

Reviewer 3:

The reviewer noted that X-ray Raman will be introduced to provide additional information about surface structure; however, the crystallinity and composition change inside bulk should also be studied.

Reviewer 4:

The reviewer observed that the project team's experience tells us that work related to coatings using ZnO and Al_2O_3 will be waste of time since it is not effective in the long run.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that the availability of high-performance battery systems will speed the development of electric propulsion for all levels of automobiles.

Reviewer 2:

The reviewer affirmed that the low specific energies and high costs of Li-ion batteries are serious impediments to their widespread adoption in electric vehicles. High energy density electrode materials will result in improved specific energy for Li-ion cells, increased range for the vehicle, as well as reduced overall cost for the battery. The reviewer stated that the state-of-the-art cathode materials provide capacities of only approximately160 mAh/g, or about half of the capacities from the carbon anodes. The reviewer confirmed that the battery research community needs to explore new cathode materials with higher specific capacity and voltage, while maintaining the stable layered structures of the cathodes, which the present project is addressing.

Reviewer 3:

The reviewer agreed that understanding of surface properties will provide useful information for improving cathode capacity and cyclability.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that sufficient resources are available.

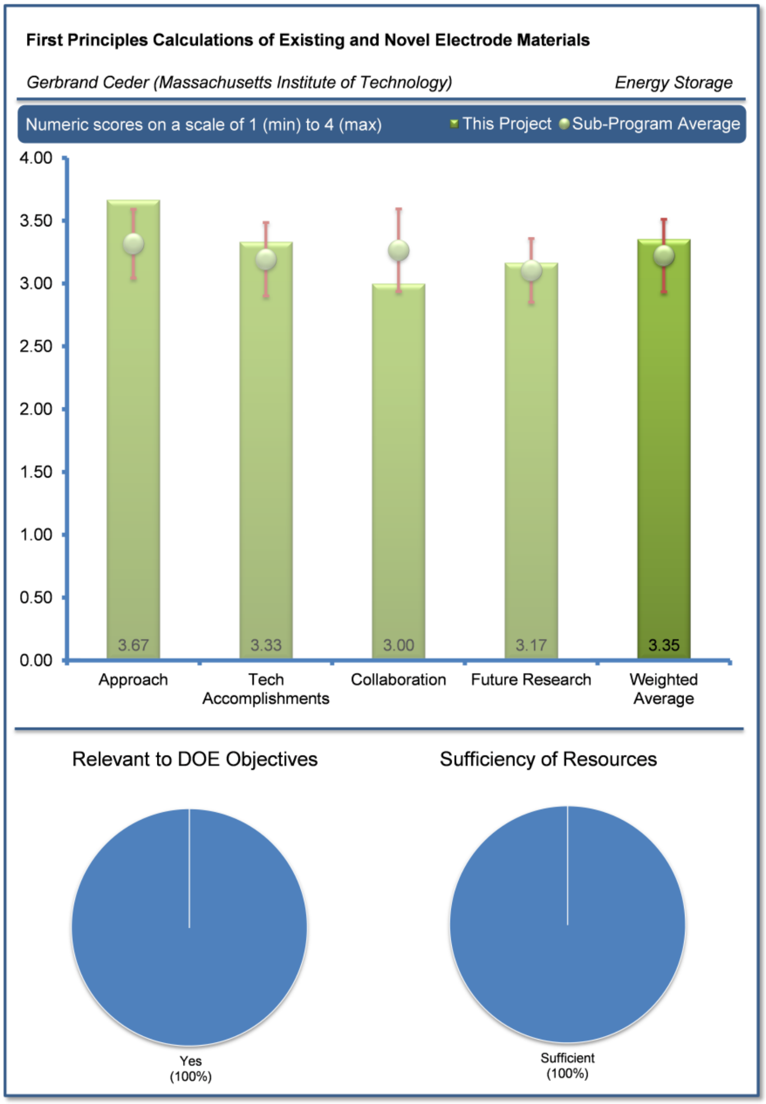
Reviewer 2:

The reviewer commented that the resources are adequate for the scope of the project, but cautioned that it may be a little on the high side.

Reviewer 3:

The reviewer asserted that it appeared that LBNL has a very high overhead.

First Principles Calculations of Existing and Novel Electrode Materials: Gerbrand Ceder (Massachusetts Institute of Technology) - es054



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer recognized that the PI's use of several complementing theoretical tools to examine the stability, transport, and voltage of many electrode active materials is very useful. The reviewer acknowledged that seeking out fundamental mechanisms and new high capacity positive electrode materials is a huge challenge that the PI has readily taken on these activities. The reviewer pointed out that there is a lot of interest in sodium-ion materials, that the reviewer was not sure was justified. Nevertheless, this reviewer said it will be interesting to see the PI's results on this aspect of the project.

Reviewer 2:

The reviewer commented that the mapping of the potential energy for Li-ion diffusion path reminded them of a text book, which density functional theory studies should be. The reviewer asked whether it would be possible to see a comparison of the calculated diffusivity and the experimental data. The reviewer suggested that the computation for the bulk structure may not represent exactly the electrochemical behavior since the electrochemistry is often controlled by the surface structure of the material which is not exactly an extension of the bulk structure. Namely it is highly possible that the lattice parameter and/or the oxidation state of the electrode particles near the surface are different from those of the bulk material.

Reviewer 3:

The reviewer affirmed that this is an important contribution that is trying to explain Li mobility on relation to the state of charge of the material. The reviewer pointed out that the presenter stated that “in layered materials slab spacing contracts at low Li concentration, thereby reducing Li mobility, and reducing practical charge capacity.” It seemed to this reviewer that Li is also shielding the negative charges from the oxygen atoms above and below the Li layer. The reviewer asked if it can also be said that as Li is removed, the Li that remains in that layer is more tightly bound to the oxygen atoms. The reviewer also stated that, in the areas where Li has been removed, the oxygen-oxygen repulsion should increase, so asked whether that would result in a less noticeable contraction of the slabs.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that, as done by the author, a correlation of experimental information with theoretical calculations is very valuable. The reviewer hoped that the author continued in this direction. The reviewer proposed that additional insight and guidance could be provided to the experimentalist for the design of better cathode materials.

Reviewer 2:
The reviewer stated that it would provide a better solid ground for the approach if more extended experimental data including cycling performance were shown.

Reviewer 3:
The reviewer praised that the PI is very productive in several areas. In the work on highly-lithiated materials, it was not clear to the reviewer whether the PI considers the case of the material being a composite structure and how that would influence the results. The reviewer also highlighted that the PI's work with MoCr transition metal oxides is interesting, but it is not clear to this person how these materials will ever get into a transportation application. It was also not clear to the reviewer how many different materials were studied by the PI. The reviewer would like to see the PI try to verify the results with experimentation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged that it was good to see collaboration with experimentalists.

Reviewer 2:
The reviewer commented that the program is fairly new, so thought that additional collaborations will probably be seen in the future.

Reviewer 3:
The reviewer remarked that the PI lists only a limited number of collaborations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that, as suggested by the author, further connection with the Li-excess ANL-style materials should be strongly pursued.

Reviewer 2:
The reviewer asked how useful the sodium-ion material is. This person also asked what the projected anode material was and how practical the chemistry was.

Reviewer 3:
The reviewer expressed not being overly excited by the proposed future work that based on the PI's present efforts. The reviewer acknowledged that the PI will continue to study the MoCr system, rather than looking for other more relevant materials. The reviewer acknowledged that the PI's interest in highly-lithiated materials is more than justified, but did not indicate that more complex structures will be considered.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

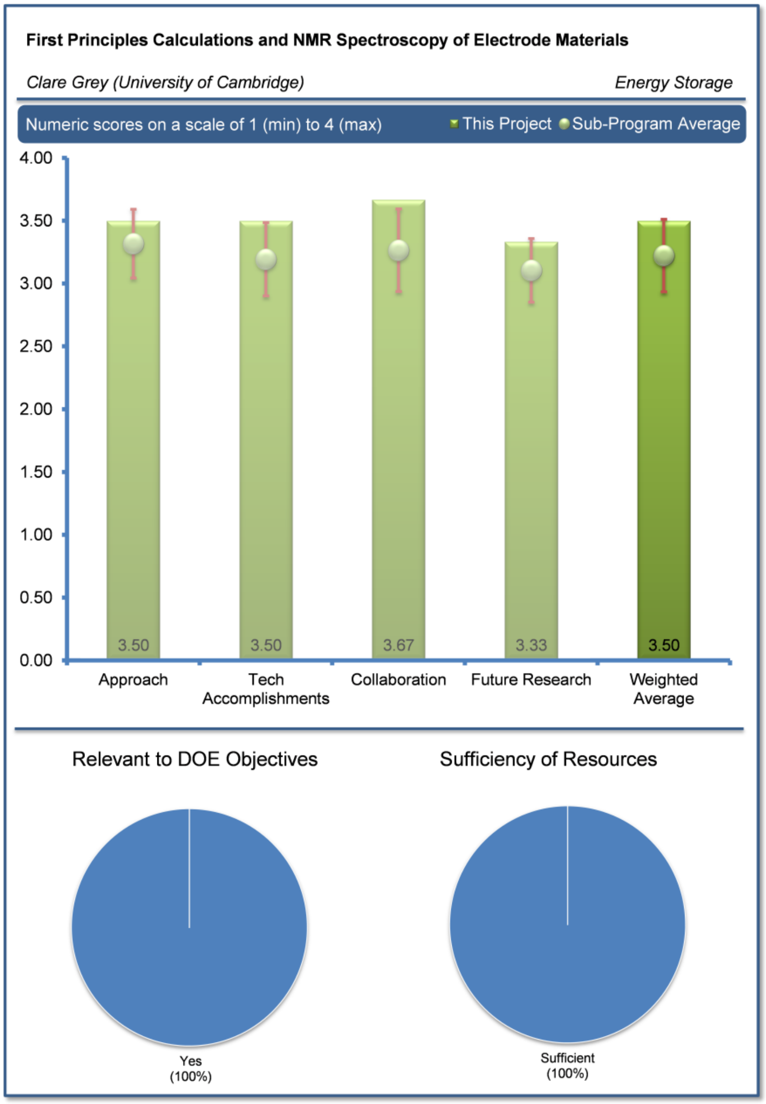
The reviewer acknowledged that the PI made a solid case for relevance. The reviewer, however, was not sure how general one can be, but liked the plot with material capacity using different anions.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the PI seems to have sufficient resources to attack the difficult problems on multiple fronts.

First Principles Calculations and NMR Spectroscopy of Electrode Materials: Clare Grey (University of Cambridge) - es055



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer claimed that the PI is in the unique position that brings the in-situ nuclear magnetic resonance (NMR) techniques for better understanding the battery material behavior that often is difficult to characterize by other techniques. The reviewer wondered if the PI could look at other state-of-the art materials instead of the high-voltage spinel that has been well-studied by in-situ synchrotron X-ray probes in the literature.

Reviewer 2:

The reviewer emphasized that this was world-class work in the methodology of multi-NMR. The reviewer remarked that it was important for the researcher to keep in close contact with the battery community to be sure to be working on the most important problems to batteries. The reviewer explained that the technique was unique in revealing the details of the environment around the nucleus under study and that we are fortunate that Li has an isotope with reasonable abundance that has a nuclear magnetic moment that is available for study.

Reviewer 3:

The reviewer reported that NMR studies on these advanced electrode materials give the battery research community a unique chemical insight into their operation and degradation mechanisms. Further, the PI's focus on silicon materials is also pertinent. Finally, the reviewer asserted that the use of in-situ studies is very good.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer recognized that the NMR studies of solid electrolyte interphase (SEI) layers in collaboration with the electrolyte/additive specialist are good.

Reviewer 2:

The reviewer recounted that the work on Si lithiation has been very revealing of the mechanism for lithiation as a function of Li level. This person noted that the information developed on the SEI formation on litihiated silicon will be quite valuable in helping to design a high-energy silicon electrode with good cycling capability. The reviewer also explained that the work on high-voltage spinel is also revealing for determining the differences between the ordered and disordered forms of the material and the reflection on electrochemical performance differences. The reviewer mentioned that the work on tortuosity is novel and will be useful to electrode designers if the results are translated to the field.

Reviewer 3:
The reviewer explained that the PI chiefly utilizes NMR integrated with electrochemical and other diagnostic techniques, which adds a unique perspective on battery studies. Further, the PI has conducted a wide array of studies on a number of pertinent electrode materials. The reviewer recognized that the PI's focus on the Si and its SEI is very timely.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that the PI is known to have an extensive collaboration network that involves the best battery material scientists.

Reviewer 2:
The reviewer expressed that most of the collaborations are long-standing and well-developed. The reviewer suggested that it would be good to include some collaborators in the tortuosity field to highlight important problems in this field as well.

Reviewer 3:
The reviewer stated that the PI has an extensive list of collaborations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer simply remarked that the outstanding work was expected to continue.

Reviewer 2:
The reviewer indicated that the PI's future work is an extension of their present work.

Reviewer 3:
The reviewer asked whether the PI had any interest in ANL’s materials or coating materials.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

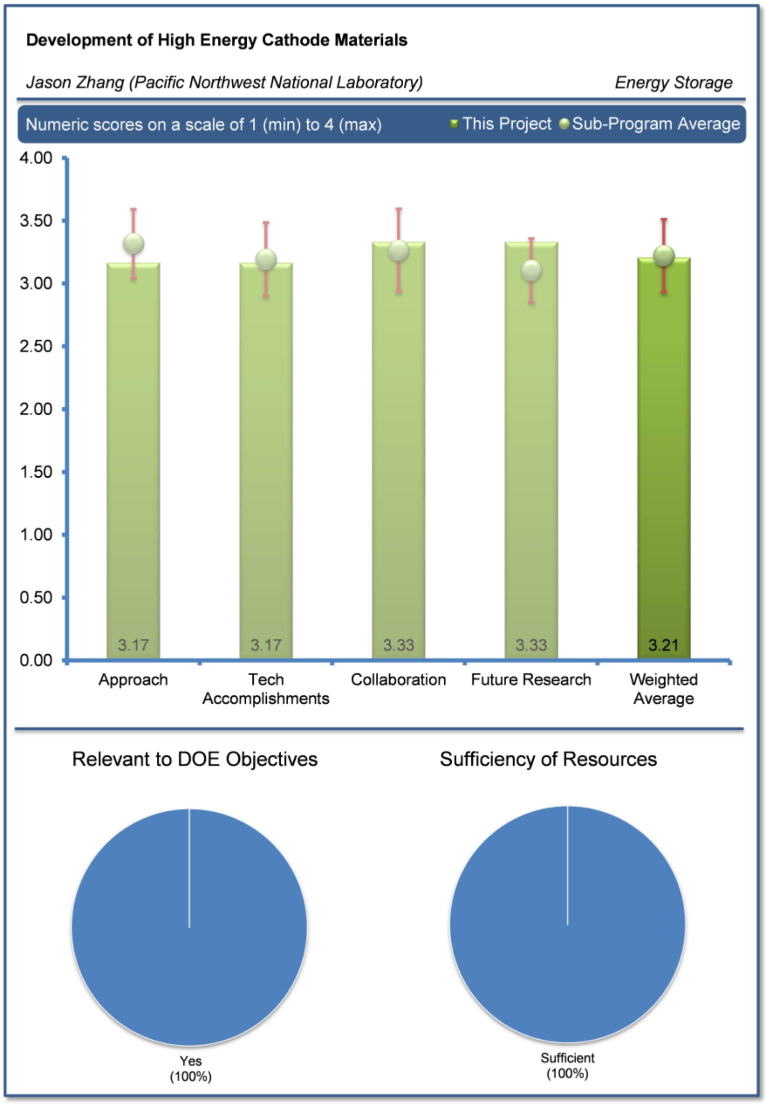
Reviewer 1:
The reviewer agreed that the work on Si and high-voltage cathodes and on diffusivity/tortuosity measurements is highly-relevant to battery issues.

Reviewer 2:
The reviewer praised that the PI is carrying out very relevant work, although the reviewer did not think the PI necessarily has made the best case for the importance of their work. The reviewer also noted that the relevance slide seems to have been an afterthought at the bottom of the overview slide.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that, based on the PI's productivity, the project seems to have sufficient resources.

Development of High Energy Cathode Materials: Jason Zhang (Pacific Northwest National Laboratory) - es056



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer described that Dr. Zhang's work has concentrated on the synthesis of lithium-manganese rich (LMR) layered composite cathode materials as a means to identify cost-effective approach to their commercial production. In particular, the PI has used advanced instrumental approach to better understand the failure mechanisms of the LMR cathode materials and develop electrolyte additives to improve the stability for long cycle life.

Reviewer 2:

The reviewer explained that the project objective is to understand the mechanisms contributing to the capacity loss of the LMR-LLC cathode materials and to improve their cycle life by modifying the electrolyte formulation, elemental doping of the cathode, and developing alternate low cost hydrothermal assisted synthesis of these cathode materials. The reviewer agreed that this project thus addresses one of the key performance barriers of the LMR-LLC cathodes, and adopts a viable approach and is well-integrated with the other efforts in understanding/mitigating the voltage fade. The reviewer expressed that it would be better to have this project coordinated through ANL for better synergy, based on the substantial effort being undertaken at ANL on various aspects of the LMR-LLC cathodes.

Reviewer 3:

The reviewer observed that the data indicates that synthesis routes or use of additives, although appearing beneficial to some degree, are some temporary measures to retard the eventual evolution of voltage decay or poor cycle-life.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer asserted that the improvements were good, but this person was not sure they will hold at elevated temperatures or in the course of long-term cycling. The project person praised that the analytical work the authors have carried out to identify the failure mechanism was quite good.

Reviewer 2:

The reviewer indicated that good progress has been made in understanding the performance fade of the LMR-LLC cathodes from the elemental distribution and the Ni segregation. The reviewer summarized that the cathode particles tend to fragment due to the stresses originating from the oxygen release, which in turn change the Mn valence form the bulk. The hydrothermal-assisted synthesis appears to reduce the problem of Ni segregation on the surface as well as the voltage fade to some extent. The reviewer also noted that the cycle life is also improved with this synthetic approach. The reviewer requested that the cathode loadings adopted here should be included (example on Slide 9). The reviewer noted that the LMR-LLC cycle life looks impressive, but only at low loadings. The reviewer also indicated that the cycle life improvements with the additive TPFPB (though not new), attributed to reduced SEI and the increased oxygen solubility, are encouraging. The reviewer pointed out that there were some good publications that emerged from this project. The reviewer reiterated an earlier comment that this project needed to be aligned with the ANL effort on the LMR-LLC cathodes.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer recognized that there were good collaborations with the other DOE laboratories and external university partners.

Reviewer 2:

The reviewer pointed out that Dr. Zhang followed the work at other institutions as well as the publications in the current literature, and as a result was a good source of information of the work in this field.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed work appeared to be quite extensive and well thought out. The reviewer proposed that modulating the Ni/Mn ratio or the use of additional dopants might be an effective route to fundamentally improve the LMR stability.

Reviewer 2:

The reviewer stated that the proposed work is in keeping with the need for improved performance from cathode materials.

Reviewer 3:

The reviewer described that the proposed future research is to continue improving the hydrothermal-assisted synthesis methodology with the objective of identifying the key parameters for layered-to-spinel phase transition, for example by optimizing the Ni/Mn ratio in LMR to balance the specific energy and cyclic stability. The reviewer reported that it was observed that the voltage fade appeared to be a minor component of the energy fade upon cycling, which the reviewer tends to agree with; the capacity fade is as serious a problem if not more. The goal remains to be a better understanding of the changes in the interfacial and bulk properties of the LMR-LLC cathodes during cycling. The reviewer concluded by stating that the future plans were consistent with overall goals of the DOE Applied Battery Research for Transportation program.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer emphasized that the low specific energies and high costs of Li-ion batteries are serious impediments to their widespread adoption in vehicles. LMR-LLC cathode materials are promising both from an energy and cost perspective, but are hampered by issues such as capacity and voltage faced upon cycling. The reviewer affirmed that it is essential to improve the cycle life of these high-energy materials to make them applicable for EV applications, as is being done in the present project.

Reviewer 2:

The reviewer expressed that, because of its very large capacity and potential low cost, work on LMR will go a long way in developing a long-life, low-cost battery.

Reviewer 3:

The reviewer indicated that the successful conclusion of Dr. Zhang's work will add significantly to the available knowledge of cathode materials and provide more options is selecting commercial electrode materials.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

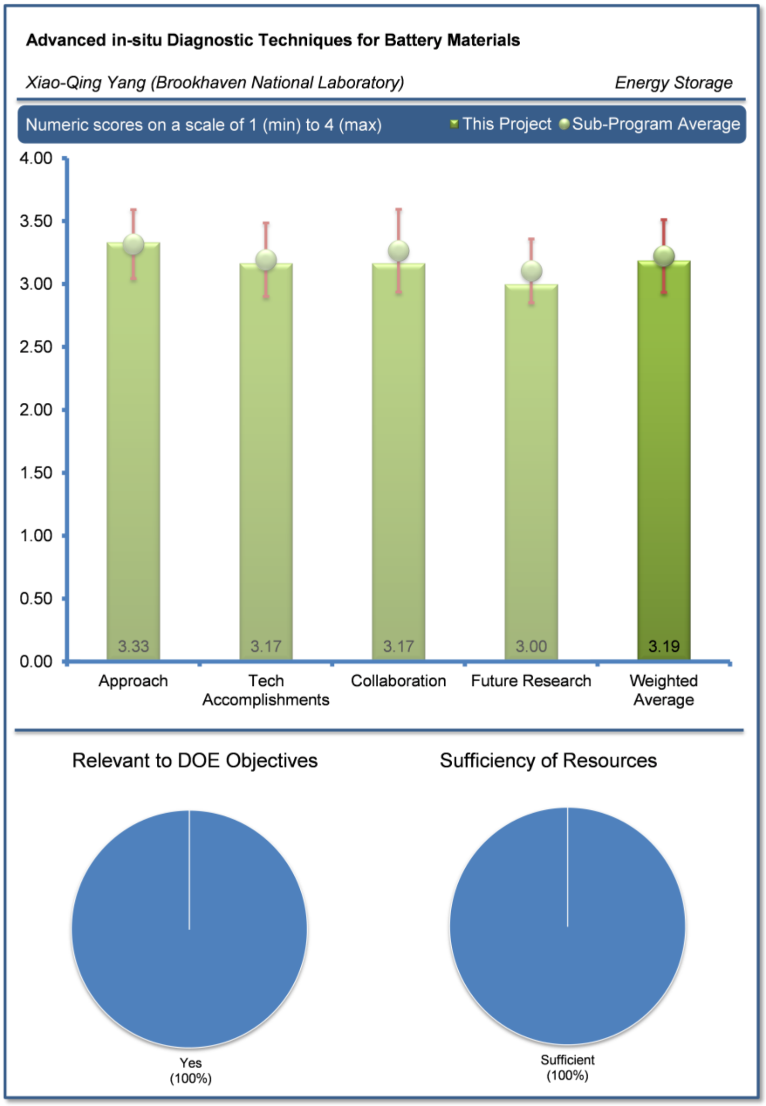
Reviewer 1:

The reviewer commented that the resources were reasonable and available for the success of the project.

Reviewer 2:

The reviewer stated that the resources were adequate for the scope of the project.

Advanced in-situ Diagnostic Techniques for Battery Materials: Xiao-Qing Yang (Brookhaven National Laboratory) - es059



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that monitoring oxygen generation during charging and discharging the cathode materials is an excellent approach to identify the operation voltage range for the given materials. The reviewer also commented that in-situ XRD and XAS are powerful tools for understating the battery chemistry that potentially address the issues the battery research community faces.

Reviewer 2:

The reviewer explained that the use of high- and low-energy X-ray beams at the BNL facility has proved to be very useful in determining structures of active materials at various stages of charge and discharge as well as time resolved studies which have been useful in determining kinetic factors is electrode reactions. The reviewer reported that the approach has been well-validated by the researcher and coworkers. The reviewer also pointed out that unique studies have been carried out by combining X-ray absorption studies in parallel with diffraction studies to advance the state-of-the-art. The project person recognized that the author has been able to develop important collaborations to ensure that key problems of interest to the DOE VTO program have been attacked. The reviewer reported that the closing of the BNL National Synchrotron Light Source will necessitate a revision of the work scheduling until the new light source is available; Dr. Yang is developing such plans according to a follow-up discussion.

Reviewer 3:

The reviewer commented that the PI has been studying pertinent electrode materials using mainly XRD and XAS, combined with electrochemical and thermal studies, for many years. The reviewer highlighted that the PI continuously works to expand the toolset used to examine these materials. The approach this year represents another solid year of studies.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that it can be better if full analyses of Extended X-Ray Absorption Fine Structure data are carried out. The reviewer also mentioned that this group has an excellent track record.

Reviewer 2:
The reviewer reported that the accomplishments have been excellent and have revealed interesting facts concerning the operation of Li excess materials, high-voltage spinel materials (including the important differences in properties of ordered and disordered materials).

Reviewer 3:
The reviewer claimed that this work seems to be similar to other XRD and XAS work being conducted under this program and elsewhere. The PI's extensive use of in-situ studies and mass spectrometry to detect released gasses are two aspects of this work that help make it special. The reviewer also mentioned that the PI's past experience with battery materials is another plus. The reviewer particularly liked the PI's discussion of the proposed mechanisms.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that this group has a good research network.

Reviewer 2:
The reviewer indicated that the researcher has fostered a number of long-term collaborators to keep up with the important battery problems. The reviewer noted that the PI recognizes that the collaborations need to expand the collaborations with U.S. industry and academic researchers, however and the reviewer agrees with this effort for the future.

Reviewer 3:
The reviewer said that the PI has collaborated extensively with several institutions around the world.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer simply stated that the PI proposed to continue the present studies.

Reviewer 2:
The reviewer wondered if the studies of voltage fade on the ANL material by in-situ XRD and XAS were organized with the ANL group (e.g., Croy's team).

Reviewer 3:
The reviewer explained that there were some uncertainties about future projects because of the closing of the light source. The reviewer pointed out that for some time it will be necessary for the group to travel to other synchrotrons in order to accomplish new studies; this will require considerably more planning. The reviewer also noted that the development of new collaborators will require careful thought to optimize the collaborative results.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that the work had good relevance to DOE objectives.

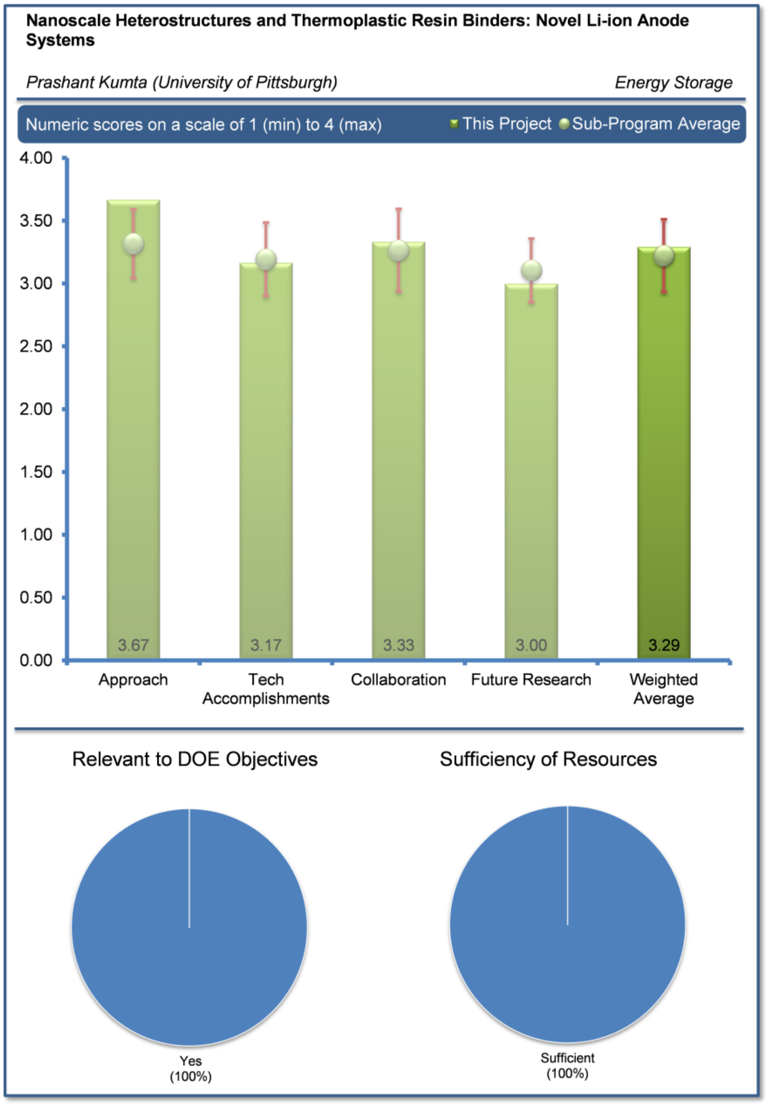
Reviewer 2:
The reviewer confirmed that these studies were very relevant, although the PI did not make a very good argument.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the sooner the new light source was available, the better the resources were for the kinds of studies to be carried out by this project.

Reviewer 2:
The reviewer remarked that based on the PI's productivity, the resources were adequate.

Nanoscale Heterostructures and Thermoplastic Resin Binders: Novel Li-ion Anode Systems: Prashant Kumta (University of Pittsburgh) - es061



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer simply stated that the approach is good and meaningful.

Reviewer 2:

The reviewer agreed that the technical approach was interesting, but suggested that the cost for h-SiNT may be a barrier for the potential commercialization of the material.

Reviewer 3:

The reviewer commented that the work presented targeted the specific objectives regarding improvement of the anode active material, and addresses the issues of the anode-binder-electrode structure interfaces.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that several types of Si, and or their composites, have been studied and the results are promising. However, the reviewer cautioned that some challenges remained such as the charge/discharge efficiency was still relatively low and the capacity decay was still high. The reviewer suggested investigating and understanding the correlation of the charge/discharge efficiency. Hopefully that will help to explain the correlation of the efficiency and the materials structure.

Reviewer 2:

The reviewer explained that the investigator selected two differing approaches to address the active material structure. The issue the reviewer had was that a clearer demonstration of the gaps against the DOE performance and cost objectives as a function of project progress would be beneficial.

Reviewer 3:

The reviewer described that h-SiNTs were tested at very high current rates (10 A/g) and showed a decrease in capacity in the beginning cycles compared to the other capacity measurements performed at (2 A/g) that showed an increase in capacity for up to 50 cycles and then decrease to a steady state. The reviewer asked how the loading in the electrodeposited films could be improved. This person also asked if any post-mortem analysis of high strength binder, especially PE and composite binders, had been done. The reviewer observed that the broad resonances in the region 3.0-4.2 ppm corresponding to the polypropylene polymer seemed to be shifted and enhanced after cycling.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that the collaboration was solid.

Reviewer 2:
The reviewer indicated that the collaboration had been improved.

Reviewer 3:
The reviewer suggested that it would have been helpful if the slides for reviewers to review had one or several bullet points talking about the contribution of the collaborators to this project. For example, the reviewer asked what Ford Motor Company's contribution was and how the company was involved in this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that several approaches had been proposed for the future work. The reviewer hoped a Go/No-Go plan with targets could be listed. The proposed coating approach may not solve the FIR decay problem completely if the broken electric contacts are the major issue. The reviewer asked whether it was possible to try any conductive binders in this project.

Reviewer 2:
The reviewer stated that the approach to future work was general. The reviewer described that the two approaches used for active material design led to two difference electrode designs, and with differing problems to be resolved. The PI should clarify which improvements applied to which method.

Reviewer 3:
The reviewer explained that the future research included improving the areal capacity of electrodeposited Si film by using stacked multilayered composite electrode of [a-Si/C/]n. The reviewer suggested that adhesion of the films should be considered. The reviewer also suggested that the researchers considered improving the electronic conductivity of the binder.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that the objective of this study was to investigate Si anodes as a potential graphite anode replacement for increased battery energy density.

Reviewer 2:
The reviewer praised that the project was a solid example of innovation; success in this area would support the delivery of higher energy density cells.

Reviewer 3:
The reviewer commented that the project reduced the consumption of fossil fuel resources and pollution.

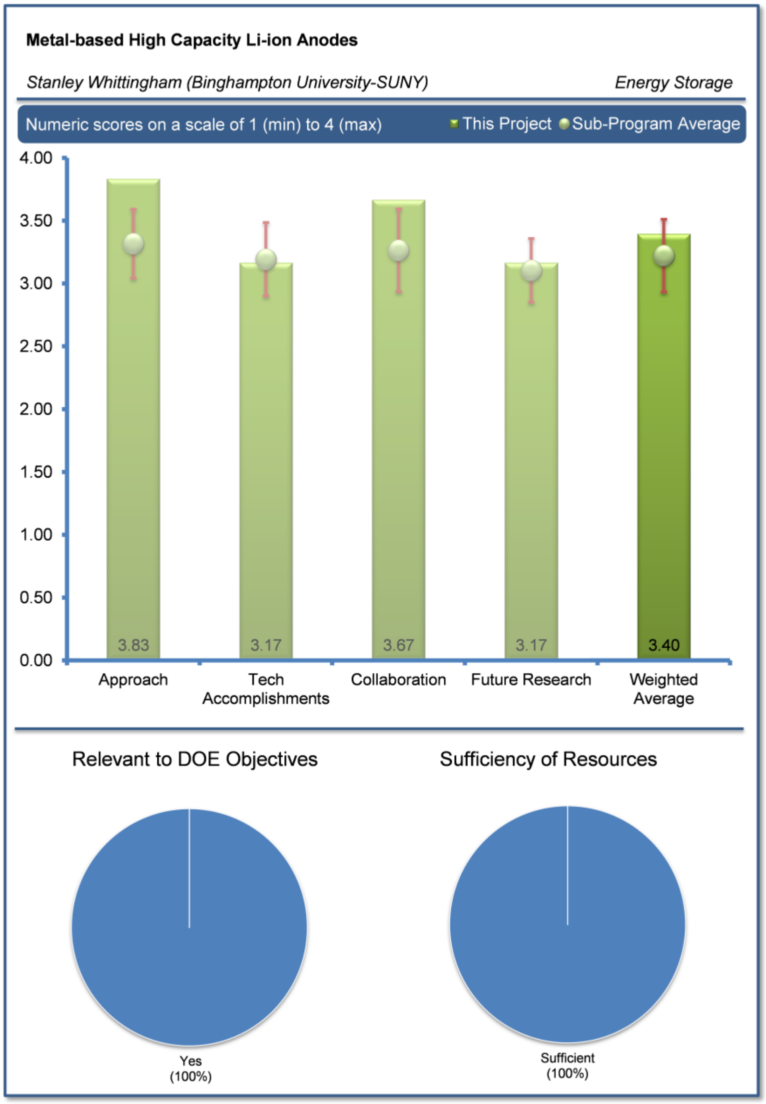
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that it appeared the researcher had sufficient resources and collaborators to conduct the proposed research.

Reviewer 2:
The reviewer noted that the overall program management was sound, and that the resources appeared to have been managed appropriately.

Reviewer 3:
The reviewer reported that the resources were sufficient for the project.

Metal-based High Capacity Li-ion Anodes: Stanley Whittingham (Binghamton University, State University of New York) - es063



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the work addressed a critical barrier to increase anode volumetric capacity and gravimetric capacity as well as the anode.

Reviewer 2:

The reviewer described that the applied technical approach demonstrated a good example of multivariate design approach. The reviewer was interested to see the PI's recommendation for the most promising of all routes employed.

Reviewer 3:

The reviewer observed a good approach, and inquired about how good the Sn-Fe-C composite is compared to Sn-Co-C.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer praised that this project has so far achieved goals that surpass the original goals; for example, 2.0 Ah/cc had been achieved when compared to 1.6 Ah/cc of original goal. It was unclear to the reviewer what the volumetric capacity and gravimetric capacity were at a higher rate.

Reviewer 2:

The reviewer observed that the results of the work address energy density (specific capacity), cyclability, and general stability, but that calendar life and cost have yet to be addressed. This person also stated that it would also be beneficial to see the supporting calculation for the claim to a potential 50% improvement in cell energy density.

Reviewer 3:

The reviewer indicated that a comparison slide for all the methods with capacity would be helpful, instead of switching back and forth between volumetric capacity and specific capacity for tin (Sn), Sn-Fe, Sn-Fe-C composite. In the methods of mechanochemical synthesized Sn-Fe-C and solvothermal synthesis of Sn-Fe composite, the reviewer asked how much carbon is involved and how does the carbon content affect similar to tin in Slide 11. The reviewer also asked what the reason is for the better capacity when Sn-Fe composite ratio is 5:1.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that this project has a strong collaboration with other institutions.

Reviewer 2:
The reviewer reported no issues.

Reviewer 3:
The reviewer indicated that the collaboration was good.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer suggested adding the cycling performance versus rate in the go/no-go targets.

Reviewer 2:
The reviewer suggested that the PI investigate more closely the cost-related claims (with support from an external resource, potentially a battery maker), as well as the technical viability for material scale-up (paper study, not demonstration).

Reviewer 3:
The reviewer explained that graphite converts to active carbon reacting to give LiC_2 was mentioned; this might enhance the SEI layer formation similar to carbon. In addition to determining the impact of carbon-type, the reviewer suggested that the amount of carbon used should also be considered.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the work addressed battery energy density and specific energy improvement by addressing critical barriers to improve anode volumetric capacity and gravimetric capacity.

Reviewer 2:
The reviewer commented that this anode work had good potential in improvement of cell energy density and safety, and potentially cost.

Reviewer 3:
The reviewer agreed that the project targets reduced petroleum use and emissions.

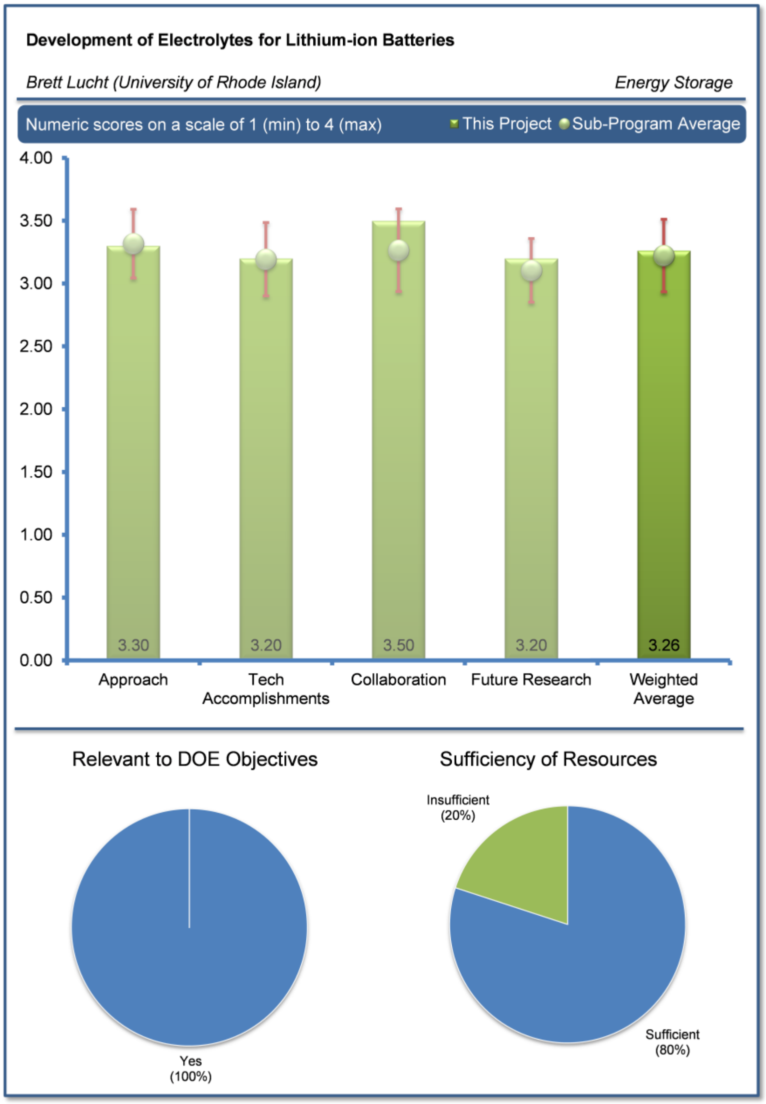
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that there were sufficient resources allocated for this project.

Reviewer 2:
The reviewer reported that the good management of resources, as well as program management. No issues in the management of the project were observed.

Reviewer 3:
The reviewer said that sufficient resources were available for the project.

Development of Electrolytes for Lithium-ion Batteries: Brett Lucht (University of Rhode Island) - es067



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer asserted that the investigator was one of only a few researchers in the electrolyte field and continued the high performance and excellent science applied to battery related materials. The reviewer confirmed that new stable electrolytes were essential for continued development of high-performance electrode materials; adding that the work has concentrated on electrolytes for cells with high-performance silicon anodes. The reviewer explained that the approach was to use ex-situ surface analysis to understand the interaction of the anodes with the electrolyte and develop an understanding of the using FEC and VC. The reviewer said that the initial results are very promising.

Reviewer 2:

The reviewer expressed that the refocus on the SEI was important. The reviewer also noted that the technical barriers were addressed properly.

Reviewer 3:

The reviewer applauded that the team has done an excellent job on the initial screening of the effects of different additives on SEI formation on Si anodes in a very short period of time. The reviewer recognized that the team understands that the systematic approach is necessary to optimize the composition. The reviewer commended that the team is using different thicknesses Si electrodes to study effects of electrolyte formulations; this is very important to continue and provide reasons for the difference in performance.

Reviewer 4:

The reviewer asserted that a well thought-out approach is being taken to address the technical barriers that limit electrolyte performance for silicon-based anode systems. The PI will study the mechanism of improved capacity retention for Si nanoparticle electrodes in the presence of various electrolyte additives such as FEC and/or VC. The reviewer suggested that it would have been good if there were information regarding the experimental techniques. The reviewer was also concerned that contamination may happen when transferring the electrode sample to the scanning electron microscope (SEM), XPS, and Fourier Transform Infrared spectroscopy (FTIR) devices which may significantly change the results.

Reviewer 5:

The reviewer offered that the PI's strength is in their expertise of chemical synthesis, not for electrochemical chemical testing or surface physical analysis. It seemed to this person that the project was not sufficiently designed for leveraging the PI's strength.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer reported that new high-performance electrolytes were identified and evaluated and that the work has concentrated on the study of the electrolyte composition and additives effect on the structure of the SEI on the silicon particles. The work has related to understanding the effect of the volume changes on charge and discharge on the anode performance. The reviewer explained that the effect of various electrolyte additives leads to greater stability and longer cycle life.

Reviewer 2:
The reviewer reported that the PI has studied the electrolyte with the addition of FEC and VC, and has performed electrochemical and ex-situ analysis for the anode surface. The reviewer indicated, however that limited information for the reaction mechanism was provided due to the lack of in-depth analysis (e.g., alternating current [AC] impedance).

Reviewer 3:
The reviewer affirmed that the investigator made good progress this past year. The cycling performance of electrolytes with different concentrations of added FEC and/or VC was investigated. The reviewer reported that the optimal electrolyte formulation for cycling Si anodes was found to be 10% FEC in 1.2 M $LiPF_6$ and 1:1 EC/DEC. Surface analyses of the electrodes were also performed using SEM, XPS, and FTIR.

Reviewer 4:
The reviewer pointed out that the team was recently redirected to study the SEI on Si anodes, so given the time spent on the project, only background work was completed that should become a foundation to addressing DOE goals. The reviewer reported that very interesting findings were identified on the mixture of FEC/MEC and the effect of Li salt/polymer ratio on the SEI stability needed to be systematically studied.

Reviewer 5:
The reviewer cautioned that it was not clear why the electrodes cycled with less additives had much less cracking. The reviewer emphasized that it was important to understand this problem so better electrolytes could be designed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer described that the work has concentrated on developing a clear understanding of the effect of electrolyte additives on anode performance leading to developing the best electrolyte composition for the Si anode structure. The reviewer applauded the excellent cooperation; highlighting that samples supplied to other programs have added to the progress.

Reviewer 2:
The reviewer agreed that the collaboration was outstanding and that the team has had a good combination of people from academia and industry.

Reviewer 3:
The reviewer praised that the collaborators were well-suited for the research. The reviewer suggested that the PI should demonstrate the contribution of each collaborator.

Reviewer 4:
The reviewer recognized that the PI had assembled a good team of investigators to accomplish their goal. The reviewer detailed that the team includes members from BASF, LBNL (both the High-Voltage Spinel Focus Group and Silicon Focus Group), Yardney Technical Products, ANL, and the National Aeronautical and Space Administration Jet Propulsion Laboratory. The reviewer stated that this should ensure that the electrolyte being developed was the best material for the electrochemical couple that the DOE had been developing.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer explained that the future research would develop a mechanism for the interaction of the electrolyte on silicon anode materials on cycling, as well as a mechanism for capacity retention on cycling.

Reviewer 2:
The reviewer asserted the very good understanding of the challenges, particularly the reactions of the electrolyte with the surface of the lithiated silicon. It would be interesting to the reviewer to see if the researchers could do investigation on ex-situ pre-lithiated silicon anode to separate complex data interpretation based on the full cell studies.

Reviewer 3:
The reviewer noted that this was the final year for the project and that the work would be completed in the final months and a manuscript would be submitted for publication.

Reviewer 4:
The reviewer hoped that the authors at some point would propose a mechanism that would be able to explain the beneficial properties of added VC and FEC on the SEI. The reviewer highlighted that that should help in the guidance for future research.

Reviewer 5:
The reviewer proposed that the PI should focus on synthesis of new additives, salts, and solvents, and not on the physical and electrochemical analysis, which were not in the area of the PI's expertise.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that high conductivity, stable electrolytes and high capacity anodes were critical to the use in batteries for powering automobiles.

Reviewer 2:
The reviewer agreed that the project supports the overall DOE goals and that electrolyte investigation is critical for the development of high energy Li or Li-ion batteries for transportation technologies.

Reviewer 3:
The reviewer confirmed that in order to meet DOE's goals, a new electrochemical anode such as Si will be necessary. Thus, according to the reviewer, it is highly-relevant to investigate electrolyte to determine the best system for cycling Si.

Reviewer 4:
The reviewer agreed that enabling advanced anode materials was necessary for EVs to succeed.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

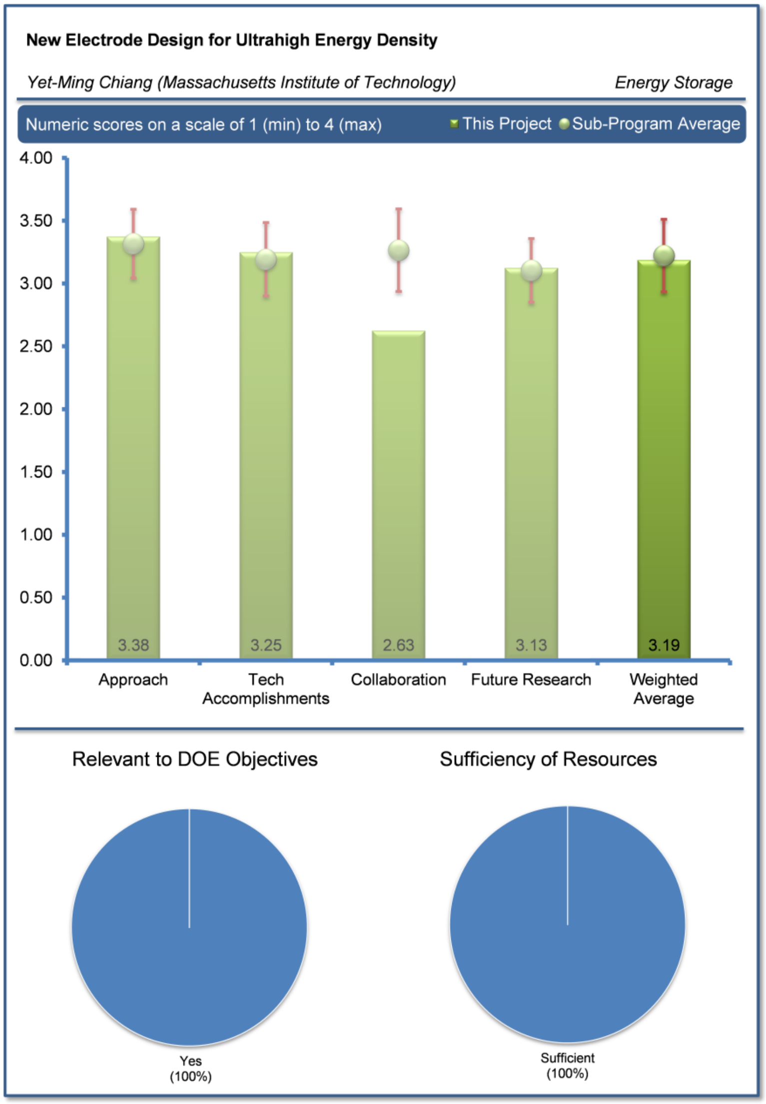
Reviewer 1:
The reviewer commented that the total project funding appeared to be appropriate.

Reviewer 2:
The reviewer stated that the resources were adequate for the present work schedule.

Reviewer 3:

The reviewer commented that the PI should have focused on the chemical synthesis of new compounds either additives or salt or solvent, in which area the PI has adequate resource and expertise.

New Electrode Design for Ultrahigh Energy Density: Yet-Ming Chiang (Massachusetts Institute of Technology) - es071



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that this was a fascinating approach that may result in a nearly ideal electrode structure, promoting the ionic conductivity. However, it was not quite clear to this person on how to enhance the electronic conductivity for materials with low intrinsic electronic conductivity.

Reviewer 2:

The reviewer offered that this is an interesting and very innovative approach to make high aspect ratio electrode structures. Moreover, it would seem both easy to scale and relatively inexpensive. The reviewer noted the researchers' that the use of blocking electrodes and impedance to measure ionic and electronic conductivities is also very good. The reviewer also explained that the researchers were using a good filtering process to select those materials that could best benefit from this fabrication method and which ones to drop from consideration, rather than trying to force fit every material into their technique.

Reviewer 3:

The reviewer agreed that the approach to develop a more efficient electrode structure was important from a technical standpoint. The reviewer also anticipated that the likelihood of achieving higher energy density than with conventional structures is also excellent. However, the reviewer stated that complications of the process (LN_2 cooling, careful handling and control) may make the process too expensive for the cost goals of the DOE program. The reviewer suggested that it would be useful for the PI to begin to investigate modified processing to enhance the utility of the method; for example, the sintering step may not need to be as complete as presently done leaving some internal porosity that could conceivably be filled with an electronic conductor, at least to some extent. This would make the requirement of excellent conductivity of the base material less important, although it would compromise to some extent the electrode loading. At present, it appeared to the reviewer that 10 times the conventional loading could be achieved with this technique (as shown for LCO), but perhaps five times the loading would still represent a major step forward in improving energy density. The reviewer noted that the PI alluded to this in the remaining barrier slide where they discussed the results of calculations showing the need for microporosity in the lamellae.

Reviewer 4:

The reviewer agreed that increasing the area capacity through electrode thickness was a great approach to impact battery specific energy and energy density. The reviewer also noted that being able to eliminate binders and carbon additives was an added advantage which the reviewer stated the PI has some unique ideas to accomplish this. While the concepts are unique, there did not seem to this reviewer to be any cost-benefit analysis to these studies. The reviewer recounted that the primary issue with thick electrodes was the current distribution throughout the electrode during constant current discharge; specifically, the electrolyte cannot support the current. The reviewer criticized that there did not seem to be a plan, at least this year, to discharge the electrodes at significant C-rates (i.e., C/3 and higher). The reviewer also indicated that because there was not any conductive carbon additive and that these oxides did not have a high electronic conductivity, the PI was correct to be concerned about electronic conductivity effects.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that it would be more interesting to see the performance as the electrode, particularly the cycle life, since it is questionable how robust the structure is upon cycles in which the electrode material undergoes expansion-contraction cycles. The reviewer highlighted that the enhanced ionic conductivity can be obviously expected for such a structure. The reviewer also cautioned that the current data concerning the capacity at the low rate is not impressive.

Reviewer 2:

The reviewer indicated that the PI had shown excellent results to date with the good conducting LCO. The reviewer also reiterated that the poorer conducting NCA would clearly need thinner lamellae as discussed by the PI. The project person described that the methodology had also allowed the measurement of intrinsic properties such as electronic conductivity, ionic conductivity and tortuosity.

Reviewer 3:

The reviewer observed that the PI spent a lot of time measuring conductivity and diffusion rates in the solid active material phase of the electrodes; while these were important values, it was more important to see what C-rates the thick electrodes will support. Also, the reviewer did not see what electrolyte the PI was using, but noted that the transport of Li ions in the electrolyte did not seem to be important to the PI.

Reviewer 4:

The reviewer described that the researchers have successfully used the method to make pillar-like electrodes that have very low tortuosity. The reviewer pointed out that the researchers' measurements of the change in conductivity and ionic diffusivity for NCA as a function of state of charge was also very worthwhile, however this person was not sure how new this information actually was. The reviewer also indicated that the initial samples did not show the rate performance the researchers were going after, but acknowledged that there was a plan to reach the targets.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer would have liked to see some collaboration developing between the group and either a national laboratory group interested in battery engineering or an industrial partner.

Reviewer 2:

The reviewer agreed that the researcher probably did not need much collaboration for now, but if successful, that this would need to be brought into the cell validation program at ANL. The reviewer recognized that not every project needed a lot of collaboration, so did not see why this is factored into a total score.

Reviewer 3:

The reviewer simply indicated that the PI had a few collaborations.

Reviewer 4:
The reviewer agreed that it was very important to examine the electrochemical performance.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer requested that the researchers show more electrochemical data including the rate capability.

Reviewer 2:
The reviewer voiced that the focus on the critical barriers seemed to be developing. The reviewer proposed that additional considerations, such as suggested in the review on the approach could be quite helpful.

Reviewer 3:
The reviewer agreed that the PI had a good plan that included testing to the United States Advanced Battery Consortium (USABC) protocols and starting work on a negative electrode.

Reviewer 4:
The reviewer reported that the researchers planned to try and go thinner and also to thin the space between the electrode pillars to permit the electrolyte to penetrate.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer asserted that intrinsic energy density of materials could be greatly enhanced by clever electrode structures such as this work.

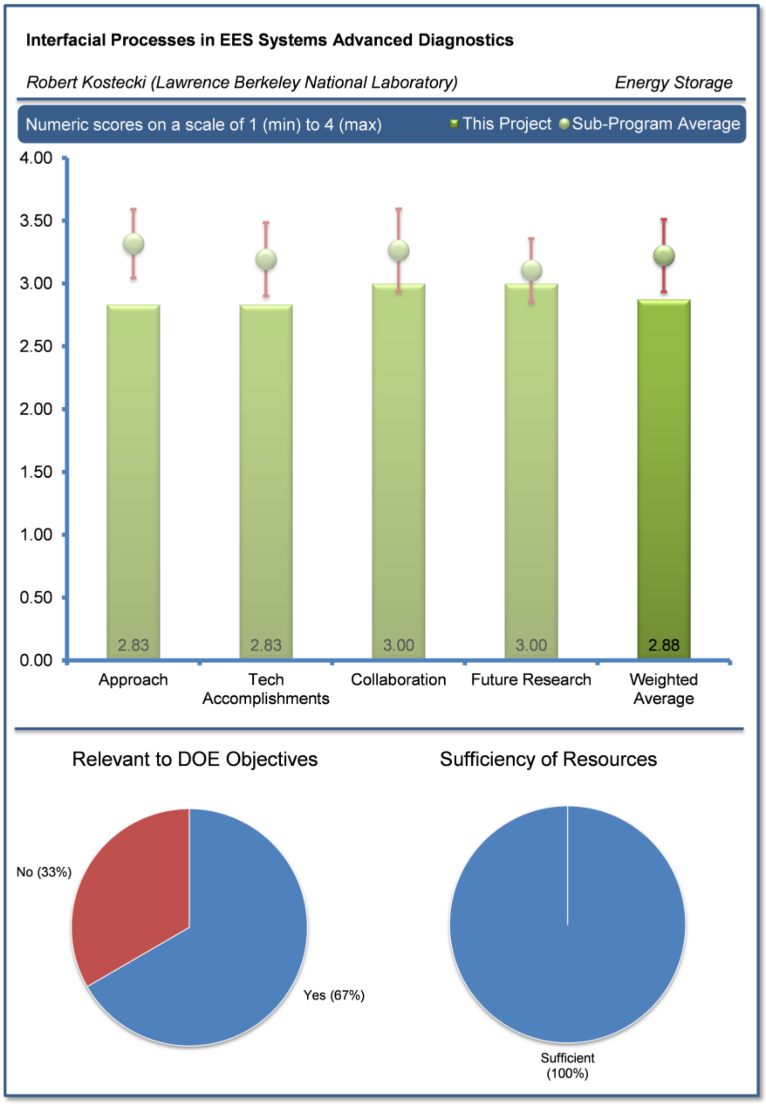
Reviewer 2:
The reviewer explained that this work, if successful, promised to yield thick electrodes that could also be charged and discharged at high rates, which addressed a critical factor in trying to achieve both high energy and high power for HEV and PHEV cells. The reviewer also stated that, as the researchers were aware, the method may be somewhat limited to materials that are good or at least not bad electronic conductors.

Reviewer 3:
The reviewer agreed that overall, the project was very relevant.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that, based on the productivity of the PI, sufficient resources seemed to be available.

Interfacial Processes in EES Systems Advanced Diagnostics: Robert Kostecki (Lawrence Berkeley National Laboratory) - es085



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer described that, in general, the PI applies spectroscopic techniques in-situ and ex-situ in conjunction with electrochemical studies to examine the SEI on pertinent electrode materials. The reviewer stated that the PI has been conducting these studies for many years and generally has expanded the diagnostic tools.

Reviewer 2:

The reviewer commented that the use of spectroscopic methods to study the interfaces of active materials to infer the direction of parasitic reactions is well-developed. The reviewer would like to see some more detail, however, on the approach used in this contract. The reviewer asserted that many of the slides were very general and similar to those of the previous year.

Reviewer 3:

The reviewer described that many spectroscopic and imaging techniques were applied to examine electrode materials; however, no clear understanding and goals appear to have been defined.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer found the PI's studies using fluorescence unique and worthwhile. The reviewer also said it will also be interesting to see where the PI goes with the Li alloy studies.

Reviewer 2:

The reviewer criticized that lots of data were thrown in, but the project did not provide new findings beyond information that was available in the literature. The reviewer also expressed that in the SEI layer that contains products of electrolyte oxidation by oxidized transition metals (e.g., Mn(IV) and Ni(IV) during charging), the presence of Ni(II), Mn(II), and Mn(III) were easily expected.

The reviewer also criticized that the interpretation of some data (Slide 19) was not convincing, for example the electrode size was not specified, but currents instead of current densities were plotted. Thus, it was not clear if the peaks were due to surfaces or bulks. The reviewer offered that, rather than oxidation of electrolyte, the reduction peaks can be due to reduction of surface oxides. This person also asked if there was any Li UPD on Sn. The reviewer concluded by asking what new findings or contributions were accomplished.

Reviewer 3:

The reviewer stated that the accomplishments seemed to be mainly a continuation of the previous year's studies, as shown by the similarity of the presentations. It was not very clear to this reviewer what had been accomplished in the current year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer simply stated that the researchers presented a good research network.

Reviewer 2:

The reviewer indicated that the collaborations were good, but the reviewer would like to see some stronger interaction with electrochemists working on EV battery problems to keep the work grounded.

Reviewer 3:

The reviewer stated that the PI had a few collaborations outside the organization.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the degradation of the high-voltage spinel is due to the reaction associated with electrolyte and instability of the material itself (e.g., oxygen evolution from decomposition). The reviewer asked what the SEI poisoning was and requested that the researchers please show how the high-voltage spinel is "poisoned" because this was not clear. The reviewer asked if the SEI layer is slowing down the charge-discharge processes. The reviewer suggested using more practical approaches and clear data presentations for better and wider contributions.

Reviewer 2:

The reviewer observed that the future work was practically identical to 2013.

Reviewer 3:

The reviewer commented that the PI was proposing to continue these studies; specifically, that the PI was going to attack several challenging problems.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that the relevance of this work was clearly demonstrated.

Reviewer 2:

The reviewer observed a lack of focus and commented that too many different techniques were thrown in; lacked a focus.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

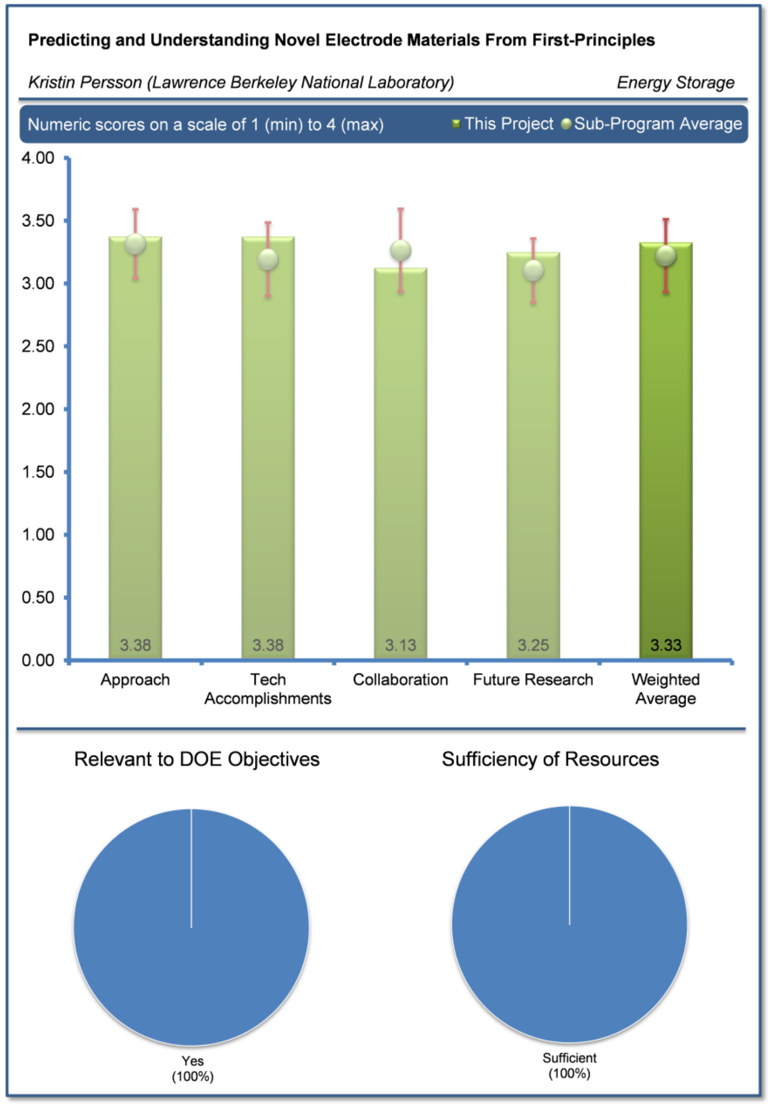
Reviewer 1:

The reviewer stated that, based on the productivity of the PI, the funds were sufficient for the project.

Reviewer 2:

This reviewer admitted to not having a clue.

Predicting and Understanding Novel Electrode Materials from First-Principles: Kristin Persson (Lawrence Berkeley National Laboratory) - es091



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This is an excellent use of computational modeling to understand the key problem inherent in the Li_2MnO_3 cathode material, in the opinion of this reviewer, and a good use of activation energy to estimate the likelihood of a reaction actually occurring versus just looking at the thermodynamic driving force.

Reviewer 2:

The reviewer considered investigation of Mn migration from the Mn layer to the lithium (Li) layer to be very important and critical to understanding the mechanism of failure in these types of cathode powders. It will be a big plus if the research can be expanded further so that these results are used as guidance for the experimentalist, the reviewer said.

Reviewer 3:

The reviewer found the approach very interesting and felt that the results provided good insight into the structural evolution with charge-discharge cycles. However, the reviewer noted, this computational study is based on the bulk structures, while many electrochemical aspects of the material's behavior in the LIB environment are dominated by the SEI layers.

Reviewer 4:

The reviewer said the PI's approach to theoretical examination of Li_2MnO_3 during cycling to determine the implications for lithium- and manganese-rich (LMR) electrode materials was a good idea at the time. Recent experimental evidence, however, seems to indicate Li_2MnO_3 domains in LMR-NMC cycle behave quite differently from the pure compound.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer found it difficult to correlate the computational results of Accomplishment 4 with experimental results, since the experimental results are for the material with x greater than one and the phase separation in the calculation occurs at less than 1. Trapping Mn in the Li layer appears to be reversible according to calculations, the reviewer observed, since the Mn defects are no longer favorable in energetics at x=1, which does not explain the voltage fade. Identifying the possible migration paths should be useful in considering degradation mechanisms, the reviewer concluded.

Reviewer 2:
The PI has several interesting results concerning overall structural stability and manganese migration, the reviewer said.

Reviewer 3:
The reviewer urged that the dumbbell path be investigated further, since it seems to be a fairly new phenomenon. Further understanding of this pathway is desirable, the reviewer said, to see if it represents a new variable by which Mn migration can be suppressed.

Reviewer 4:
The reviewer expressed the opinion that this modeling effort basically explains that manganese migration into the lithium layer at high states of charge is the main issue related to the fade of this material in cells and called this finding absolutely critical. It is very hard, the reviewer observed, to solve a problem without being clear about its true nature and this work provides that knowledge. The reviewer elaborated with the observation that this work suggests surface treatments are unlikely to make any improvement in cycle life for this material. Discussions with other PIs, the reviewer said, suggest this is indeed the case for pure Li_2MnO_3, but the Envia Systems work shows advantages for atomic layer deposition (ALD) on the mixed layered material. So it appears that the findings of this work perhaps address only one of the degradation mechanisms of the layered-layered material. The reviewer found it interesting that the mechanism defined is counterintuitive in that the oxygen changes oxidation state rather than the transition metal ions.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said it was good to see collaboration with experimentalists.

Reviewer 2:
The reviewer noted that the project has a few collaborations outside its own organization.

Reviewer 3:
Important collaborators are in place, the reviewer said, in particular with experimentalists.

Reviewer 4:
The reviewer was unsure if this project required much collaboration to run the modeling, but was unwilling to mark the project down for lack of collaboration, despite knowing that the Annual Merit Review (AMR) rating system calls for that. The reviewer urged that this work be disseminated and leveraged by the experimentalists in the DOE community, but had the impression others were unaware of it or perhaps unpersuaded because it is only modeling. The reviewer considered it very important that experimentalists follow up on any new insights this work generates on possible solutions, but was concerned that this might not happen unless the work were more widely reviewed and critiqued within the DOE program. This concern was somewhat moderated by the Envia Systems presentation in which this modeling work was at least acknowledged, the reviewer said, although it seemed it had been ignored by the Argonne group. If there is a disagreement, the reviewer went on, resolve it as a team using science, logic and data. Perhaps the PI needs to force the issue, the reviewer concluded, but in any case, management should ensure they fully capitalize on good work such as this.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer wondered if it would be possible to look at the SEI layers.

Reviewer 2:
Noting that the PI is moving to study LMR-NMC materials, the reviewer said it will be interesting to see how the composite structure is approached.

Reviewer 3:

Deeming future research plans excellent, the reviewer described the next steps as attempting to determine whether Mn migration can be blocked by using dopants to pin the Mn in place and prevent the structural change. In essence, the reviewer said, leverage their new-found knowledge and the ability to rapidly model the effects of such doping on the stability of the structure. The reviewer recommended that any success in this area be prioritized by experimentalists to see if it really works.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The PI's work is very relevant, the reviewer said, although a great case for its importance had not been made.

Reviewer 2:

This work addresses one of the most important issues facing implementation of the high energy cathode Li_2MnO_3 that forms part of the layered-layered cathode material.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

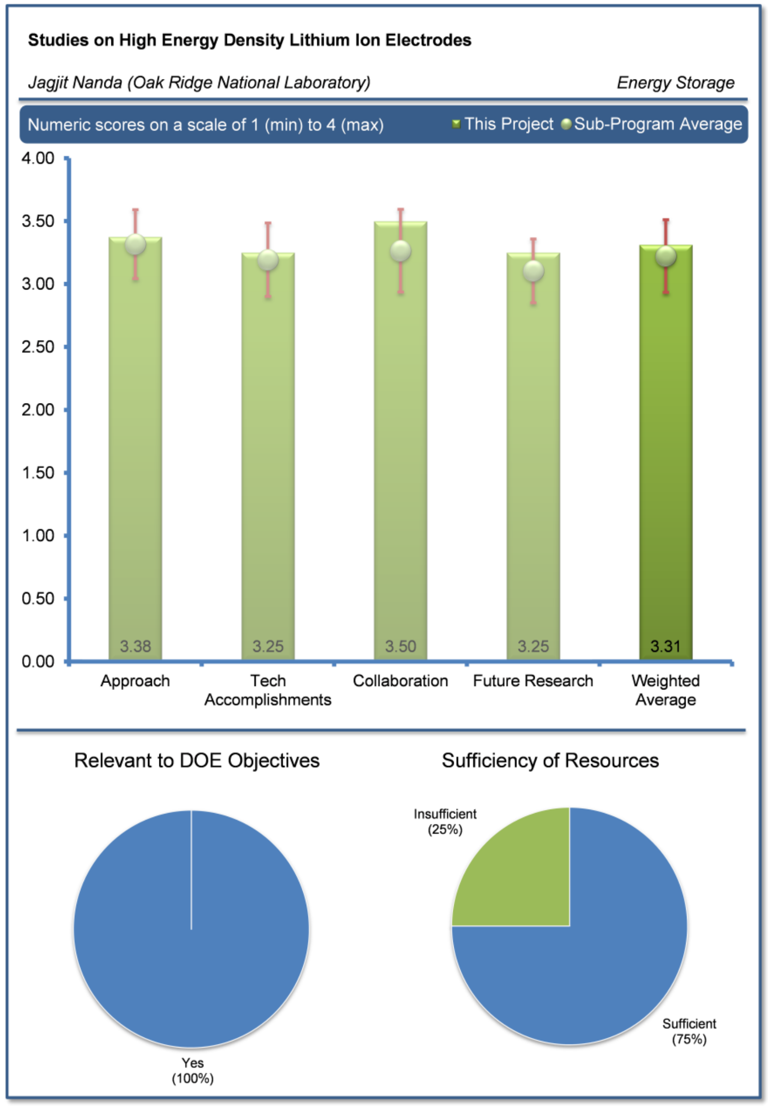
Reviewer 1:

The reviewer wondered if all computations are carried out by the presenter or if the presenter needs additional hands.

Reviewer 2:

Based on the PI's productivity, the reviewer said, funds are sufficient to support the effort.

Studies on High-Energy Density Lithium Ion Electrodes: Jagjit Nanda (Oak Ridge National Laboratory) - es106



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

In the opinion of the reviewer, the program entails a comprehensive but excessively ambitious approach to solving far too many problems, including a new synthesis of high- capacity cathode, which by itself is a huge project.

Reviewer 2:

The reviewer cited some project aims, including developing methods and diagnostic techniques such as Raman mapping, x-ray absorption near edge spectroscopy (XANES), etc. and studying surface morphology/structure on LMR-NMC cathode materials to better understand capacity loss on cycling. The reviewer noted that transmission x-ray microscope (TXM)-XANES studies revealed changes in the Mn oxidation state that correlate with voltage fade.

Reviewer 3:

The reviewer said that the approach seemed to be feasible and is consistent with the overall program goals, but deemed the effort rather diffuse, noting that it ranged from material-related studies (bulk to interface), with electrolyte additives and surface coatings, to multi-electron cathodes. The reviewer listed the project objectives as including utilization of new diagnostic techniques to understand the life-limiting mechanisms of high-voltage cathodes, including the local inhomogeneities and correlating performance with the material properties (crystal structure and morphology; evaluating high-voltage electrolyte additives and solid electrolyte coatings (LiPON) for improving the cycle life of LMR-LLC cathodes; and designing new syntheses of high-capacity cathodes. The reviewer remarked the use of Micro-Raman mapping to monitor the inhomogeneity in state-of-charge during cycling, and X-ray imaging and spectroscopy (XANES) for three-dimensional elemental mapping and tomography of cycled LMR-NMC cathode particles.

Reviewer 4:

The reviewer noted that different image techniques were used for mapping particle morphology and valence state and found the tomographic reconstruction using XANES particularly interesting.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Overall, the reviewer said, the progress is good and consistent with the DOE goals. There were some interesting and useful accomplishments presented in understanding the bulk and morphological changes in the LMR-LLC cathodes, the reviewer went on.

Noting that correlation of the oxidation state of TM cations (manganese) to the onset of voltage is not new, the reviewer nonetheless pointed out that it substantiates the findings of previous DOE researchers, although the results are not entirely consistent. To support that observation, the reviewer noted that these results point to the decrease of all three TM concentrations in the surface, contrary to Zhang's finding of surface–enrichment of reduced Ni. The reviewer also found the use of micro-Raman mapping interesting, but questioned the conclusion of PF_6- intercalation at less than 4.8V into carbon (diluent). The study with LiPON the reviewer judged to be promising and approved of its being scaled up. The reviewer felt that some questions from previous reviewers on the efficacy of coating electrode vs. particle had not been properly answered. The benefit from various high-voltage electrolyte additives on cycle life the reviewer called encouraging, but wondered what the electrode loadings were and cited the need for them to be comparable to the current values for NCA cathodes. The performance of multivalent cathodes, the reviewer felt, is too preliminary to permit an assessment.

Reviewer 2:

It is not expected that additives will solve the cycle-life/voltage fade issues, the reviewer said, since they are not predominantly related to surface phenomena. The reviewer then inquired about justification for all the work on additives. The PNF-2 additive apparently looks good, the reviewer said. The diagnostic work using XANES tomography, in the reviewer's judgment, appears quite informative and will certainly help to expand our knowledge about the failure modes of these cathodes. SOC-dependent analytical studies are also novel. But in general, the reviewer concluded, there is nothing significant in this cathode work, as multiple groups are working on these types of low-voltage cathodes and the uniqueness of each approach is not obvious.

Reviewer 3:

Changes in the oxidation state of Mn on cycling have a strong correlation with voltage fade on cycling, the reviewer stated. Also, the change in morphology-oxidation state of cathode particles on cycling gives rise to a change from spherical to an oblong particle, the reviewer observed questioningly, and cathode materials with capacity of over 200 mAh/g were synthesized.

Reviewer 4:

The result of electrolyte additives was not surprising, the reviewer said. New cathode material $Li_2Cu_{0.5}Ni_{0.5}O_2$ showed poor cyclability and a poor voltage profile, the reviewer observed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer called the team a great collaborative team.

Reviewer 2:

There has been a strong, deliberate effort to coordinate with the Army Research Lab (ARL), ANL, LBNL, Ford Motor and Tennessee Tech on various parts of this activity, the reviewer said.

Reviewer 3:

There are good, ongoing collaborations with the other DOE laboratories, a university, and Department of Defense (DOD) researchers, the reviewer said.

Reviewer 4:

The reviewer observed that the project team works with ARL on electrolytes.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer expressed the opinion that the project should still be on novel diagnostic studies and less on these $LiMM'O_3$ compounds, which in the reviewer's view, show very little promise.

Reviewer 2:

The reviewer summarized the future work by noting that it will include Raman and X-ray (XANES) studies to correlate state-of- charge phenomenon with changes in NMC cathode materials, and that high-voltage additives to the electrolyte will be evaluated for their effect on charge retention. Under continuous high-voltage cycling, the reviewer observed, the LMR and LMC particles undergo a change in morphology and that it has been found that the surface structure of the cathode particles changes.

Reviewer 3:

Overall, the reviewer said, future plans are consistent with the overall goals of the advanced battery research (ABR) program. The reviewer cited three tasks in the proposed future research, the first of which is continuing development of high-capacity, 4-Volt lithium-ion cathodes (Li_2MiMiO_2 and $Li_2MiMiiO_3$, where Mi and Mii are Ni, Cu, Fe, or Cr) by incorporating an isovalent or supervalent dopant to stabilize the structure upon the extraction of second lithium. The second is local state of charge (SOC) and characterization studies on the cycled electrodes, and the third is utilizing electrochemical impedance spectroscopy (EIS) to monitor the growth of surface films upon cycling. The reviewer suggested focusing more on the first two topics, as the third topic is more general and is being pursued by others in ABR.

Reviewer 4:

The reviewer felt it is unclear what the advantages are of using full-cell, since EIC can also be performed from a half-cell. When a full-cell is used, the reviewer asked, how the contributions of the anode and cathode can be distinguished.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The work is definitely important from the standpoint of DOE's objectives, the reviewer said, since a good understanding of the failure mechanism is critical in developing high-energy, low-cost batteries for automotive applications.

Reviewer 2:

The work is at the cutting edge of the need for higher-performance cathode materials, the reviewer declared, and the rate of progress is outstanding.

Reviewer 3:

High specific energy, long cycle life and low cost are the performance drivers for Li-ion batteries in electric vehicles, the reviewer said, and LMR-LLC cathode materials are promising due to their high capacities at high voltages, and possibly their low cost owing to high Mn contents. However, the reviewer went on, their performance degradation upon cycling, both in capacity and voltage, is an impediment to their use in Li-ion cells. This project is aimed at understanding and mitigating these failure modes, the reviewer concluded.

Reviewer 4:

The reviewer simply stated to develop high capacity and high voltage cathode for Li-ion batteries.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer, deeming project resources insufficient, said that consideration could be given to increasing the funding for this team given the broad scope of the program.

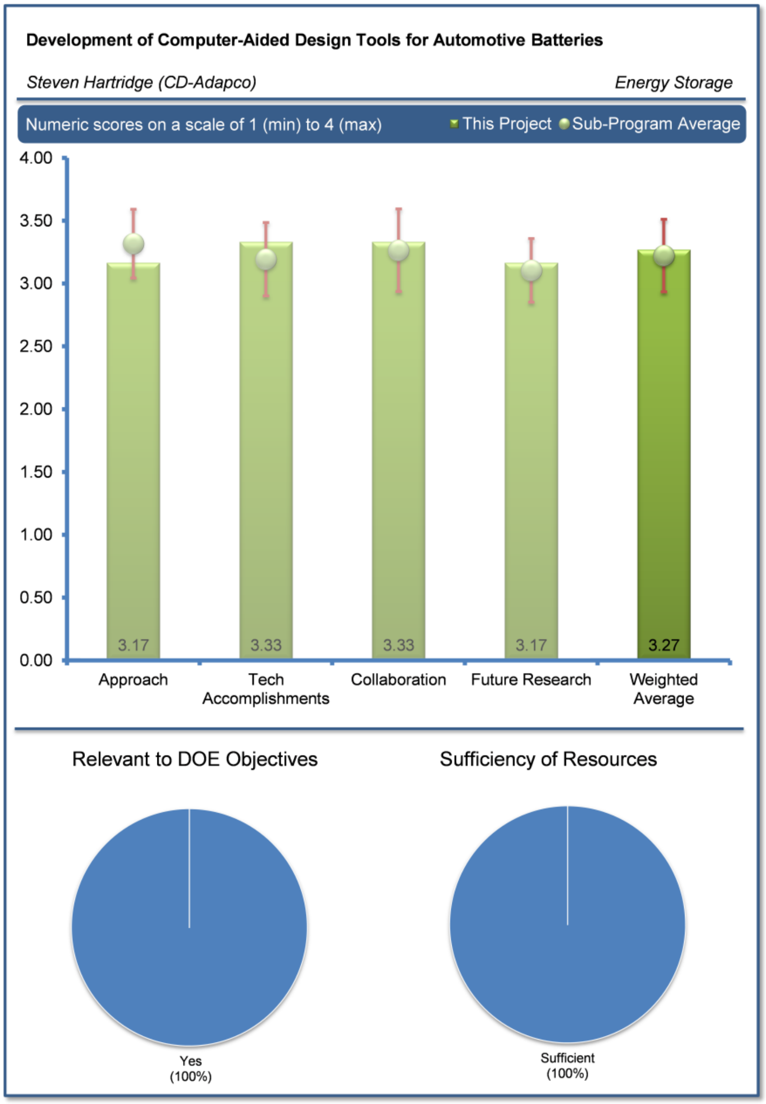
Reviewer 2:

Resources are barely adequate for the proposed program, the reviewer said. An increase in funding would allow widening the study with appropriate speed in arriving at the best cathode composition, the reviewer went on, and urged that such an increase be considered.

Reviewer 3:

The resources are adequate for the scope of the project, in the opinion of this reviewer.

Development of Computer-Aided Design Tools for Automotive Batteries: Steven Hartridge (CD-Adapco) - es118



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer termed this project (noting that it is now nearing its end) one of the essential building blocks in computer aided engineering (CAE) tool development. If further work is awarded, the reviewer recommended, it should depart from the spirally wound cell variants and incorporate large- format cell variants with boundary conditions of design intent for pack level performance, including safety stability. The reviewer concluded by saying that this was a great approach to identifying lithium loss and SCI layer development.

Reviewer 2:

The reviewer observed that CD-adapco and Battery Design LLC, working together, have created a computer aided design (CAD) tool to aid in reducing the time/cost for battery design. The work began with the creation of electrochemical and thermal models, which then led to cell-level and pack models, the reviewer went on, while electrolyte data was input from an electrolyte model developed at Idaho National Laboratory (INL). The cell models and overall CAD tool were, or are being, tested by National Renewable Energy Laboratory (NREL) and Oak Ridge National Laboratory (ORNL); cell performance was provided by JCI (Johnson Controls, Inc.) and perhaps A123 Systems, the reviewer concluded. However, the reviewer said, it is unclear what validation has been made for the property inputs or what these are, specifically.

Reviewer 3:

The project team proposed using separate electrochemical and thermal models to predict performance and life, the reviewer noted. Their models were not coupled and seemed to be empirically based, since it required iterative fitting of parameters, the reviewer added, thus, the applicability of the models to cells not manufactured by JCI or A123 Systems is unclear. The reviewer felt the team need to show how their materials database was used in their models.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The milestones, the reviewer noted, indicate that ORNL was to validate the open architecture compatibility by May 2014. No information was provided during the presentation with regard to the results of that validation testing, the reviewer said, and without significant validation, the utility and reliability of the CAD tools will be very limited. The project seems to rely on electrolyte data obtained from Gering's (Idaho National Laboratory) electrolyte model, the reviewer noted, and while this is perhaps understandable given the limited amount of rigorous electrolyte property data available in the scientific literature, but a model based upon a model may have severe limitations. Very little validation data, and no blind tests that the reviewer was aware of, have been openly reported for Gering's model. Thus, the reviewer said, the accuracy of Gering's model remains questionable to an external observer. The reviewer was left with two questions and asked what electrolyte properties were required for the CAD tool and could these be determined experimentally in a straightforward manner; and how dependent on or sensitive to specific material properties were the results of the CAD tool. Some validation via a comparison of tool results and experimental data was provided in the Technical Approach slides, the reviewer noted, but felt that does not conclusively demonstrate the CAD tool's validation.

Reviewer 2:

The data showed good correlation between the measured voltage and the modeling results on the cell types specified in the project team's accomplishment table, the reviewer said. However, since their model was empirically based, the reviewer felt the applicability of the models to other cells not specified in that table was not clear.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This program collaborated with the well-respected expertise of A123 Systems and JCI, the reviewer said, but there is always room for involvement by many more cell and battery developers, although, the reviewer added, that this is perhaps too difficult to be practical. There is the fundamental paradox, the reviewer noted, that all these cells are quite different by many metrics.

Reviewer 2:

JCI has evidently been very open with input data for the CAD tool, which has greatly facilitated its development, the reviewer observed. JCI provided various cells and performed the experimental testing for CD-adapco and Battery Design, LLC. Likewise, the reviewer said, A123 Systems provided pouch cells to extend the CAD tool evaluation to cells of that type, since the tool was developed for spirally wound cells. The reviewer felt it was unclear how open A123 Systems had been with data input. NREL and ORNL are noted to be collaborating with CD-adapco and Battery Design LLC to create an open architecture software framework to enable model transfer between CAEBAT projects, the reviewer said, but no information was provided regarding how far this has progressed. Nonetheless, overall the collaboration appears to be highly fruitful, the reviewer concluded.

Reviewer 3:

The intention to use JCI and A123 Systems to validate the results was good, the reviewer felt, but it seemed their participation was mostly limited to testing coordination rather than to validation testing.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer referred to earlier comments, which this reviewer stated was well recognized by the presenter.

Reviewer 2:

No future work was mentioned, as the project will be finalized in July 2014, the reviewer noted, but the major milestones for the project appeared to have been met.

Reviewer 3:

No future work was presented the reviewer observed because the project was 90% complete.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

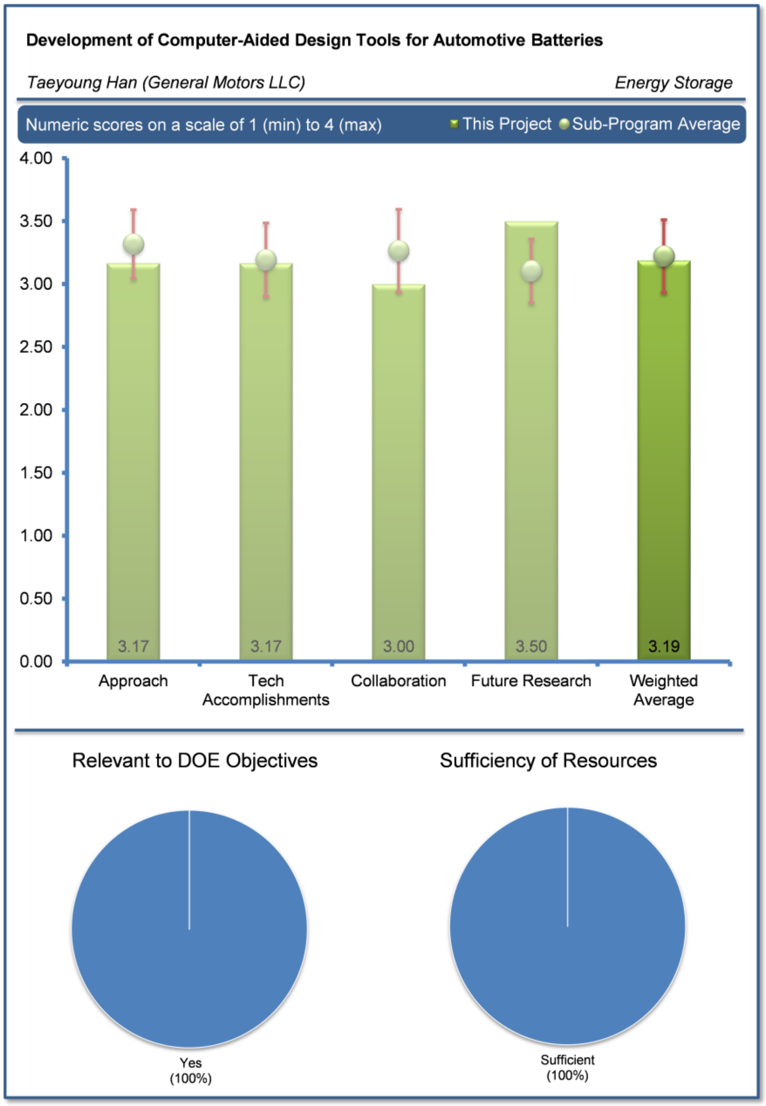
The program to develop computer-aided design (CAD) tools for transportation batteries is well-founded, in the reviewer's judgment. Much of the technology and design development for transportation batteries has matured and CAD tools, the reviewer predicted, will likely be the key to future design improvements and manufacturing cost reductions. The work may also provide additional insight into fundamental science needs for battery materials, the reviewer speculated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

With the project coming to an end, the reviewer said, CD-adapco and Battery Design LLC appear to have accomplished the goals laid out for the project, suggesting that they did have adequate resources (with collaborations) for the work.

Development of Computer-Aided Design Tools for Automotive Batteries: Taeyoung Han (General Motors LLC) - es119



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer expressed a desire to have seen more technical details of the models used, especially the underlying physics and chemistry of the batteries and how they are simulated.

Reviewer 2:

The project, the reviewer noted, has developed a cell-level model which is now being developed into a full pack-level model. Reduced-Order Models (ROMs) are used for the flow and thermal analysis at the pack-level. The strategy, the reviewer said, is to develop a range of methods which will permit trade-offs between computational expense and resolution.

Reviewer 3:

The project team proposed to use the ANSYS ABDT tool to simulate electrochemical and safety performance at the cell and pack level, the reviewer observed, with ROM used to simplify the computation time, at the expense of accuracy.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Significant progress seems to have been made for the model and many of the difficulties clearly identified, the reviewer said. However, no information was provided about the material properties inputs for the models. The reviewer was left with asking questions on this aspect of the project including how these are being experimentally determined or if they are estimates; how sensitive the models are to these input parameters; and if blind evaluations have been conducted as part of the verification process. The reviewer cited accomplishments of the project including the official release of ANSYS (Version 15) to the public in December 2013 and completion and validation of a system-level model without ROM (comparison of full field simulation with test data), which demonstrated the system's simulation for the US06 drive cycle. Development of a linear (LTI) ROM model, the reviewer noted, is in progress, but challenges remain, as some features required for the models are in fact nonlinear.

Reviewer 2:

Data showed good correlation between the measured temperature and the modeling results, the reviewer noted, but it did not seem that the electrochemical and thermal models were coupled, which the reviewer felt might have contributed to some of the errors. No simulation data on life was presented, the reviewer concluded.

Reviewer 3:

Progress toward development of a battery management system (BMS) does not seem to have been initiated yet, the reviewer observed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer skipped the slide that discussed collaboration.

Reviewer 2:

The reviewer cited General Motors' (GM) work with Ansys and Esim to develop the models; NREL's technical direction and cell chemistry model for multiple particle/active materials; ORNL's provision of the Open Architecture Software and GM's conduct of the mathematical model verification and cell/pack-level validation.

Reviewer 3:

The reviewer said that there is good collaboration with various teams and noted that their specific roles were described. However, the reviewer would have liked to see more validation data from independent testing by one of the collaborators.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that implementation of an already-developed thermal abuse/runaway model will be done to address thermal propagation within the pack and that practical cell cycle life models have been defined and will be added in the third quarter of 2014. A physics-based cycle life model will be added in the fourth quarter, the reviewer added. Work flow automation for the LTI/LPV ROM process will be completed and models will be implemented for multiple particle materials, since most commercial battery manufacturers are using multiple active materials in the cathodes and anodes, the reviewer went on and pack-level validation as well as other tasks will continue. All these are well-aligned with the project goals, the reviewer stated.

Reviewer 2:

Although the project team planned to finish the physics-based life model by December 2014, the reviewer said, no preliminary life data were shown.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

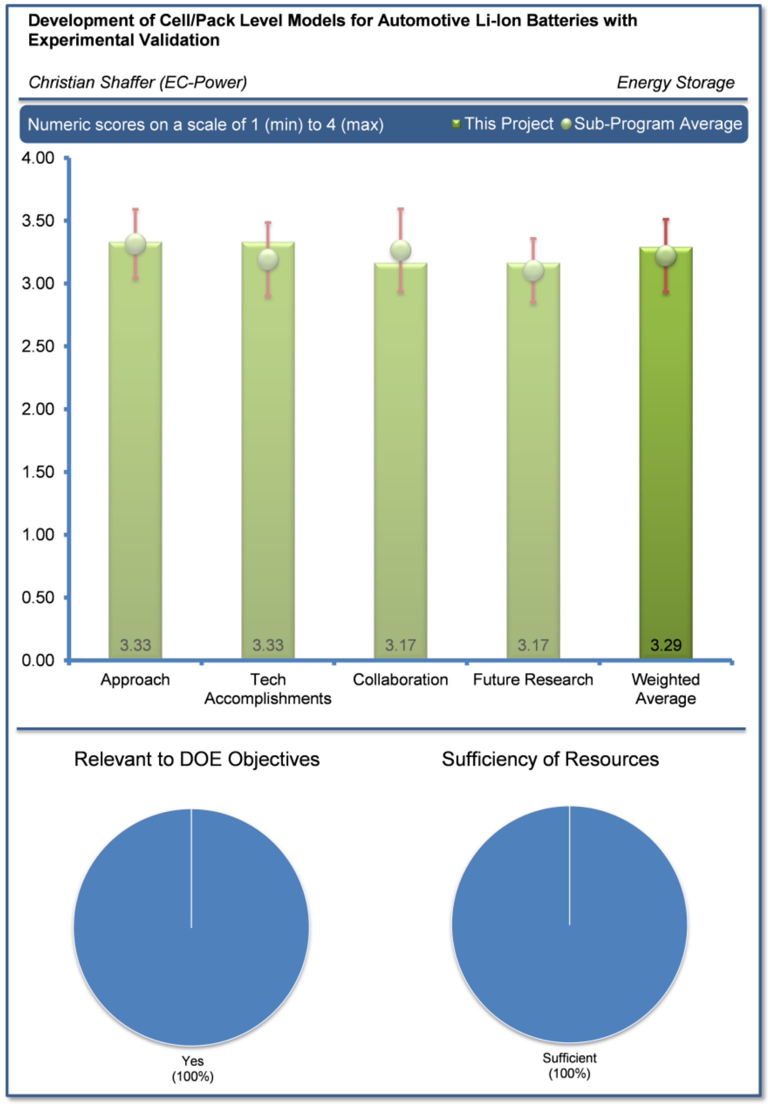
The program to develop computer-aided design (CAD) tools for transportation batteries is well-founded, in the reviewer's judgment. Much of the technology and design development for transportation batteries has matured and CAD tools, the reviewer predicted, will likely be the key to future design improvements and manufacturing cost reductions. The work may also provide additional insight into fundamental science needs for battery materials, the reviewer speculated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The project seemed to have sufficient resources, the reviewer said. Some difficulties have been identified, but these are not due to limited resources, in the reviewer's opinion.

Development of Cell/Pack Level Models for Automotive Li-Ion Batteries with Experimental Validation: Christian Shaffer (EC-Power) - es120



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer would have preferred to see more of a technical description of the physics and chemistry of degradation that were incorporated to accomplish the lifetime simulations.

Reviewer 2:

The reviewer listed the accomplishments of the project, including development of an electrochemical/thermal (ECT)-coupled cell and physics-based pack model and creation a of a materials database to support the models for commercially relevant materials, which are claimed to be accurate over a wide range of temperatures, SOC, etc. Evidently, the reviewer said, this used thousands of coin cells to obtain high-quality material properties. The ECT3D software was integrated with the CAEBAT Open Architecture Standard (OAS), the reviewer concluded.

Reviewer 3:

The reviewer noted that the project team proposed to use the Electrochemical-Thermal Coupling (ECT) model to predict life. The ECT, the reviewer felt, should be predictive since it is not empirically based, but based on parameters extracted from the extensive materials database.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said it looked like good model verification had been accomplished for many technical features.

Reviewer 2:

The reviewer found validation/performance testing to obtain data on the temperature distributions and cycle life of cells quite interesting, but it was not clear what the results were from the Ford and JCI testing/validation of the models, except for the commercial cell external short data, which was compared with JCI data. What inputs, the reviewer wondered, are required for the models in terms of material properties, and if these are all now readily available from the materials database created. Further, the reviewer asked if this database will be available to other researchers. The presentation summary, the reviewer noted, indicates the software is commercially available and has been for several years. The project, in the reviewer's opinion, therefore seems to be one devoted to validation of an existing or recently updated model. Finding nothing wrong with this, the reviewer nonetheless found it unclear how well the model performs and what its limitations are (i.e., how thoroughly it has been validated and whether blind evaluations have been done).

Reviewer 3:

Data showed good validation between actual performance and simulation results at various rates and temperatures, the reviewer noted, and there was also good validation between actual life data and simulation results during early life. There was more deviation at later life, the reviewer observed, which discrepancy was attributed to error on the graphite anode. Good agreement on temperature rise was obtained in the nail penetration test with simulation data, the reviewer said.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

Noting that the project is led by EC Power with additional contributions from the following: NREL, the CAEBAT Program Administrator; ORNL, who provides the Open Architecture Software; Pennsylvania State University for materials testing and model validation; and Ford Motor Co./JCI for testing, validation and feedback. The reviewer said this seems to be an effective partnership, but said little information was provided regarding how the collaboration has worked out.

Reviewer 2:

The reviewer deemed there to have been good collaboration with various teams, whose specific roles were described. However, the reviewer would like to have seen more validation data from independent testing by one of the collaborators.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This project's completion date has already passed, the reviewer noted, but the work has been extended for a few extra months to finalize the deliverables.

Reviewer 2:

The reviewer noted that the project is near completion and most future work is focused on finishing up the reports, but expressed approval of the team’s recommendation to refine the life model to gain accuracy, especially for longer life at high temperatures.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

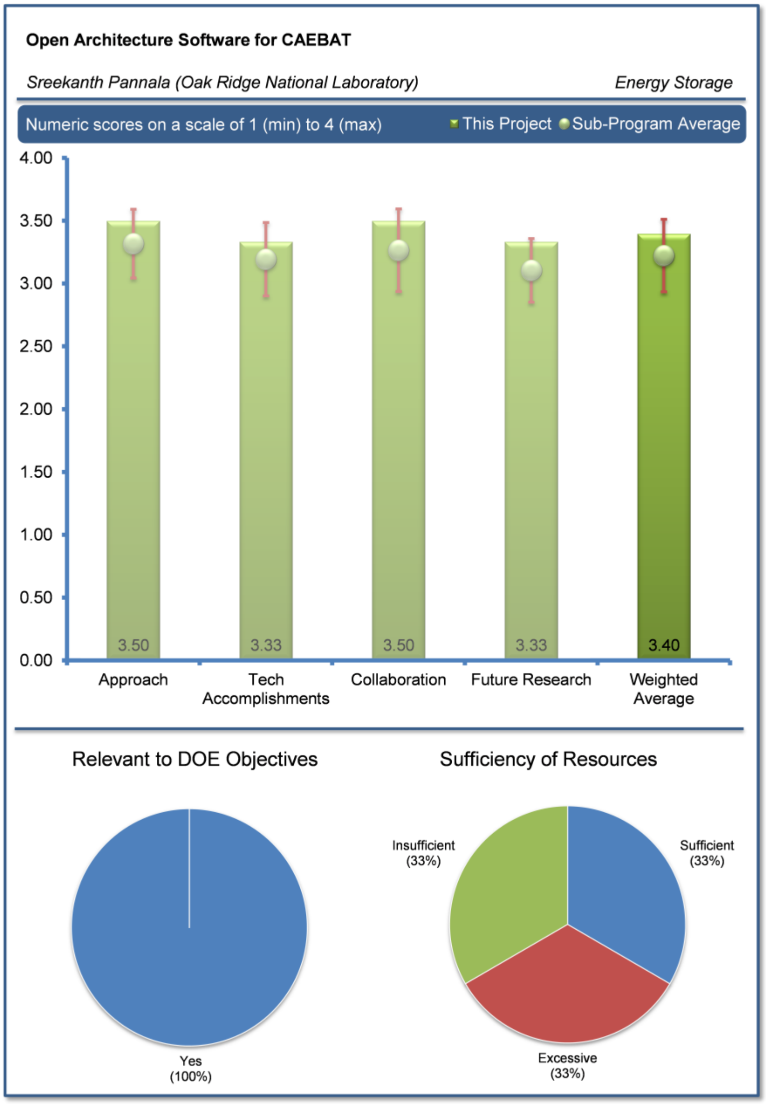
The program to develop computer-aided design (CAD) tools for transportation batteries is well-founded, in the reviewer’s judgment. Much of the technology and design development for transportation batteries has matured and CAD tools, the reviewer predicted, will likely be the key to future design improvements and manufacturing cost reductions. The work may also provide additional insight into fundamental science needs for battery materials, the reviewer speculated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer felt it was unclear that resources were indeed sufficient, but assumed so in the absence of other information.

Open Architecture Software for CAEBAT: Sreekanth Pannala (Oak Ridge National Laboratory) - es121



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

According to this reviewer, great emphasis was given to existing methods and pursuit to Open Architecture. The reviewer also observed the use of well-defined macro (thermal, electrical, mechanical) environment with a diversity of approaches and numerical methods.

Reviewer 2:

This reviewer recounted that the goal of this project is to create open architecture software to facilitate the integration of battery models for improved battery design. Standardized interfaces and file formats are used to provide access to commercial and public software. The reviewer summarized that the Open Architecture Software is being used for several of the other CAD projects within CAEBAT.

Reviewer 3:

This reviewer noted that a common standard is needed to compare the different battery models. However, to this reviewer, it was not clear why there was a need to integrate different battery models. Per Slide 4, each of the three commercial software suites is fully capable of battery simulation. There is a bigger need to benchmark the three commercial software suites to compare their accuracy than to integrate them. In addition, since the commercial software contains proprietary components, it was not clear to the reviewer the extent that those proprietary components could be shared for the integration effort.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer commented the project for its well-executed and focused to goal achievement including scalability, standardization, and usability.

The reviewer noted thorough coupling and interfaces to build to larger devices (modules/packs).

The reviewer commented that the definition of the BatML as a “standardized” mark-up language was intriguing.

Reviewer 2:

According to this reviewer, this was a rather complicated, ambitious effort with its many components (OAS, VIBE, BatML, Battery State and NiCE). The indicated goal was a robust and user-friendly CAEBAT simulation platform. It was not clear how difficult this would be for users to learn and operate. The presentation does state that NiCE will permit users to easily switch components/choose from preconfigured inputs and that BatML may be edited through a standard XML editor. The reviewer added that the interactive (visual) component for these was an excellent feature. There was no indication of how well the project had succeeded in achieving its goals and what problems remained—without this information, the reviewer said it was difficult to judge what progress had been made. Perhaps some of this will only be determined through the use of the integrated software over time. It seemed that numerous presentations had been made regarding the outcomes from the project, but few written documents had been produced to demonstrate the capabilities of the work achieved. The reviewer asked if this software would ultimately only be for battery manufacturer and OEM usage (perhaps due to a high user cost) or if feedback from the integration of the models would also become widely available to battery researchers by some means.

Reviewer 3:

This reviewer said there were no solid accomplishment examples on integration of models. One example showing OAS to couple (or integrate) electrochemical (durafoil) and thermal components can be accomplished with the ECPower ECT model alone, said the reviewer.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer noted that ORNL was the lead for this project. Collaborations are with NREL and the industrial partners (CD-adapso, EC Power and GM-Ansys teams). Other collaborations/coordination are with SNL (modeling capabilities), University of Michigan (modeling capabilities), Ford Motor Company and others. The reviewer concluded that the presentation suggests that this was a well-coordinated program with plenty of discourse and inputs from interested parties.

Reviewer 2:

This reviewer thought that there seemed to be good collaboration with specific roles described for each team member but that the collaborated integration results were not articulated clearly.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This reviewer noted that the ongoing milestones included the demonstration of the coupling possible from combinations of components from different project partners and the release/documentation of the User Environment V1 Software.

Reviewer 2:

The project will be completed by September 2014, said the reviewer, and agreed with the future research using the remaining fund.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer commented that the program to develop computer-aided design (CAD) tools for transportation batteries is well founded. Much of the technology and design developments for transportation batteries have matured and CAD tools will likely be the key to improving future designs and cost reductions for manufacturing. The reviewer continued to say that the work may also provide additional insight into fundamental science needs for battery materials. The reviewer concluded that the Open Architecture Software for this particular project seems to be the core, critical component for the integration of the different models developed as part of CAEBAT.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

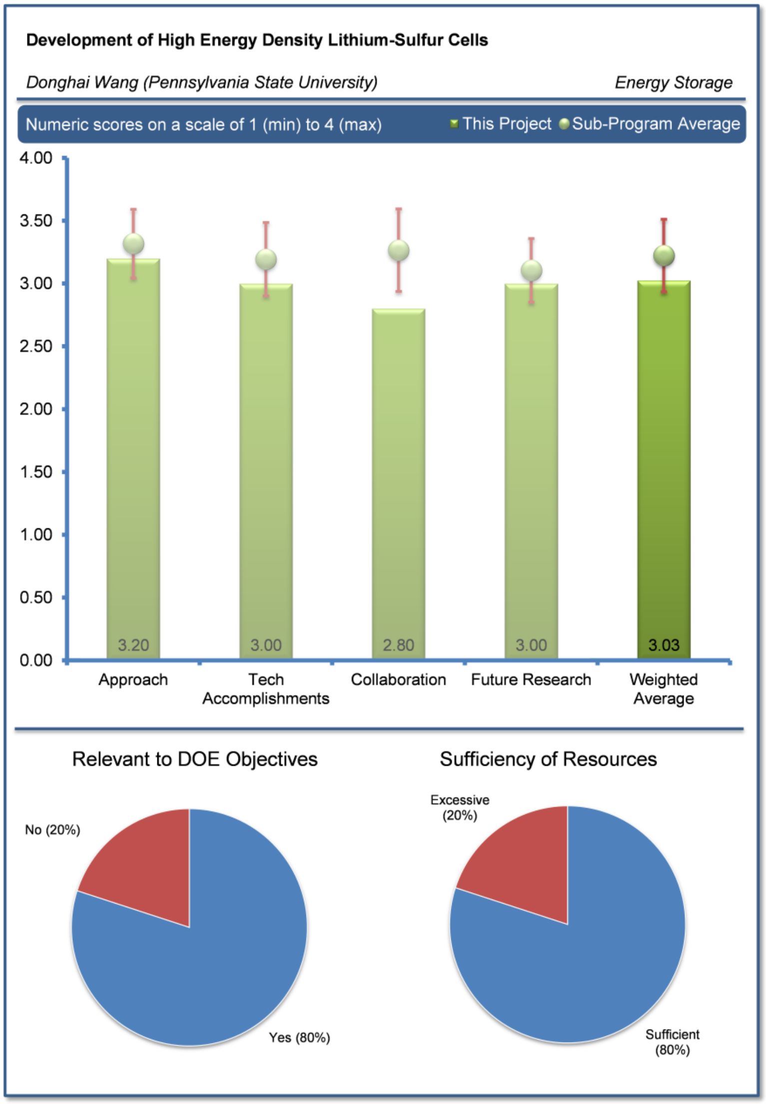
Reviewer 1:

According to the reviewer, no information was provided about the resources available, but it was assumed that these were sufficient.

Reviewer 2:

This reviewer pointed out that $700,000 per year seemed excessive for integration effort. Some of the resources should be used to benchmark various battery models.

Development of High Energy Density Lithium-Sulfur Cells: Donghai Wang (Pennsylvania State University) - es125



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer simply stated that a solid and well-explained approach was being used.

Reviewer 2:

The reviewer applauded that the PI was taking an excellent approach to tackling the problem of identifying a higher energy density system than today's Li-ion system. The reviewer explained that the investigator planned to develop a full Li-S battery system which will include not only the nanocomposite sulfur cathode, but also the anode (Li or Si) and the electrolyte. The reviewer also noted that electrode dopants will be explored to prevent polysulfide dissolution. The reviewer also explained that the materials under investigation would be tested using 1.0 Ah pouch cells. This person stated this approach was far better than using coin cells since electrode performance does not always scale-up to a real manufactured cell. It was unclear to the reviewer how the team plans to investigate the mechanisms of polysulfide dissolution and self-discharge (Slide 10).

Reviewer 3:

The reviewer reported that the project goal was to develop a lithium-sulfur (Li-S) metal battery system with a Li or Li-Si alloy anode for high current density, high energy storage capability and calendar life. The initial work concentrated on 1.0 Ah cells with potential for 600 Wh/l, cycle life of 500 cycles, and excellent safety characteristics. The reviewer noted that the researchers used a 1.0 Ah pouch cell as the experimental tool.

Reviewer 4:

The reviewer stated that although the researchers were using a comprehensive approach using the chemisorption materials, the project was still beset by all the well-known challenges of the Li anode. The reviewer also criticized that the goal of a 600 Wh/l energy density was too modest for such a large project when commercial Li-ion batteries are already hitting close to 800 Wh/l target.

Reviewer 5:

The reviewer agreed the approach seemed okay conceptually, but criticized that there was no detailed plan was offered that seemed likely to work. The reviewer noted that there was a lot of progress on durability, but power, and capacity are needed and the plan is not detailed. The reviewer exclaimed that without a plan that lead to the goal, the researchers will not get there. The reviewer reinforced that they did not hear a plan that was likely to meet the project goals when they talked to the presenter.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that the PSU-6 data looked impressive, but cautioned that the long-term and high temperature data were left wanting. The reviewer also asked what the N/P ratio is.

Reviewer 2:
The reviewer stated that this last year with a 1.0 Ah Li-sulfur (S) cell as a test vehicle, the properties reached over 400 Wh/l, scaled-up cathode to a 1.0 kg batch size and 600 and 500 cycles and good safety characteristics. The reviewer indicated that cycling testing was in progress, with 80% capacity retention results after 200 cycles. The reviewer also reported that a pressed carbon/sulfur cathode was developed with a 70% sulfur loading based on spherical phosphorous composite cathode with 70% sulfur loading; the cells had negligible self-discharge characteristic and good performance. This person also noted that cells with improved construction and $LiNO_3$ added gave stable cycle life for over 200 cycles with no degradation.

Reviewer 3:
The reviewer acknowledged that good progress had been made this past year. The reviewer explained that the investigators scaled-up their active materials to the 1.0 kg level and developed a 1.0 Ah prismatic cell with greater than 400 Wh/L that demonstrated 80% capacity retention in 200 cycles at the C/2 rate. The reviewer highlighted that it should be noted however, that the team must identify a system that is capable of more than 200 cycles. The reviewer pointed out that the PI's performance goal is 500+ cycles, so there is a long way to go.

Reviewer 4:
The reviewer recognized that the researchers have improved their cells in many ways, but asserted that the cells were still not to the level of commercial products. So, the reviewer said that good progress was made, but there was still a long way to go.

Reviewer 5:
The reviewer criticized that the prospects for achieving a viable cycle life in full cells did not appear to be promising.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged that the PI had assembled an excellent team of research collaborators.

Reviewer 2:
The reviewer explained that the investigators were working with ANL on electrolyte development and on a Li powder based anode development for improved performance. The reviewer also stated that an independent evaluation of cells was being carried out at the INL.

Reviewer 3:
The reviewer expressed that there are good collaboration with other organizations that can provide support to this effort exists. The reviewer also mentioned that the researchers are partnering with EC Power. The reviewer explained that large-format Li-ion batteries are essential for vehicle use and EC Power can provide the expertise of transitioning any new materials developed into a viable battery. The reviewer specified that this effort would also benefit from the collaboration with ANL where concurrent electrolyte development is underway. This person said there is hope that, between the two laboratories, progress can be made to mitigate the poor cell performance.

Reviewer 4:
The reviewer proposed that partnership with at least one industrial partner might be beneficial to the commercial focus of project.

Reviewer 5:
The reviewer observed that the ANL collaboration was modest and that EC Power cannot give any real insight on production as they are effectively an intellectual property company and not an industrial firm.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer agreed that the proposed future work as outline on Slide 35 was reasonable.

Reviewer 2:
The reviewer explained that the future work will continue to work to scale-up both the anode and cathode in a prismatic configuration and optimize performance. Electrolyte development and stopping polysulfide migration will continue to improve performance will also be addressed. The reviewer reported that the cell size will be increased and safety testing will be carried out to define the cell's safety performance, as well a means to stop/slow polysulfide migration.

Reviewer 3:
The reviewer stated that the high temperature stability of the cell needs to be studied. The reviewer also asked whether the issue of battery management system development for this strange open-circuit voltage curve has ever been discussed; adding that must be a big challenge.

Reviewer 4:
The reviewer criticized that more detail was needed and recognition of the imminent end of the project merited a clear timeline which was totally absent in the presentation, but a discussion afterwards with the presenter revealed that a plan of sorts is present. The reviewer reported that at present the plan still included Li negative electrodes. The reviewer suggested that achieving the high current durability was probably a bigger problem that the researchers seemed to be ready for. The reviewer also suggested that some validation work in this area would be a good idea.

Reviewer 5:
The reviewer criticized that the scope of the extensive safety tests that are planned are unclear. The reviewer recommended that complete mechanical abuse testing, including crush be performed to demonstrate relative response of technology.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that Li-S cells operating at room temperature and in a prismatic format should have superior energy storage capability. The reviewer also stated that their energy density and safety should be superior to most other Li cells.

Reviewer 2:
The reviewer stated that the project was highly-relevant to the goals of the DOE EERE, VTO (i.e., increasing specific energy from 100 Wh/kg to 250 Wh/kg and energy density from 200 Wh/L to 400 Wh/L).

Reviewer 3:
The reviewer agreed that Li-S systems, if made to work, would enable many DOE goals for electrified vehicles.

Reviewer 4:
The reviewer did not see this project as having any realistic chance of being deployed for vehicular applications; too many challenges.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources were adequate for the planned development. The reviewer explained that continued success should lead to a new system that could have significant uses other than transportation.

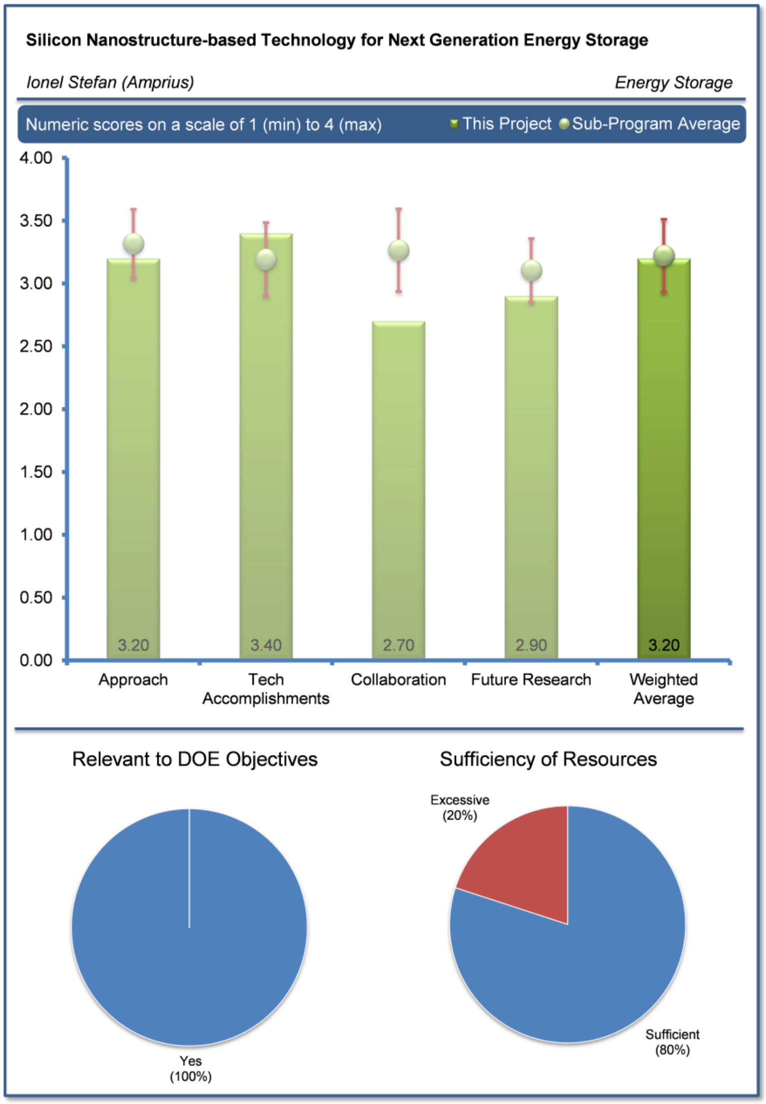
Reviewer 2:

The reviewer highlighted that this effort was significant, and as a consequence, the total cost of the project was over $5 MM. The reviewer reported that the amount of resources provided for this project appeared to be sufficient, which was evident by the amount of work that had been completed.

Reviewer 3:

The reviewer thought the funding level was too much for a project which has a long history of serious challenges.

Silicon Nanostructure-based Technology for Next Generation Energy Storage: Ionel Stefan (Amprius) - es126



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer's main concern for this technology for vehicular applications was whether it could be scaled-up cost-effectively, manufactured, and still beat the Wh/l value achievable using a conventional graphite electrode.

Reviewer 2:

The reviewer reported that silicon nanowire anodes had the capability to significantly improve energy storage capability. The reviewer also pointed out that the work should apply to other Li battery anode systems and cathodes for a breakthrough to double the present energy storage capability. The reviewer also mentioned that the anode physical structure is key for high-performance.

Reviewer 3:

The reviewer said that it was nice to see a gated timeline and making progress to the planned trajectory. The reviewer agreed that Si nanowire directly attacks a key Si problem of swell fracture. The reviewer also noted that it was good to see the Hybrid Pulse Power Characterization test, an accepted industrial test, not some homemade test, be used for verification.

Reviewer 4:

The reviewer indicated that the approach was generally good or excellent in terms of technical demonstration, but appeared to have avoided investigation into, or explanation regarding, the potential costs related to manufacturing of this technology.

Reviewer 5:

The reviewer remarked that it was difficult to fully assess the approach that was being taken on this project. The reviewer asked what exactly was being done to meet the program goals other than developing growth-rooted silicon nanowires. The reviewer also wondered if there was a rationale for selecting certain electrolyte formulations and additives. The reviewer also requested if any information could be provided without compromising intellectual property.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that although good progress had been made, the results certainly were not the state-of-the-art. Even with conventional anode and cathode technologies, current consumer batteries are already in the 270 Wh/kg and approximately 785 Wh/l.

Reviewer 2:
The reviewer reported that Amprius had delivered 18 cells for testing at INL to confirm their findings. The cells were rated at over 700 Wh/l and 285 Wh/kg with a cycle life of over 500 cycles at 80% DOD. The reviewer noted that the anode construction should lead to good high rate performance as well as high energy storage capability.

Reviewer 3:
The reviewer could not find a presenter to answer some questions after the presentation, but thought there seemed to be good progress. The reviewer stated that it was nice to see durability only claimed to 80% (330 cycles and 700 cycles in early slides) and the progress is good and on trajectory. The reviewer wondered, while the deviation in cells sent for analysis was good, if there were many sorted out prior to sending off a hand-picked few, or do the results represent the true mean.

Reviewer 4:
The reviewer applauded that excellent progress had been made on this effort. The reviewer specified that an energy density of greater than 700 Wh/L and a specific energy over 285 Wh/Kg at the C/2 rate were achieved along with a cycle life of greater than 500 cycles.

Reviewer 5:
The reviewer commented that the project was a solid demonstration of significant energy density advancement with non-catastrophic cycle life in small format cell.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that there was good collaboration among the key players in these technologies.

Reviewer 2:
The reviewer observed that there had been good cooperation with others developing Li anode cells. The reviewer also pointed out that national laboratories had been involved in independent cell testing.

Reviewer 3:
The reviewer would have liked to see domestic partners. The reviewer noted that Amprius was engaging the USABC, so should use those contacts to get more domestic advice and input.

Reviewer 4:
The reviewer explained that the majority of this effort was being conducted by the PI's company. This person noted that lower level effort was being conducted by BASF (cathode development) and Nissan (cell design). This was satisfactory if the PI wanted to maintain tight control of the project but may not be the most expedient method to advance the technology. Consultation with electrolyte experts would have been beneficial.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer expressed that the future plans were in keeping with the excellent opportunity to improve energy storage capability. The reviewer also indicated that the unique form of the anode was especially interesting.

Reviewer 2:
The reviewer indicated that this project was near its completion (ends September 2014). The reviewer reported that the proposed work was good, detailing that the researchers planned to complete the model of high volume anode manufacturing processes then deliver the 18 cells and final report.

Reviewer 3:
The reviewer reported that this was a well-funded project entailing cutting-edge anode and cathode materials. However, the reviewer cautioned that completion of the remaining work would not push the limits on scaling-up, manufacturing, or even energy densities. The reviewer recommended that the team focus on those aspects more than on refining a cell that was not state-of-the-art.

Reviewer 4:
The reviewer agreed that the future plans included the correct things to do, but criticized that the plans were vague on how this would be done.

Reviewer 5:
The reviewer noted that the project was nearly complete and that no future work plans were noted. The reviewer proposed that evaluation of basic relative abuse tolerance of technology in full cells, even on a small scale, would be beneficial.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer asserted that increased support should be in order as this was an outstanding development.

Reviewer 2:
The reviewer stated that, if successful, it would greatly raise the driving range of EVs.

Reviewer 3:
The reviewer explained that Si had emerged as one of the most promising next-generation anode materials for Li-ion batteries due to its high theoretical capacity. Unfortunately, the extreme volume change leads to rapid capacity fading; this effort addresses this problem.

Reviewer 4:
The reviewer asserted that this project definitely supports overall DOE objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

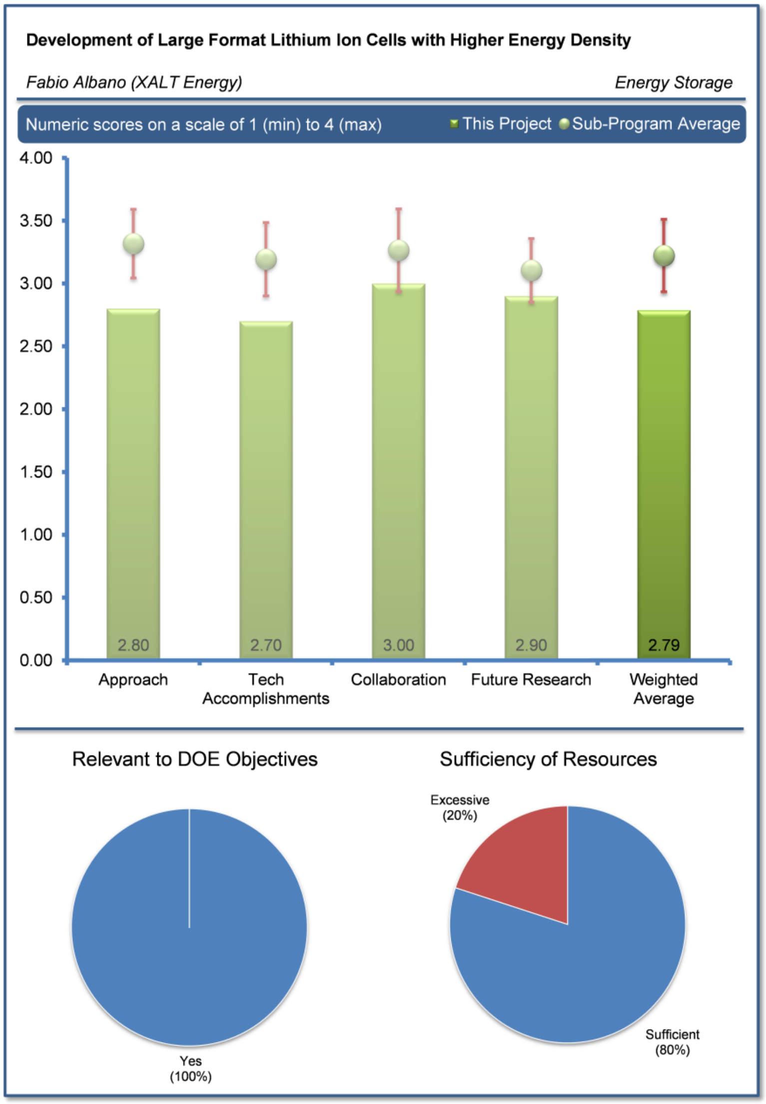
Reviewer 1:
The reviewer remarked that sufficient resources were provided for this effort.

Reviewer 2:
The reviewer pointed out that while resources are adequate for the present program, an increase in resources should speed the development of the Li-alloy anode with exceptional performance.

Reviewer 3:

The reviewer agreed that there was more than enough cash, but also a decent cost-share level. The reviewer suggested that the PI needed to engage future customers in the battery industry and end-user customers much more aggressively.

Development of Large Format Lithium Ion Cells with Higher Energy Density: Fabio Albano (XALT Energy) - es127



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed that the project goal is to produce a large format prismatic cell with an energy density greater than 500 Wh/L and a cycle life of over 1,000 cycles to 80% of original capacity. The reviewer stated that, based on the results, the approach has been very successful. The reviewer also described that the program plan has been carried out in smaller cells, and in November 2014, the research team planned to produce large format cells for delivery to national laboratories for evaluation.

Reviewer 2:

The reviewer agreed that the development of large format Li-in battery was important. The reviewer said that the authors have shown progress; however, it was not very clear from where they are getting the advanced materials, and how reproducible the quality of such a material is.

Reviewer 3:

The reviewer summarized that the goal of this effort is to develop and demonstrate a large format Li-ion cell with an energy density of greater than 500 Wh/L and a power density of greater than 500 W/L. The reviewer pointed out that in order to meet these goals, new materials are required. The reviewer said that Wildcat Discovery Technologies is screening new materials and that there has been significant progress in this area which should be able to benefit the program. Unfortunately, it appeared to this reviewer that, from Slide 32, the cells continue to gas. The reviewer also noted that there is capacity fade (Slide 29). The reviewer had concerns that Wildcat Discovery Technologies may not be able to identity suitable materials within the time allocated for this project.

Reviewer 4:

The reviewer stated that the core-shell approach is nice, but asked what the rest of the system is; so, it was hard for this person to say if the approach is right without really knowing what the project team was working on.

Reviewer 5:

The reviewer stated that the project approach seemed to partially duplicate other funded projects.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that, based on differential scanning calorimetry curves of cells at ANL, the cells show excellent safety characteristics. The reviewer reported that the cell performance exceeds the DOE standard of 500 Wh/L. Nail penetration testing is next. The reviewer highlighted that the group had established a good track record of accomplishment.

Reviewer 2:

The reviewer cautioned that the authors should be careful about the specification of the raw materials that are proposed to be used in the future. The reviewer warned that these experimental powders were not easy to reproduce, in particular if they were under development.

Reviewer 3:

The reviewer stated that the progress seemed to be well behind the expected timeline. This person stated that the accomplishments are okay, but until durability and performance is seen it is hard to validate claims.

Reviewer 4:

The reviewer criticized that the progress made this year did not appear to be commensurate with the funding provided. The reviewer explained that many of the slides presented this year were the same as last year. For example, the accomplishments (Slide 20) looked almost identical to that submitted last year (Slide 13). Another example is that the cathode Slide 26 has a figure that is the same as last year's Slide 9.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that good collaboration existed within the project. The reviewer recounted that the team includes Wildcat Discoveries Technologies (Bin Li), ORNL (David Wood), ANL (Ira Bloom), NREL (G.H. Kim and A. Pesaran), University of Missouri, Kansas City (Xiaobo Chen), and the Department of Defense (Dilip Punatar).

Reviewer 2:

The reviewer indicated that the partners include Wildcat Discovery Technologies, the NREL, ANL, ORNL, and the University of Missouri, Kansas City for analytical work.

Reviewer 3:

The reviewer agreed that the extent of collaboration seemed reasonable in the case of XALT Energy's current technological maturity. However, the reviewer suggested that involvement of significant industrial partners would have the potential to greatly improve project focus and tangibility of project, even with reduced number of non-industrial research partners.

Reviewer 4:

The reviewer noted that there were lots of collaborators, but asked what their roles were. The reviewer said that other than NREL, the other collaborators were not mentioned. The reviewer also stated that ANL tested the researchers' cells, but that was a service that DOE provides so it was not really collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer explained that in the future, the cell size will be scaled-up to 2.0 Ah. Increased cathode capacity will be considered as well as lowering the fabrication cell costs.

Reviewer 2:

The reviewer noted that the mitigation strategies are going to be critical.

Reviewer 3:

The reviewer commented that the future research was in the right direction, but that details were scant.

Reviewer 4:

The reviewer stated that the future efforts are satisfactory; describing that the work will continue on identifying high-voltage/high-capacity cathode materials. The reviewer also noted that a cost and biasness analysis will be conducted.

Reviewer 5:

The reviewer indicated that the plan for comparative abuse tolerance testing in large format cells or otherwise in any other full cells was not clear, but would be beneficial to project relevance.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that the project is very relevant, resulting in higher energy storage capability and potentially lower cost.

Reviewer 2:

The reviewer remarked that if the researchers succeed, the number of electric miles driven would go up.

Reviewer 3:

The reviewer reported that this project is relevant to DOE's goal as it is aimed at the development of an affordable, high-energy density battery.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

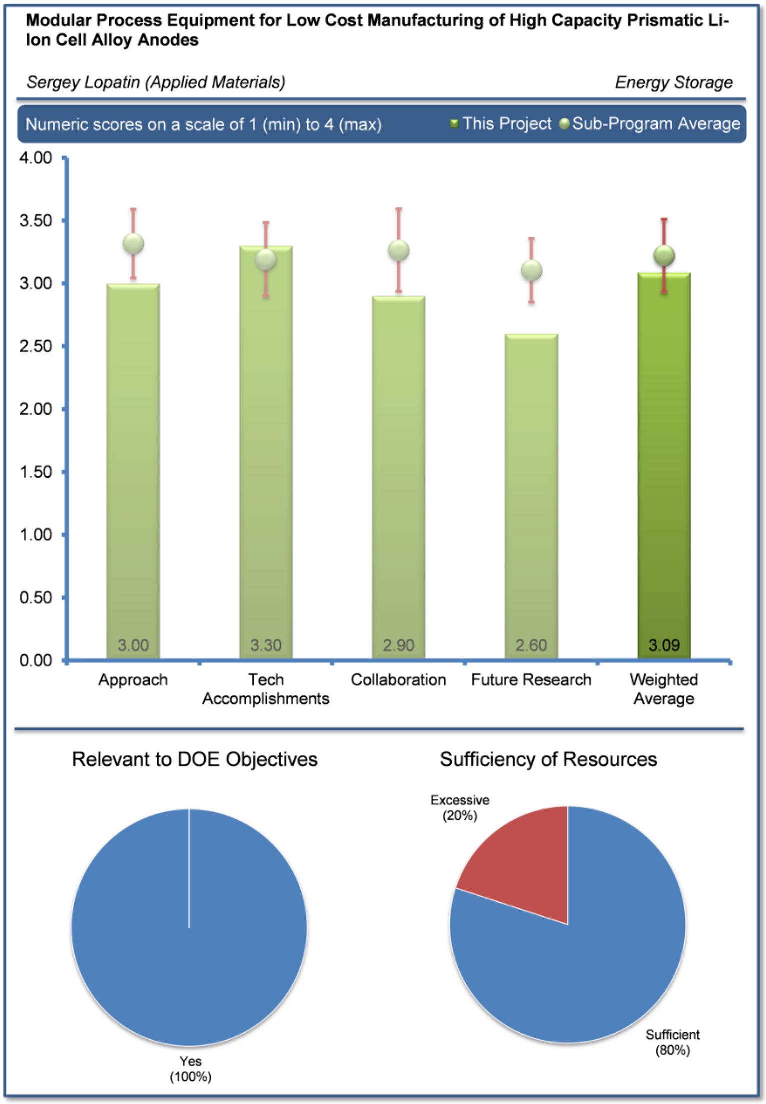
Reviewer 1:

The reviewer stated that the resources are adequate for the present plans, but proposed that an increase is needed to meet the promise proposed.

Reviewer 2:

The reviewer said that it appears that the performer has sufficient resources to complete the work.

Modular Process Equipment for Low Cost Manufacturing of High Capacity Prismatic Li-Ion Cell Alloy Anodes: Sergey Lopatin (Applied Materials) - es128



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer affirmed that the approach taken is excellent; describing that it concentrates on methods to achieve a low-cost, high-energy density battery that includes investigating a new class of Li battery anodes and an innovative micro-porous 3D copper-Li alloy structure. The reviewer anticipated that the 3D electrode concept will increase capacity, fast charge capability, and result in improved energy and power densities.

Reviewer 2:

The reviewer reported that the prototype prismatic cell assembly line has been designed, constructed, and operated and the test cells based on NMC cathode and graphite (CuSbFe/Gr) alloy anode are being evaluated for their performance at INL. A new 3D CuSn anode is also under development. No detail was presented on the equipment or the design concepts. The reviewer said that it obviously works, but it is impossible to compare the cell assembly line with existing equipment.

Reviewer 3:

The reviewer highlighted that the approach was pushing boundaries in the right directions, but the reviewer would have liked the researchers to have better data that this could be done at low cost and quick enough to make millions of units per year.

Reviewer 4:

The reviewer claimed that the approach was excellent, or outstanding, in most technical respects, but appeared to avoid the understanding of, or focus on, the potential cost issues of this novel approach or its competitive manufacturing viability.

Reviewer 5:

The reviewer stated that the researchers have done some good work in looking at the impact of both rate and low temperature on the performance of their anodes. The reviewer added that the researchers also are cognizant of the importance of being able to wind their materials for roll-to-roll processing etc. The reviewer suggested that it would also maybe give them an earlier entry to the market if this technology could be applied to commercial Li-ion cells for the consumer market that use a wound construction. Fundamentally, the reviewer indicated that they do have a concern with the anode structure; the nanostructures deposited onto the substrate look to be very sharp and likely to cause internal shorting in real cells. The reviewer acknowledged that the researchers have apparently overcome this by having a thick overlayer of carbon. The reviewer feared that if this layer is thick enough to protect the separator from the porous copper network, that the performance of that overlayer will not be any better than that of a normal Li-ion anode. The reviewer reported that the researchers' approach seems to excel in anchoring a thin layer of carbon or other anode material to the collector. The reviewer remarked that if a thick carbon overlayer is required either to get better capacity/area or to prevent shorting, it would seem that one would lose, at least in part, the benefits of their anode structure at the current collector interface.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer indicated that the researchers claimed good cycle life now and good capacity.

Reviewer 2:
The reviewer commented that excellent progress was made this past year. The reviewer summarized that Applied Materials completed the baseline cell characterization and the researchers developed a 3D CuSnFe nano-structure alloy anode that decreased electrode thickness and showed improved coulombic efficiency. During this process the reviewer reported that the researchers developed a water-soluble process for graphite coating and demonstrated high rate performance.

Reviewer 3:
The reviewer applauded the researchers' excellent progress and accomplishments to date in demonstrating the technical capability of the novel approach.

Reviewer 4:
The reviewer reported that the cell assembly line was designed and constructed and test cells were supplied for evaluation. The reviewer devalued the accomplishments, as no comparison with existing cell assembly equipment was included in the presentation. The reviewer concluded by asking why this concept was better.

Reviewer 5:
The reviewer explained that the researchers have shown that they can create effective anode/carbon structures. The reviewer also reported that the researchers have attained a significant increase in anode capacity, while still keeping the discharge potential of the anode low (so a full cell voltage will be high). The reviewer noted that the rate performance, low temperature, and cycle life look good. The researchers have also submitted full cells to DOE laboratories for testing, but no results are yet available. The reviewer would have liked to have seen some more fundamental work with the national laboratories. It seemed to the reviewer that the work by Wheeler et al., where they measure the bulk anode layer resistance and the interface resistance with the carrier, could be used to demonstrate and better understand the true benefits of this approach (Project Number es220).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the team was excellent and included ORNL, LBNL, FMC, Navitas, and the Nissan Technical Center North America.

Reviewer 2:
The reviewer stated that this is mainly an industrial collaboration project. The reviewer would have liked to have seen some more fundamental work done with the national laboratory (e.g., modeling work to evaluate effect on conductivity/diffusion of their porous Cu layer with a thick graphite overlayer and collaboration with Project Number es220).

Reviewer 3:
The reviewer indicated that it was not clear whether the partners were having influence or if they were more than just contractors. The reviewer would like to see wider and more domestic input from customers in the battery industry and end-users in the automotive or consumer electronics industries so that they get the real picture of what is needed.

Reviewer 4:
The reviewer explained that there was no mention of outside collaboration, except for the test cells at INL. The reviewer also stated that evidently everything about the equipment is confidential.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that the development of a new anode concept would continue. The reviewer cautioned that there was little detail, only reports of cell with copper anode current collector.

Reviewer 2:
The reviewer agreed that the future plans are good and will benefit the project. The reviewer explained that the cell will be manufactured and sent for characterization and analysis to LBNL and ORNL, who will characterize grain size, porosity and other parameters. Applied Materials, Navitas, and Nissan Technical Center North America will perform work on increasing the anode loading which will be demonstrated in battery unit.

Reviewer 3:
The reviewer explained that the anodes were fairly flexible, but it was not yet clear if they really could be wound at production speeds in a roll-to-roll manufacturing system. Thus, the reviewer highlighted that this was an important area that the researchers have identified as their next steps. The reviewer emphasized that the researchers needed to really follow-up on DOE lab testing to see how their anodes performed in real cells and also, with diligent analysis of the testing, provide some insight as to where to go next with this anode approach. This person pointed out that the researchers' plans to incorporate Si was also very important, although their plans involved a simple Si/C mixture and the reviewer was not sure if that would work very well. The reviewer commented that other people's approach of using Si with nano-tailored structures seems to be more promising from a technical viewpoint (although many of those other approaches may be unrealistic from a cost point of view), so the reviewer was not optimistic that their Si/C anodes will cycle well.

Reviewer 4:
The reviewer proposed that plans to evaluate the relative abuse tolerance response of the technology, even at a small scale, would be beneficial.

Reviewer 5:
The reviewer warned that the researchers were desperately behind their plan and that there was no recognition of this in the future work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that the project would indeed help meet DOE's goals.

Reviewer 2:
The reviewer asserted that this project is highly-relevant and supports DOE's objectives to displace petroleum with electric drive systems. For example, the EV Everywhere battery goals for 2022 are a cost of $125/kWh and energy densities of 400 Wh/L and 250 Wh/kg. Reaching these goals will require significant improvements in material development and advanced high volume manufacturing.

Reviewer 3:
The reviewer commented that the project promises a substantial, albeit not revolutionary, boost to anode usable capacity, especially at high rate and/or low temperature. Thus, the reviewer indicated that the project could become really influential if the researchers could get it to work with Si, but the likelihood of success in this seemed low to the reviewer.

Reviewer 4:

The reviewer commented that the availability of cell assembly equipment with superior performance is needed; however it was impossible for the reviewer to judge the performance of the equipment itself from the presentation.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources were adequate.

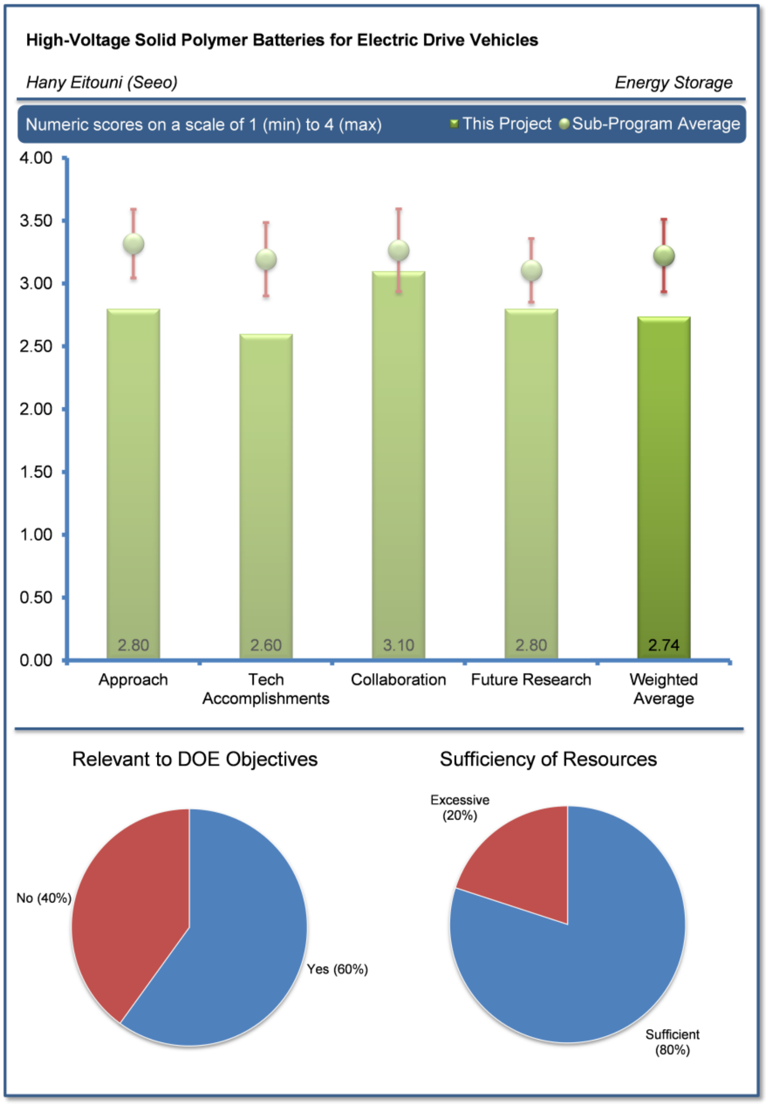
Reviewer 2:

The reviewer agreed that it appeared that sufficient resources were provided, as evident by the good progress that was made this past year.

Reviewer 3:

The reviewer cautioned that there was no need to spend dollars on demonstrating high-volume manufacturing (HVM) with this technique until a more firm background for the manufacturing costs associated with the process are demonstrated on paper relative to conventional processes.

High-Voltage Solid Polymer Batteries for Electric Drive Vehicles: Hany Eitouni (Seeo) - es129



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer described that the approach is to use a new approach to improve cell performance using a solid electrolyte that is non-flammable and non-volatile. The reviewer explained that this presents a significant opportunity to modify the internal construction of the Li-ion battery system with increased safety in operation, while still having the high energy advantage of the Li-ion cell system. The reviewer highlighted that the interaction with Hydro-Québec and their cell fabrication capability is a key part of the development.

Reviewer 2:

The reviewer commented that the approach taken during this effort was satisfactory; explaining that in order to achieve higher energy densities, a battery consisting of a Li foil anode is being developed. To do this however, the liquid electrolyte will be replaced with a dry polymer electrolyte binder/separator. The reviewer noted that having thin layers should enable good rate performance; however there are concerns that the polymer material being developed will not have the necessary electrode stability to reach DOE's cycle life goals.

Reviewer 3:

The reviewer acknowledged that the project uses an innovative solution, but pointed out that really hard questions about the cold weather use and parasitic power loss may just not be tolerated. The reviewer recounted that at least the researchers claim there is no permanent damage if it "freezes."

Reviewer 4:

The reviewer cautioned that the fundamental limitation of polymer electrolyte conductivity will limit the usefulness of this system for vehicular applications; however the reviewer added that it will find niche applications if developed successfully. This person indicated that multiple coatings were not the preferred routes for building a cost-effective battery. The reviewer also mentioned that coatings, if not conformal, are oftentimes band-aids, so might not meet the life targets.

Reviewer 5:

The reviewer criticized that the approach appeared to avoid performing work to address several of the fundamental issues with this particular technology. The reviewer explained that the scope of planned safety testing was unknown, but should be a key aspect of the project.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that work with Li anodes is challenging and hence the cycling results are not unexpected. The reviewer was not sure results better than these can be expected using the systems being studied in this project.

Reviewer 2:
The reviewer reported that Seeo has developed a proprietary polymer electrolyte that is stable with Li anode materials. The reviewer added that the experimental cells were constructed and had excellent performance and cycle life.

Reviewer 3:
The reviewer reported that the interim cells were delivered to DOE this year. Numerous cathode coatings were evaluated and several have shown improved cycling performance in comparison to the uncoated cathodes. The reviewer stated that the cycle life was unfortunately limited as shown by Slides 10-12 of the presentation.

Reviewer 4:
The reviewer warned that 100 cycles is not nearly high enough and the project is nearing completion. The reviewer did note that it was good to see the timeline being held in other ways. The reviewer pointed out that the researchers said they have met 350 Wh/kg, though this was not very clear in the data so it was hard to be certain of the claim's accuracy. The reviewer reinforced that safety is still an issue, but indicated that the researchers seemed confident they can lick it.

Reviewer 5:
The reviewer criticized that the data shared in the presentation was offered in a form which allowed for little, to no, judgment of the technical accomplishments or progress.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer lauded that the collaboration with Hydro-Québec is a very positive situation. Hydro-Québec has full capability in cell R&D to carry out cell development and create a commercial product. The reviewer emphasized that this collaboration is essential for Phase 3 of the project.

Reviewer 2:
The reviewer applauded that teaming up with Hydro-Québec was a good idea.

Reviewer 3:
The reviewer confirmed that Hydro-Québec's participation in the project is a positive aspect.

Reviewer 4:
The reviewer asserted that the partners seemed to be interactive, which was not very common.

Reviewer 5:
The reviewer noted that Hydro-Québec is a collaborator and will provide support in the Li anode development, cell deliverables, and commercialization plan. It was unfortunate to this person that others with expertise in polymers were not included.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer explained that the third phase of the project involves the scale-up of material synthesis and design and construction of large area cells to validate the technology as well as develop a cell assembly process. The reviewer also reported that a cost structure will be developed to understand the cost of high volume production as well as the safety and cost issues for the technology.

Reviewer 2:
The reviewer simply stated that the future research was just what they need to work on.

Reviewer 3:
The reviewer agreed that the future planned efforts were appropriate for this stage of the program. The reviewer also stated that the final cell design would be tested and a commercial plan would be made.

Reviewer 4:
The reviewer proposed that there was no need to go to large area cells. The reviewer also pointed out that the safety testing scope was unknown, but was critical for demonstrating any future viability.

Reviewer 5:
The reviewer did not expect the researchers to solve the fundamental issues that were associated with this system; noting the high-temperature application and low cycle-life of the Li anode.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer confirmed that this project was highly-relevant to DOE's objective of petroleum displacement.

Reviewer 2:
In this reviewer’s opinion, this was the most promising project at the Annual Merit Review. The reviewer remarked that cells with the Seeo polymer electrolyte should have superior safety over the regular liquid electrolyte constructions and very similar charge-discharge capability.

Reviewer 3:
The reviewer stated that this work was one of the more “far out” stuff that DOE should fund, and yet it was very well along in maturity so that it could go to pack testing if a few bugs are worked out.

Reviewer 4:
The reviewer expected that only limited/niche applications would result.

Reviewer 5:
The reviewer proposed that due to the fundamental aspects and limitations of the technology, the project basis should be on stationary applications, or other non-DOE VTO applications, so it was not relevant for DOE VTO funding.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer emphasized that this project, above all others, deserves an increase in funding. The reviewer stated that present funding is adequate to demonstrate the capability, but a fast-track to commercialization will give the U.S. Li-ion community an advantage in safety while having equivalent performance to the regular Li-ion cells.

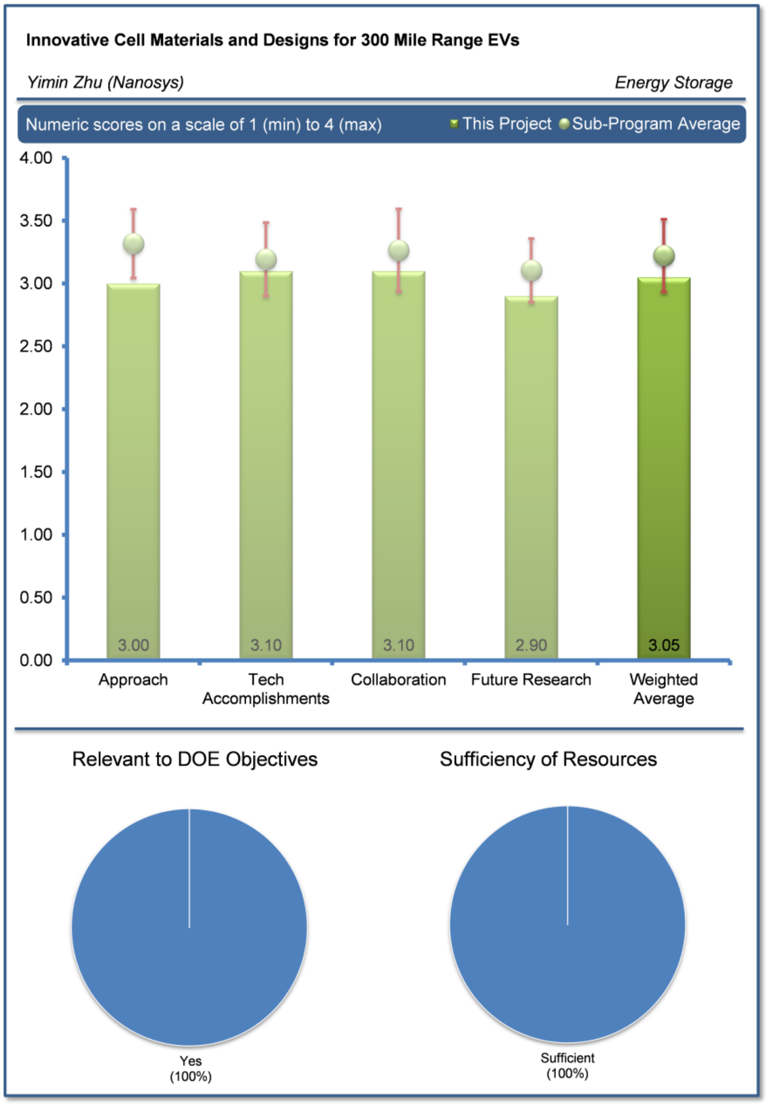
Reviewer 2:

The reviewer agreed that yes, the cash and the human resources seemed to be right.

Reviewer 3:

The reviewer simply stated that the funding appeared to be appropriate for this effort.

Innovative Cell Materials and Designs for 300 Mile Range EVs: Yimin Zhu (Nanosys) - es130



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the advantage of scale-up/manufacturability of the SiN-anode made it an attractive system to study.

Reviewer 2:

The reviewer applauded that the development of the 1D silicon anode structure for Li-ion cells is excellent. The reviewer noted that using high capacity silicon will increase the energy storage capability, while the long cycle life of the experimental cells gives hope for a significant increase in cell capacity.

Reviewer 3:

The reviewer praised that the approach being taken in this effort was clearly stated and was in agreement with DOE goals. The reviewer explained that the investigators were tackling such problems as cell energy density and cycle life. A silicon nanowire carbon composite anode would be employed and results thus far looked promising to this person.

Reviewer 4:

The reviewer agreed that the basic approach was reasonable. The reviewer explained that the project is aimed at developing a Si wire carbon nanocomposite electrode whereby the Si lies on top of the carbon. The reviewer stated that the researchers' approach may overcome some of the physical damage that comes from carbon coating silicon particles, where the carbon coating can break up as the silicon expands during charge. However, the reviewer cautioned that with their approach of using Si on top of a carbon base, that the Si is always exposed to the electrolyte which might well lead to poor anode cycling as the Si gets used up in continual SEI breakdown and reformation with continued cycling. The reviewer also noted that the researchers looked at rate and low temperature performance, which was good.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the development of a Si anode with good performance resulted in an anode with excellent capability for long cycle life and high rate performance. The reviewer remarked that the Si anode has the capability to deliver up to 1,600 mAh/g specific capacity. The reviewer also recognized that the cells have very low self-discharge on storage and a new electrolyte has been developed.

Reviewer 2:

The reviewer acknowledged that good progress was made this past year including a cylindrical full cell (SiN-anode/NCA) that had an 82% capacity retention at the 1,000th cycle, This cell was also shown to have a higher anode capacity than the graphite anode containing cell.

Reviewer 3:

The reviewer stated this was a scalable method that uses little, or no, gold. The reviewer remarked that the concept shows decent packing, so was likely okay on a volume basis as well. The reviewer emphasized that this was important, as some of the elegant methods people have developed fall down in this area. The reviewer also simply noted that good cycling data was presented.

Reviewer 4:

The reviewer observed that the key challenge of long cycle-life still remained a formidable one. The project person also noted that cells achieving an energy density of 550-700 Wh/L were already a commercial reality using conventional anode and cathode technologies.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the researchers were working with key developers, who could give good feedback on the direction of work.

Reviewer 2:

The reviewer summarized that the project had interacted with A123, LG CPI, Dow Kokam, Farasis Energy, as well as several national laboratories.

Reviewer 3:

The reviewer stated that the researchers have made good choices and involved industrial partners.

Reviewer 4:

The reviewer praised that the team, including A123, LG CPI, LGC, Dow Kokam, Farasis Energy, and several of the U.S. DOE laboratories, was very good. It was unclear to the reviewer what the role was of each of the various laboratories shown on Slide 23.

Reviewer 5:

The reviewer stated that this was mostly an industrial partnering program. The reviewer did not see much sign of integration with, or leveraging of, experts in DOE national laboratories. The reviewer asked whether this approach should not also be included in the cell builds and testing being done at ANL.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer described that the plans were to scale-up the cell fabrication to optimize cell performance, develop additives to improve electrolyte performance, improve cycle life and cell design.

Reviewer 2:

The reviewer agreed that the future work being proposed was appropriate. The reviewer described that the focus would be on improving the cycle life of the anode, including optimizing the cell by minimizing the inactive components, improving the cell design, and optimizing the cathode material composition. The reviewer also mentioned that it was good that cell evaluations at low temperatures are being conducted.

Reviewer 3:

The reviewer expressed that the researchers needed to focus on high loading, or at least high enough for a power-based HEV cell (ideally work on a PHEV design that uses a thicker electrode would also be carried out). The reviewer offered that the researchers needed to ensure that the future testing includes some work with ANL to build and test the standardized cells so that their method can be compared to other approaches to using silicon anodes on an apples-to-apples basis.

Reviewer 4:

The reviewer stated that the project ended this year and that there were no indications of the researchers' intent for future work.

Reviewer 5:

It was not apparent to the reviewer how the key bottlenecks of low cycle-life, energy density, and cost targets would be met in future research.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that since the concept was much more amenable to scale-up, and if the cyclability/cost issues could be resolved, then this project would be valuable to the overall goal.

Reviewer 2:

The reviewer stated that new high-performance Li-ion cells to power cars would reduce petroleum use.

Reviewer 3:

The reviewer asserted that this project was highly-relevant and supported DOE's objectives to displace petroleum with electric drive systems. For example, the EV Everywhere battery goals for 2022 are a cost of $125/kWh and energy densities of 400 Wh/L and 250 Wh/kg. The reviewer explained that achieving this would require lowering the cost of raw materials and material processing, as well as lowering the cost of cell and module packaging and manufacturing.

Reviewer 4:

The reviewer confirmed that this work could lead to a better anode, but that it was hard to say whether it would be better than other Si/C anodes under development.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

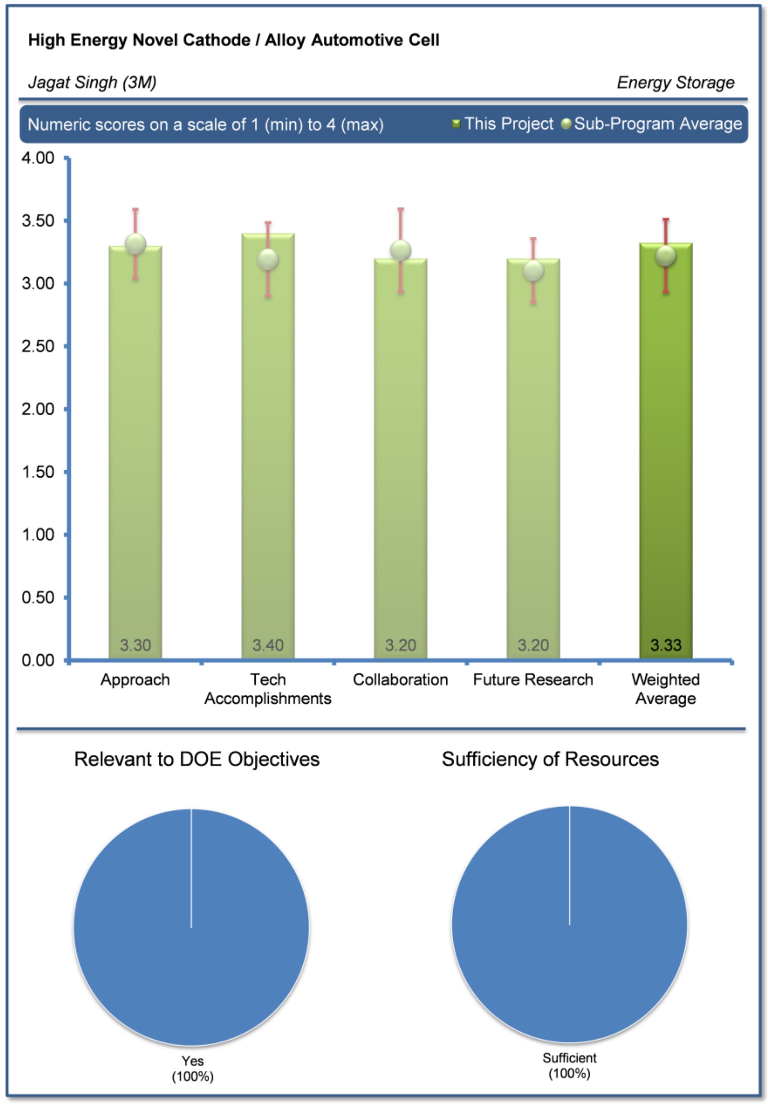
Reviewer 1:

The reviewer agreed that the resources were adequate for the proposed work.

Reviewer 2:

The reviewer commented that based on the results thus far, the resources were sufficient.

High Energy Novel Cathode / Alloy Automotive Cell: Jagat Singh (3M) - es131



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer called the approach the right one, noting that the researchers are utilizing high-energy cathodes with new-generation anodes and tested on 18650 cells.

Reviewer 2:

The approach being taken in this project, the reviewer said, is clearly defined and a logical path toward meeting DOE goals and observed that the team plans to develop a high-performance cell using high energy-density and low-cost advanced electrochemistries. The reviewer went on to note that the cathode will utilize a core-shell design, the shell consisting of high Mn content for improved cycle life and a high Ni content for good capacity and that Si alloy anode is also being developed. These materials, the reviewer said, are known for their high capacity.

Reviewer 3:

The reviewer termed the approach solid, tangible and well-focused. An additional area which could have been or could be included (and beneficial), the reviewer suggested, would be limited comparison of abuse tolerance relative to baseline cell in 18650 form. Perhaps this is included in the project's thermal stability plan, but this is not clear, the reviewer said.

Reviewer 4:

The basic approach is reasonable, the reviewer felt, and aimed at marrying a high-capacity, core-shell NMC with silicon-carbon alloy. This, the reviewer said, could lead to a modest, but still useful advance in energy density. One advantage the reviewer saw for the project team's approach is that the electrodes are practical from a manufacturing point of view.

The reviewer would have liked to see some more fundamental work done on the chemistry of degradation with cycle life and/or basic electrochemistry. The reviewer explained that the team infers that cathode instability is causing the voltage fade at high states of charge. The reviewer called the cycling followed by half-cell cycling nice work and said it supports the team's belief. However, the reviewer would have liked to see much more use made of other electrochemical tools to better understand the cause of the problem, specifically, differential capacity plots and/or reference electrodes, which the reviewer said can be very helpful in fully understanding the causes of poor cycle life.

Reviewer 5:
The reviewer described the project goal as being the development of a battery for an electric vehicle with 40% greater energy density and 25% lower in cost over present systems and noted that high-performance silicon alloys for the anode and improved NMC performance are the key elements.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
Very good progress has been made this past year, the reviewer said, noting that the team developed electrode coating procedures and delivered baseline and intermediate cells. The NMC cathode scale up appears to be successful the reviewer observed, and the pilot plant material gave similar performance to the lab material. The reviewer also noted the development of a cost-effective process for commercially viable Si alloy anode materials, in addition to the evaluation of high-voltage electrolytes and demonstration of a 18650 format cell with a 40% energy improvement.

Reviewer 2:
The reviewer noted that the researchers mentioned having produced 100 kg. of advanced material (anode) and wondered how much (in kg.) had been produced per day. The core-shell concept seems to be working, the reviewer said, again asking how much could be produced per day and how reproducible the quality of such material was.

Reviewer 3:
The team were able to get higher capacity from anode and cathode, the reviewer observed, albeit with poor cycle life at full capacity. Reducing charge voltage so the cell is not fully charged helps a lot, the reviewer said, but noted that this is true even for commercial Li-ion cells. However, the reviewer said, the penalty in energy needed to attain good cycle life is quite substantial in this case. Overall, the reviewer felt, this does not represent much of an advance. The reviewer found it hard to discern the extent of the capacity loss from undercharging the cell from the normalized plots in the presentation.

Reviewer 4:
A new high-energy NMC cathode material was developed, the reviewer blandly noted, as well as new silicon anode structure with high performance. Fade on cycling also was reduced for long life, the reviewer said, and a 40% energy improvement was obtained along with a 40% improvement in cycle life.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer cited excellent and sharply focused collaboration without unnecessary distractions.

Reviewer 2:
The reviewer cited good interaction between ANL, Dalhousie University and 3M.

Reviewer 3:
The PI is teaming with Dalhousie University who has a superior background in lithium battery technology, the reviewer said, predicting the university will bring great value to the team. Likewise, the reviewer observed, Argonne National Laboratory is helping by improving testing procedures and providing valuable insight regarding the materials.

Reviewer 4:
Terming this a mainly industrial collaboration project, the reviewer felt the team could benefit from better collaboration with the national labs, especially their electrochemists and staff who have methods to study cathode fade.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer strongly encouraged the electrochemical testing on 18650 cells and predicted the thermal stability test is going to be important.

Reviewer 2:
This effort is scheduled to be completed January 2015, the reviewer noted, and for the remaining time, 18650 cells will be evaluated, the team will continue to develop and test electrolytes for improved cycle life and the thermal stability of the cells will be tested. These tasks are appropriate and will contribute to the development of a cell that comes closer to meeting DOE goals the reviewer stated.

Reviewer 3:
The reviewer expressed the hope that useful relative abuse tolerance comparison is included in thermal stability testing plans.

Reviewer 4:
Noting that the project team was focusing on a better electrolyte to get the cycle at higher voltage, the reviewer described this as a major project in itself. Acknowledging that the fluorinated electrolytes might work, the reviewer felt the likelihood of success or other significant trade-offs (rate capability) with them seem pretty high. This project team, in the view of this reviewer, was facing a major challenge and could benefit from more help and advice from the national laboratories.

Reviewer 5:
Proposed future work includes EV testing of the new NMC material with silicon anodes in a new electrolyte, establishing the thermal stability of the system and developing new electrolytes for Phase 3 of the project, the reviewer said.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This project is relevant to DOE's objectives to displace petroleum with electric drive systems, the reviewer said. Obtaining affordable batteries will require lowering the cost of raw materials and material processing, as well as lowering the cost of cell and module packaging and manufacturing, the reviewer concluded.

Reviewer 2:
The project could enable higher energy density while using electrodes that are producible on a large scale, according to this reviewer.

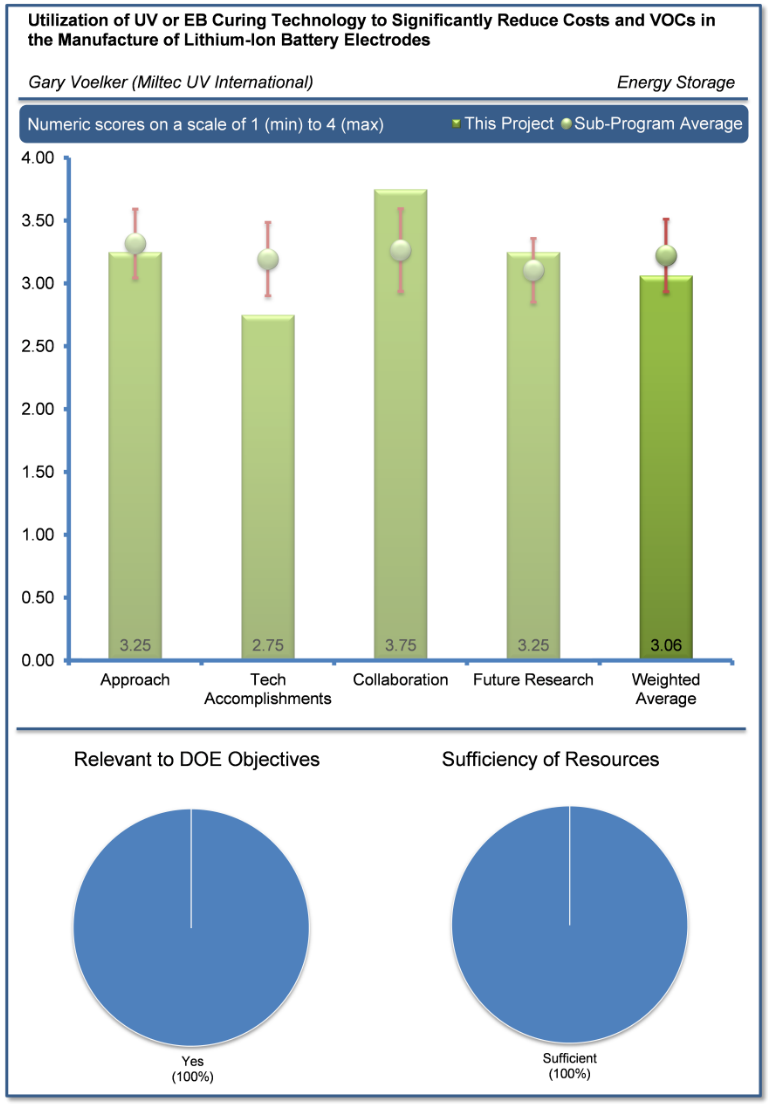
Reviewer 3:
The new cells will have greater energy storage capability and longer life, the reviewer said.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
Sufficient resources are available, the reviewer said.

Reviewer 2:
In the opinion of this reviewer, the program appears to have the necessary resources to complete the tasks successfully; the total project funding includes $4,577,909 (from DOE) and $1,961,961 from the company.

Utilization of UV or EB Curing Technology to Significantly Reduce Costs and VOCs in the Manufacture of Lithium-Ion Battery Electrodes: Gary Voelker (Miltec UV International) - es132



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The approach appears attractive from the standpoints of solvent usage, cost, etc., in the opinion of the reviewer, who was less sure about long-term life data.

Reviewer 2:

The reviewer noted that the project is intended to show that UV-curable binder technology can be applied to Li-ion cells and said the process was clearly demonstrated on NMC material,. The reviewer felt the process should be able to handle most metal-oxide-based cathodes. This advancement will contribute significantly in the reduction of capital and manufacturing costs associated with Li-ion cell fabrication, the reviewer predicted.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Observing that the data so far is quite preliminary, the reviewer expressed the concern that all the data are from half cells and that, even after three years, the project team have not been able to present data on full cells. Of course, the reviewer said, cycling of such cells at elevated temperatures will be a key test for the validity of this process.

Reviewer 2:

The reviewer felt the project has lacked in comprehensive performance analysis, but had achieved expected material density and cyclability. The anode work has taken longer than expected, the reviewer observed, but the investigator has learned about the issues associated with various electrode systems. The success with the separator work the reviewer deemed an additional bonus. The reviewer looked forward with interest to seeing the performance of a cell utilizing multiple fabricated components and encouraged the generation of a complete gap chart, summarizing initial project goals, and the degree to which these were achieved.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
There is good coordination with suppliers and testing labs, the reviewer said, which is ideal for the scope of the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer recommended the project team devote efforts to fabricating and testing full cells to demonstrate the efficacy of this process and to then test the cells at elevated temperatures, too.

Reviewer 2:
The project is closing out, the reviewer noted and would benefit from further development with a larger-scale cell development partner. The reviewer encouraged such follow-on development.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

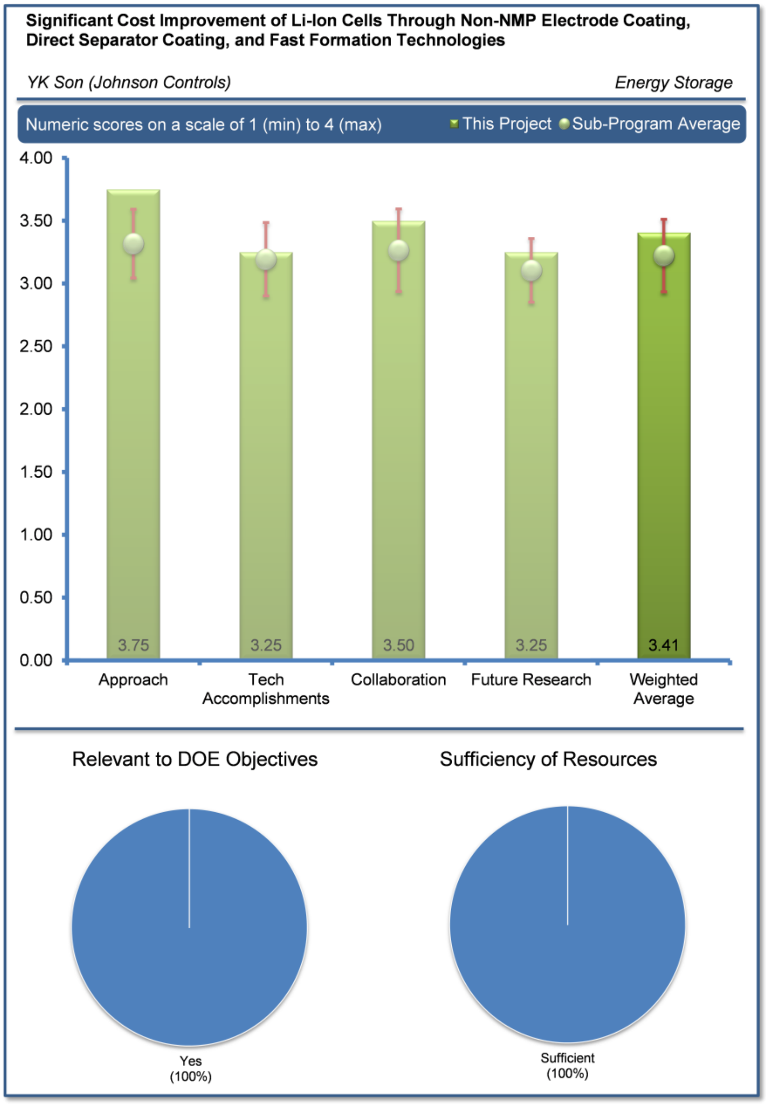
Reviewer 1:
If validated, the reviewer stated, this process has the potential to significantly lower cell manufacturing cost.

Reviewer 2:
This project is an excellent example of improvement in manufacturing processes for advanced batteries, the reviewer said.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
Resources were well balanced for the project, which was capital intensive, with significant process development, the reviewer said.

Significant Cost Improvement of Li-Ion Cells through Non-NMP Electrode Coating, Direct Separator Coating, and Fast Formation Technologies: YK Son (Johnson Controls) - es133



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The approaches promise significant cost advantages, the reviewer said, and if the processes and performance are validated, will definitely help develop low-cost batteries.

Reviewer 2:

The reviewer termed this a multi-pronged approach to generating novel manufacturing processes for high-cost components, none of which was particularly innovative, but which were executed with a solid balance between cell design, performance, and manufacturability, in the opinion of the reviewer.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The poor rate capability at continuous currents, the reviewer said, is a significant issue that needs to be addressed for these technologies to be potentially useful for Li ion battery production. The reviewer expressed the understanding that dry electrode manufacturing can be applied only to thick electrodes and it is a challenge for fabricating high-power, thin electrodes. The reviewer inquired about how the project team would address that.

Reviewer 2:

Overall, the reviewer found the results impressive. Among the results, the reviewer regarded the dry process electrode as particularly intriguing. The key targeted barrier was fabrication costs, the reviewer noted. The baseline cost indicated for process appeared to the reviewer to be very high, particularly when contrasted with the materials cost. This engendered a degree of skepticism in the reviewer concerning the true cost reduction over best-in-class cell manufacturing. The reviewer encouraged the inclusion of more cycling data and abuse results in future reports.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer regarded this as an excellent team for collaborative work.

Reviewer 2:
Noting that it was not explicitly stated which partners performed what portion of each of the tasks, on each slide, the reviewer nevertheless found it clear that solid coordination between the key partners occurred.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer observed very good prioritization of future work, and expressed confidence that the results of this program will be transferred to production. The reviewer recommended the PI report the cost improvement in terms of $/kWh for a representative cell design, in order to emphasize the savings.

Reviewer 2:
The reviewer recommended that validation of fabrication, power, life (at elevated temperatures) in the proposed 15 Ah cells, as well as cost modeling be the focus of future work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

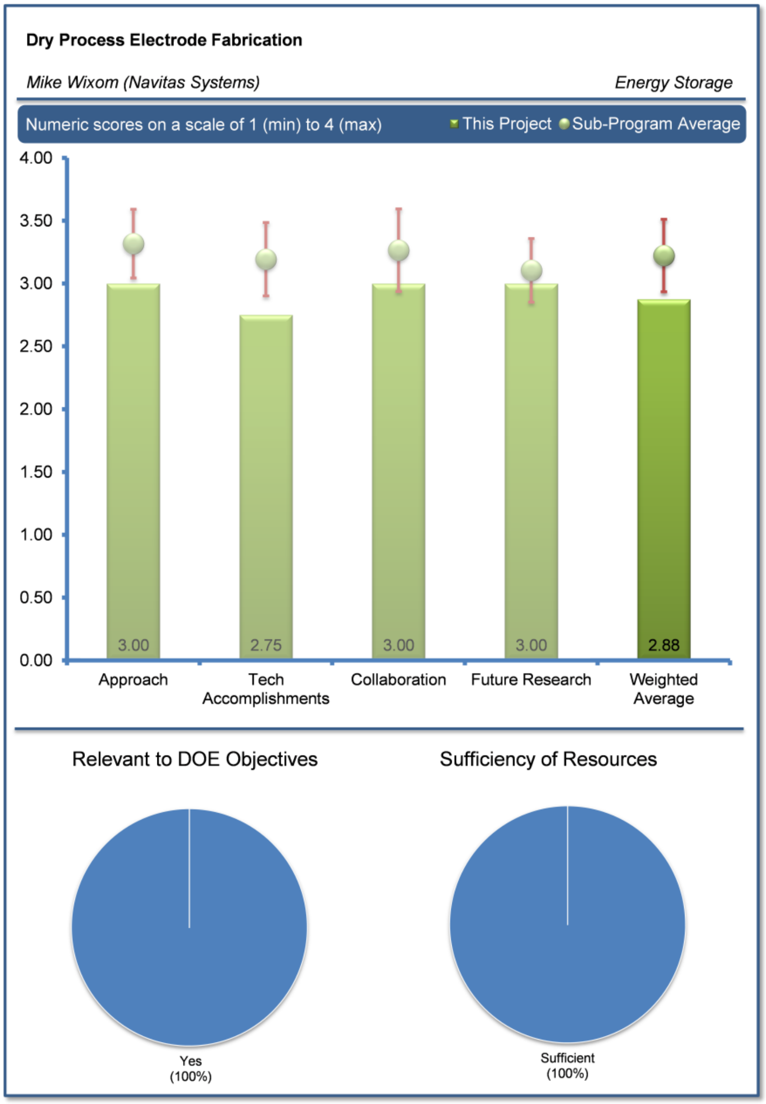
Reviewer 1:
The project is highly relevant, the reviewer said, since it targets the reduction of battery cost.

Reviewer 2:
This reviewer observed excellent demonstration of manufacturing improvements to reduce battery cost, which remains the single largest barrier to mass adoption of PEVs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The project is well planned and executed, the reviewer said.

Dry Process Electrode Fabrication: Mike Wixom (Navitas Systems) - es134



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said the approach to anode and cathode coating was multi-pronged.

Reviewer 2:

Listing the objectives of the project as developing dry process cathodes of suitable thickness to meet the rate and cycle life needs of EVs; identifying binder system for solvent-free anode fabrication stable through 500 cycles; validating the cost savings from the process improvements; and demonstrating the performance in prototype cells, the reviewer felt the approach to developing low-cost fabrication processes is valid, but also felt there should be no compromise in performance, since any performance reduction will indirectly impact the cost. Also, the reviewer said, the methods being developed are dependent on the active materials (in this case LFP and NMC cathodes).

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Noting that there is some good progress relative to dry cathode and low/zero-solvent anode, the reviewer termed it encouraging. The NMC-LFP (50:50) blended, dry-processed cathode shows reasonable rate capability and comparable cycle life and impedance values as for the LFP cathode, the reviewer observed. Likewise, the reviewer noted that development of anodes from high-solids aqueous anode slurry with advanced drying process, or with dry blending alone, is showing some promise, but there are still issues related to cycle life. Referring to the comment of a previous reviewer, this expert agreed it is important to have proper standards (baseline) for comparison, both in terms of performance and cost. A realistic cost analysis, the present reviewer said, is required to justify the effort here.

Reviewer 2:

Progress has been good, the reviewer said, although a more structured gap chart would help in evaluating the results. Calling the moisture issues with full cells a setback, the reviewer recommended including data from a baseline cell, utilizing traditional processes.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

Saying there is no formal collaboration here, the reviewer noted a few ongoing, unfunded collaborations on various materials.

Reviewer 2:

The program is driven by Navitas, the reviewer said, with a supplier-customer relationship with most partners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer deemed the plan solid, given both the original project plan, as well as response to discoveries and encouraged the PI to include details on electrode thickness and process performance, as indicated in the original program objectives.

Reviewer 2:

Citing the proposed future research as including identification of alternate processing additives for the cathode to mitigate moisture retention and increase active material content and to further improve calendaring to get wider cathode films; reformulation of dry anode to reduce initial capacity loss and down-select and scale-up anode process for final cells; and demonstration of the performance of low-cost process anode and cathode in full cells, the reviewer called these future plans consistent with the overall goals of the ABR program of reducing the cost of Li-ion cells. However, the reviewer went on, it is important to make a proper assessment of cost savings from this improved process, with assistance from a commercial EV battery manufacturer, if possible.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

High specific energy, long cycle life and low cost are the performance drivers for Li-ion batteries in electric vehicles, the reviewer stated. Cell fabrication processes for Li-ion cells are cost-intensive – as much as the cost of cell components, if not more, and this project, the reviewer said, is aimed at developing alternative low-cost cell (electrode) fabrication methods to lower the costs of Li-ion cells and increase their adoption in electric vehicles.

Reviewer 2:

Along with the future work, the reviewer said, this project will aid in reducing manufacturing costs for large-scale cells.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

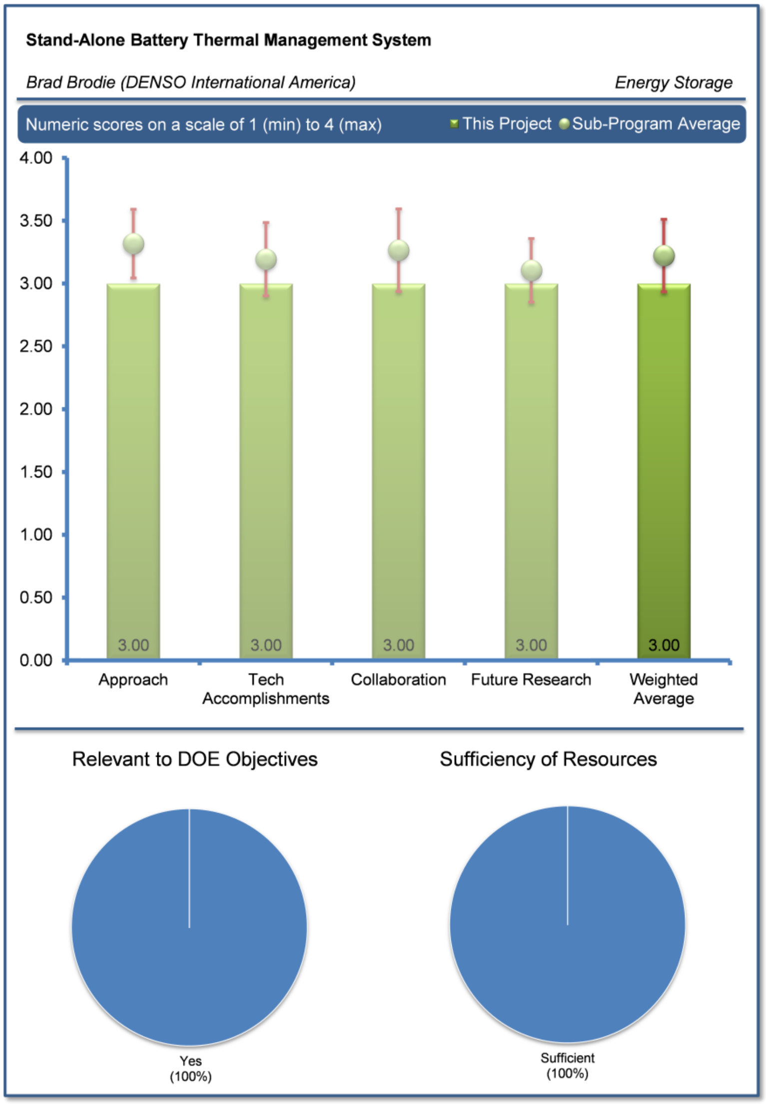
Reviewer 1:

The resources are well-balanced, in this expert’s view.

Reviewer 2:

The resources are adequate, in the reviewer’s opinion, maybe even slightly excessive for the scope of the project.

Stand-alone Battery Thermal Management System: Brad Brodie (DENSO International America) - es135



Reviewer Sample Size

A total of one reviewer evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

After establishing a suitable battery simulation model that could also incorporate thermal system modeling in Phase 1, the reviewer observed, subsequent efforts in Phases 2 and 3 focused on evaluating various thermal design concepts through modeling and validating the concepts down-selected through bench testing with a battery pack of high energy. Two thermal design concepts (reactive thermal management though high-efficiency vapor-compression cycles and passive thermal management) were also studied in detail and will be further explored with prototype samples of the selected technologies through bench testing, the reviewer concluded.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Good progress has been made toward the project goals, the reviewer said, noting specifically the battery simulation model created In Phase 1 with NREL's help, and verified with the vehicle data from Chrysler. This model, the reviewer said, predicts battery life, fuel economy and energy effects of thermal system based on vehicle usage and ambient conditions, battery heat generation and the selected thermal system. These analyses show that a heat pump system is more efficient than resistive heating and can reduce battery-heating energy more than 50%, the reviewer observed an with aggressive thermal management, it is possible to increase the battery lifetime by 3 years in the worst climate, and reduce the battery active material by 5% (over 8 years). These predictions are useful engineering guidelines in the design of proper thermal management, the reviewer said, and need to be verified experimentally. One difficulty with this project the reviewer noted is the lack of adequate fidelity for the battery simulation model for performance and degradation (first-principles) due to its complexity and specificity for the battery chemistry.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This is a good collaborative project with a national laboratory (NREL) and the EV user (Chrysler), in the opinion of this reviewer, who noted that NREL will further collaborate in the testing of the thermal management system and Chrysler will provide the battery pack.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

Proposed future research, the reviewer said, will include subjecting prototype thermal system components to bench testing to validate and demonstrate the effectiveness of the thermal system, which will be done both at DENSO and NREL These plans are consistent with the goals of the ABR program of reducing the size and cost and improving the life and safety of Li-ion batteries, in the reviewer's opinion. With the simulation tool developed here, the reviewer continued, it is probably useful to study other thermal management schemes currently being used in EV batteries for a comparative assessment of the cost and efficacy of the selected thermal management methods.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

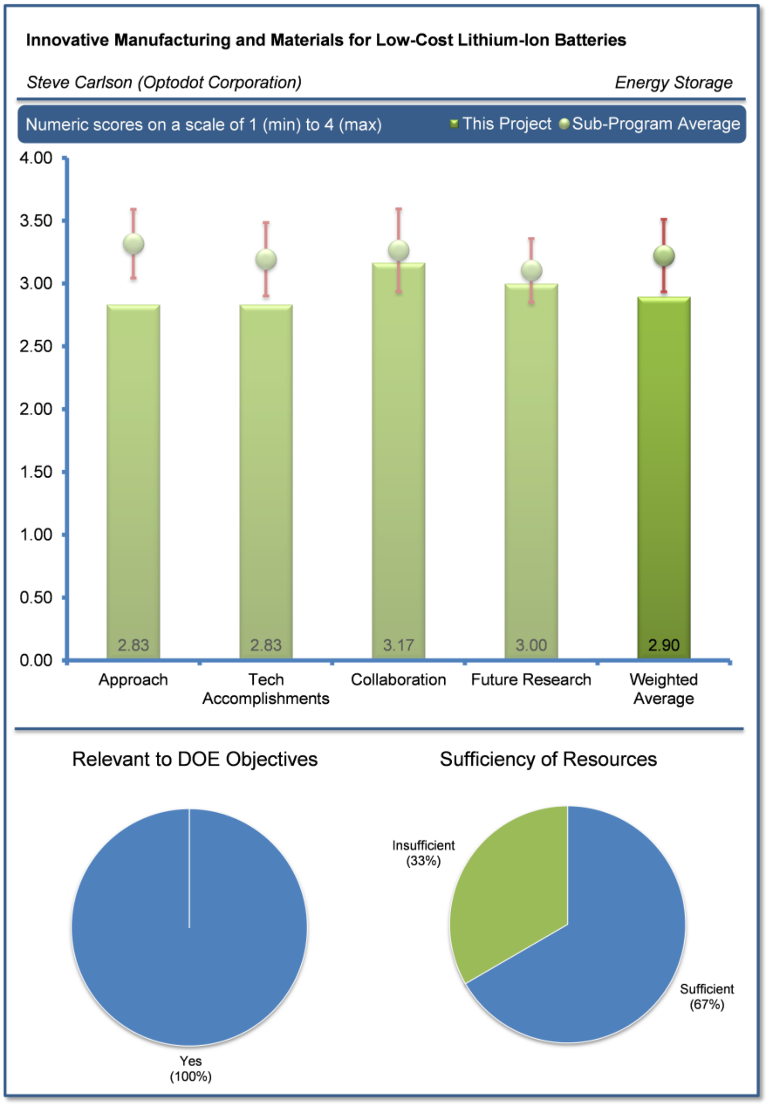
The reviewer cited high specific energy, long cycle life and low cost as the performance drivers for Li-ion batteries in electric vehicles. For Li-ion batteries, the reviewer stated, thermal management is crucial to ensure not only long cycle life and adequate safety, but high specific energy at the battery level and this project aims at developing innovative thermal management concepts that reduce the cell or battery weight, complexity (component count), and/or cost by at least 20%.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The resources are adequate, the reviewer said, perhaps even slightly excessive for the scope of the project.

Innovative Manufacturing and Materials for Low-Cost Lithium-Ion Batteries: Steve Carlson (Optodot Corporation) - es136



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The technology shown, the reviewer said, is an excellent extension of prior art technologies, but directed specifically at the DOE objectives. These were clearly identified at the start of the presentation, and supported throughout, the reviewer continued, but some concerns exist over the magnitude of the project and degree of progress.

Reviewer 2:

The reviewer felt the approach adopted here appears to be viable and is consistent with the objectives of ABR. The approach is based on replacing the conventional polyolefin separators with thinner (8 micron) ceramic separators, the reviewer said, which, because of its dimensional stability, provides improved safety and high-temperature operation, and can enable new electrode production processes – coating the active materials directly onto the ceramic separators and using thinner current collectors. Overall, the reviewer said, there will be a 20% decrease in cost and more than a 5% reduction in volume. Consistent with the approach, proprietary processes have been developed to deposit thin current collectors onto the electrode later. In addition, new, non-flammable electrolytes are being developed, the reviewer noted, although not much detailed information was provided on this subject in the presentation. These improvements, the reviewer said, are being demonstrated in 2 Ah cells to show the feasibility of the concepts.

Reviewer 3:

Somehow, the reviewer stated, the targets set for this project (250 Wh/kg; 400 Wh/l) are not aligned with reality. Lithium-ion batteries offering approximately 270 Wh/kg and 780 Wh/l are a commercial reality in late 2014, the reviewer noted. The reviewer was left unsure what targets the project team is working toward. Nor was the reviewer sure that the cost reduction from thinner components (separators and foils) would not be outweighed by processing costs. How will the uniformity of the electrode/separator interfaces and that of the electrode porosity be controlled, the reviewer asked. The reviewer also wondered if the electrode stack will survive the typical pressure used to calendar electrodes.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Overall the improvements appear promising, the reviewer said, and likely to reduce the cost and overall volume of Li-ion cells. The reviewer felt questions remained, however, namely, whether these ceramic separator-based electrode stacks are amenable to cylindrical cell designs and if there are apt to be any mechanically induced failures (from vibration and shock) of the ceramic separator. Good progress has been made toward the project goals, the reviewer went on, by demonstrating the thin current collector/active material/ separator stacks with thin ceramic separators. Specific areas of progress included development of ceramic separator and release substrate to achieve defect-free electrode/separator stack coatings, which would further reduce the ceramic separator cost by about 20% and demonstration of good cycling at room temperature of initial prototype separator/electrode stack full coin cells with thin Al and Cu current collectors. In addition, the reviewer said, the cells with ceramic separators have shown good low-temperature performance and high-temperature stability.

Reviewer 2:

The program, as reported, appears to be running late, the reviewer observed, and significant work has yet to be achieved. The fabrication process has been demonstrated, but it will be good to see the results of the complete cells, the reviewer went on.

Reviewer 3:

The cycling data, being preliminary, shed very little light on the capability of such a cell fabrication process, in the opinion of this reviewer, thus long-term and high-temperature cycling are needed to validate the stability of such interfaces.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

A strong team for collaboration, the reviewer said.

Reviewer 2:

This, the reviewer said, is a good collaborative project, with participation by four partners and subcontractors – Madico, XALT Energy, URI and Ashland for different aspects, i.e., coating and converting expertise and equipment, battery assembly and testing capability, electrolyte expertise, and polymer and solvent expertise.

Reviewer 3:

It was not clear to this reviewer the degree to which the development partners have been engaged to date and the reviewer recommended the PI indicate partner engagement on the appropriate slides.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The plans are consistent with the project goals, the reviewer said, and went on to describe them as including further optimization and scale-up of the anode and cathode stacks, the current collector/terminations; development of coated stack designs with one-third thinner electrodes for high rate/power cells; continued evaluation of new lithium salts and flame- retardant electrolytes; understanding the mechanism of enhanced cycle life with thin (8 micron) ceramic separators; assessing the cost savings with these improved cell designs and delivering cells for performance and safety demonstration.

Reviewer 2:

The reviewer expressed concern over the degree of technical work that will be required in developing internal tabbing, since this will form significant portion of development work, once the two-electrode cell construction is worked out. The reviewer encouraged the PI to investigate an EV-representative design cell, as part of a paper study, in order to pro-rate performance cost, and assess manufacturing/scaling issues.

Reviewer 3:

Instead of diluting the efforts on new work such as nonflammable electrolytes etc., the reviewer felt, the project team should focus on validating the cell results by carrying out long-term cycling at high temperatures.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This process holds promise of significantly reduced cost, the reviewer said, and urged that the program be followed through with a more applied program to demonstrate scale-up.

Reviewer 2:

Efforts to improve process and lower component costs are important for developing low-cost batteries\for automotive applications, the reviewer stated.

Reviewer 3:

High specific energy, long cycle life and low cost are generally the performance drivers for Li-ion batteries to be used successfully in electric vehicles, the reviewer said. For the current Li-ion cells, the reviewer continued, performance is satisfactory, but the cost and weight are rather high and this project aims at reducing the overall cost, weight and volume of Li-ion cells by 20-40%, without affecting the performance, by reducing the cost, weight, and volume of inactive components (separator, electrolyte, current collectors)

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

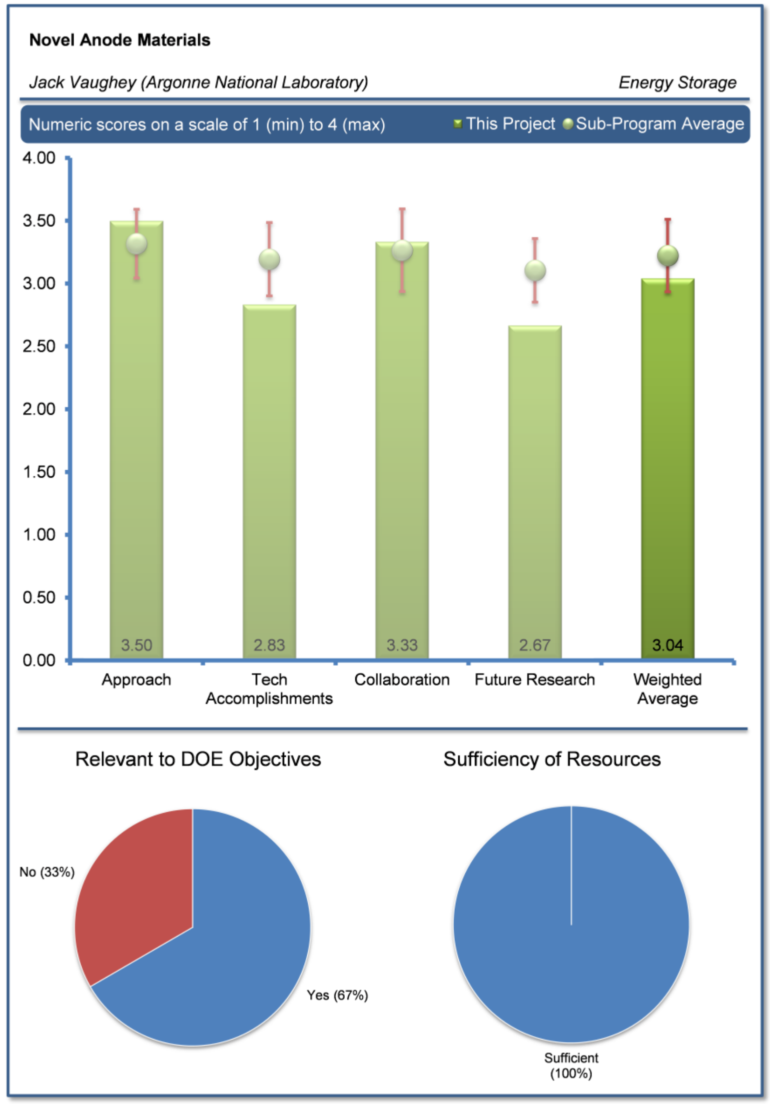
Reviewer 1:

The resources are slightly excessive for the scope of the project, though the projected improvements are attractive, the reviewer said.

Reviewer 2:

The PI indicated that the project is approximately 50% complete, with three months remaining on the program timeline, the reviewer noted.

Novel Anode Materials: Jack Vaughey (Argonne National Laboratory) - es143



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

In the judgment of the reviewer, the approach aids understanding of the operation of Si-based anode and potential replacement of current lithium-ion batteries for increased energy density and safety.

Reviewer 2:

The reviewer noted that the investigators used a methodical approach to the study of Si anode SEI formation and said it will be interesting to see how the techniques utilized can be applied to the more complex composite anodes being proposed by industry.

Reviewer 3:

The approach is good, the reviewer said, and suggested that a comparison of electrodeposition and PVD could be made.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This project has achieved interesting results, the reviewer felt, but the cycling efficiencies are still relatively low and the first-cycle capacity loss appears to be high. The reviewer observed that the interface between SEI and Si appears to play one of the key roles for the Si-based anode and wondered what the relationship of that role is to the cycling rate.

Reviewer 2:

The research has made solid strides toward determining a core mechanism for an ionically conductive SEI layer, the reviewer said. The reviewer felt, however, that the work is more a research effort than an effort to develop a solution to the main problems cited in the introduction.

Reviewer 3:

The reviewer cited accomplishments including interfacial Cu3Si formation and to improve the loading. However, the reviewer regarded most of the published papers listed as not relevant to the silicon work.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The PI has collaborated closely with other institutions, one reviewer said.

Reviewer 2:
Most work was done by the prime research facility, the reviewer stated, but the partners' results were clearly included within this report.

Reviewer 3:
Collaboration with other institutions is good, in the opinion of the reviewer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
It may be helpful, the reviewer suggested, if work on the impact of the charge/discharge rate can be included to understand the degradation caused by lithium silicates.

Reviewer 2:
It was not clear to the reviewer whether the future work will achieve its goal in overcoming the barriers listed, namely, being able to engineer a stable, high ionic conductivity SEI layer for a Si composite electrode.

Reviewer 3:
The project team should describe the type of stable materials that may influence the degradation pathways, in the opinion of the reviewer.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer described the project as addressing the problems associated with Si-based anodes for improved Li-ion battery specific energy and safety.

Reviewer 2:
The reviewer felt the technology developed herein will be difficult to apply to anodes practical for plug-in EV batteries.

Reviewer 3:
Reduce the use of petroleum was stated by this reviewer.

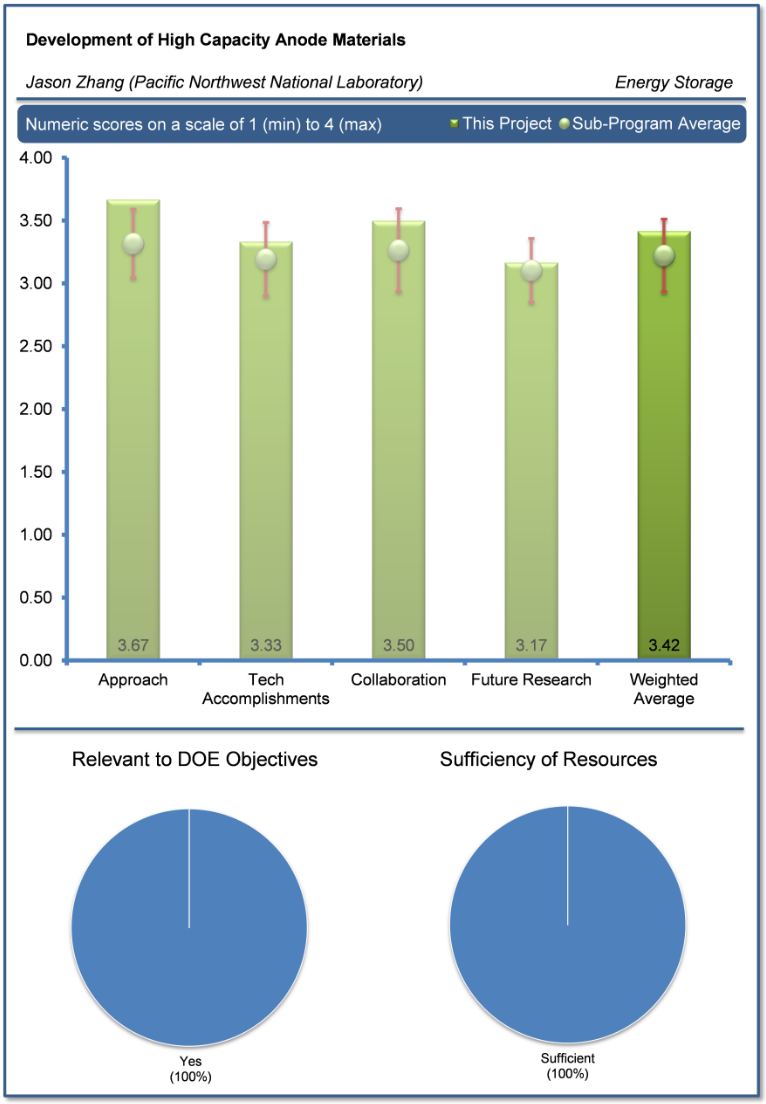
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
There are sufficient resources allocated for this project, the reviewer said.

Reviewer 2:
Progress appears reasonable, with respect to the current level of resourcing, this reviewer felt.

Reviewer 3:
Sufficient resources were observed by the reviewer.

Development of High Capacity Anode Materials: Jason Zhang (Pacific Northwest National Laboratory) - es144



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said this project structure was impressively well focused, balancing a creative perspective on the problems, while remaining focused on the goals.

Reviewer 2:

This project, in the reviewer's judgment, addresses some key technical barriers of Si-based anodes, including Si expansion.

Reviewer 3:

Porous silicon approach is a very good idea, in this reviewer's opinion.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This project, the reviewer said, has achieved several progresses accomplishments, and electrode capacity retention can be as high as over 80% after 1000 cycles for certain electrode loadings. FEC additive has been proved to be effective for capacity retention, the reviewer noted, but found it unclear if the additive can be valid over a wide temperature range. The reviewer pointed out desirability of demonstrating capacity retention at a higher rate during cycling.

Reviewer 2:

Progress has been impressive, the reviewer said. The reviewer encouraged the investigators to continue to focus on scale-up to thicker electrodes, and begin the optimization of pre-lithiation, and to characterize electrode impedance and rate capability. Future work, the reviewer said, could then move to additional optimization for electrode rate performance.

Reviewer 3:

This reviewer inquired about how to improve the loading and whether the prelithiated samples can be made stale in air.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The PI has a close collaboration with other institutions, the reviewer observed.

Reviewer 2:
The investigator clearly identified the collaborative roles and the collaborators contributed significantly to the overall program, in the view of this reviewer.

Reviewer 3:
Collaboration is very good, in the opinion of the reviewer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The PI proposed several approaches to future work, the reviewer noted, but it was unclear to the reviewer if that future work could be accomplished under this project (which is to be ended by September 2014) or for a future project.

Reviewer 2:
The reviewer directed attention to earlier remarks but did not specify which ones. The investigator, the reviewer said, has laid a firm base for future work, and should be ready to begin to move towards a more application-based investigation.

Reviewer 3:
Noting that in the presentation summary it was indicated that low-cost electrodes have been developed, the reviewer pointed out that the future work also indicates low-cost electrodes will be developed. The reviewer questioned the nature of any cost difference between these groups of electrodes.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This project, the reviewer said, supports the DOE objectives by targeting some key technical barriers of Si-anode capacity degradation.

Reviewer 2:
This technology should be transferable to practical cell designs, suitable for PEV applications, the reviewer stated.

Reviewer 3:
Reduces the use of petroleum was stated by this reviewer.

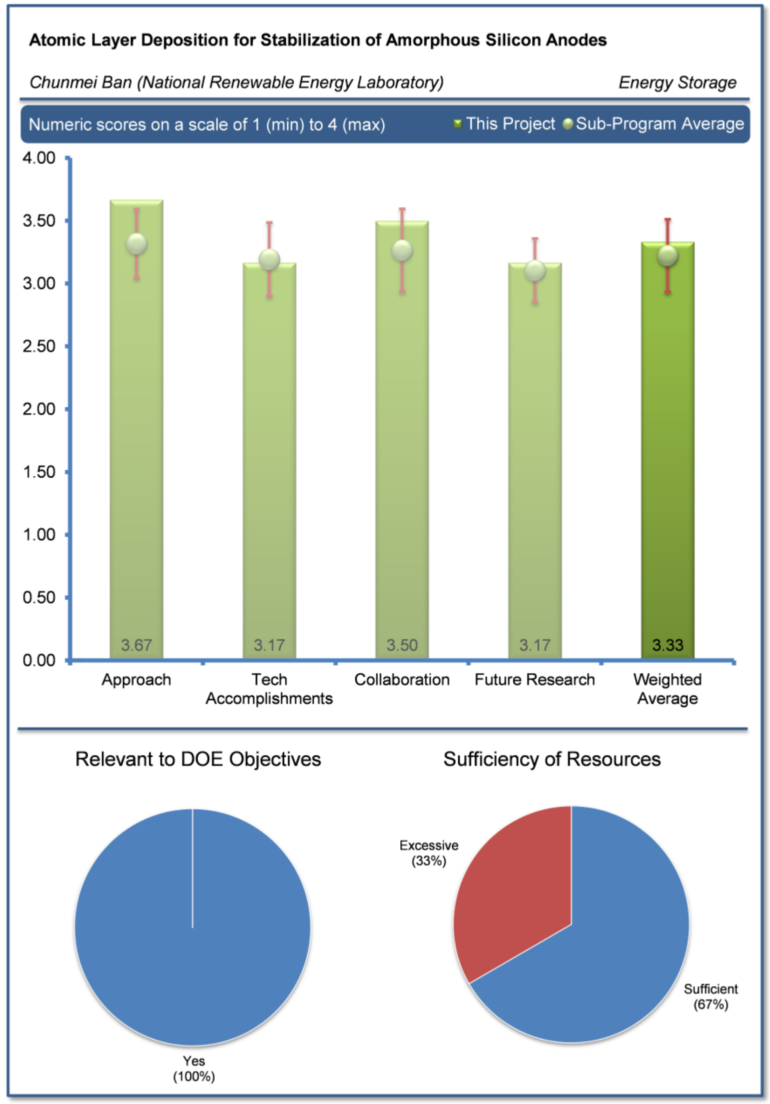
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
There are sufficient resources allocated for this project, in the opinion of this reviewer.

Reviewer 2:
Discerning no issues, the reviewer cited good program management.

Reviewer 3:
There are sufficient resources allocated to this project, the reviewer said.

Atomic Layer Deposition for Stabilization of Amorphous Silicon Anodes: Chunmei Ban (National Renewable Energy Laboratory) - es145



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer called the program an excellent example of the application of novel scientific approaches to a practical problem. The project was executed with clear, targeted focus on the goals, and the approach uses lessons learned from previous activities in the battery field very effectively, the reviewer stated.

Reviewer 2:

The novel technical approach, the reviewer said, addresses some key barriers for Si-anode applications. Cost analysis may need to be considered for ALD and MLD approaches, the reviewer added.

Reviewer 3:

The ALD and MLD approaches are new, this reviewer said, but the cost has to be indicated.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Accomplishments have been impressive, in the judgment of this reviewer, who noted the investigator's indication that the project is complete, and the subsequent description of future work yet to be done. The reviewer professed support of the notion that additional work be done, but requested clarification of whether this is part of the current program, or a future program.

Reviewer 2:

This project appears to have achieved some interesting progress, the reviewer said, but more progress in capacity retention and charging efficiency during cycling are desired.

Reviewer 3:

The reviewer inquired about how to improve the loading using ALD and MLD. The reviewer noted indication that MLD alucone coating has been developed to significantly improve both energy and power capability for Si anodes. New coating conditions for ALD/MLD are being developed in order to coat electrodes more efficiently and work at atmospheric pressure, which will greatly reduce cost. The reviewer considered that the strategy for cost reduction was not clear, along with how the challenge of improving loading was to be met.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
In the judgment of this reviewer, the project has excellent collaboration with many institutions.

Reviewer 2:
The team was well organized and effectively utilized, in the opinion of the reviewer.

Reviewer 3:
The collaboration is good, the reviewer said.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The proposed work is reasonable, said the reviewer, who offered the suggestion that pre-lithiation could help reduce the first efficiency issue.

Reviewer 2:
Future work was not detailed, since this program is closing, the reviewer observed, expressing a desire to see more investigation of this method with the use of binder systems considered more suitable for Si electrodes, in order to determine whether synergies between materials and methods can be exploited.

Reviewer 3:
An experimental approach describing how ALD and MLD are performed should be provided, along with cost reduction, the reviewer said.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The project addresses Si-anode capacity retention through coating for improved lithium ion battery energy density and life, the reviewer observed.

Reviewer 2:
This method, in the opinion of the reviewer, could potentially be implemented into the manufacture of Si electrodes.

Reviewer 3:
This reviewer said the project reduces the use of petroleum.

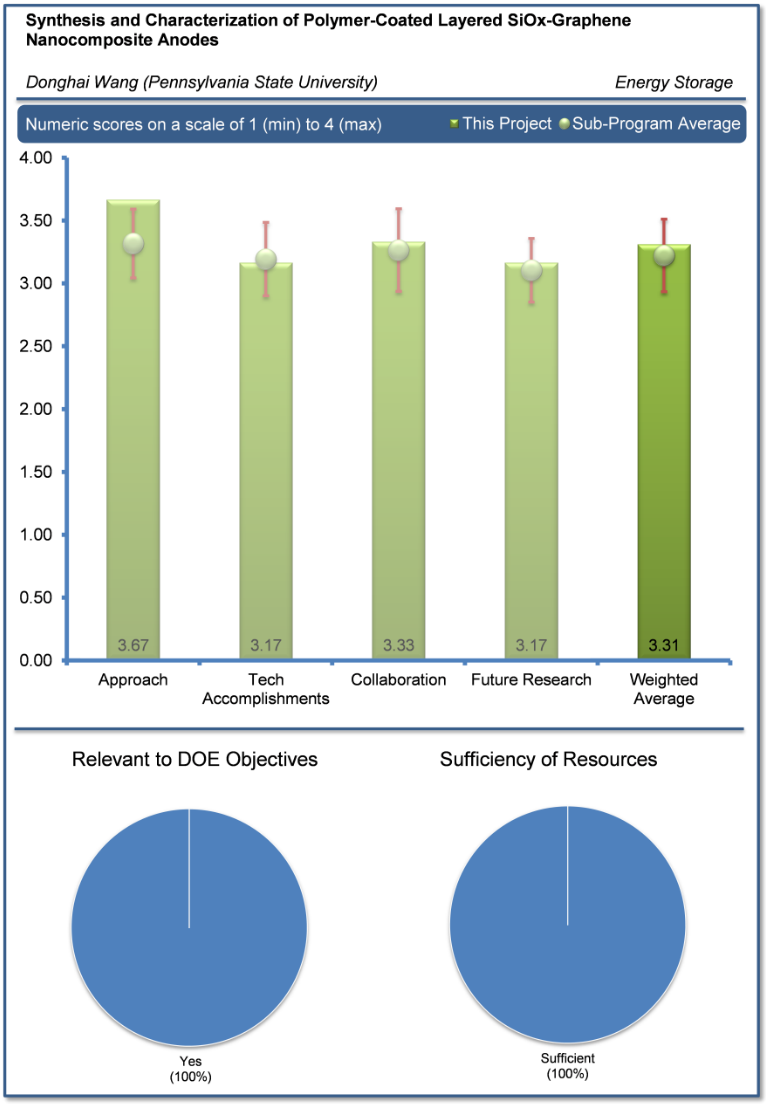
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
There are sufficient resources allocated for this project, in the opinion of this reviewer.

Reviewer 2:
The team assembled was very large, given the work, the reviewer said, but conceded having no direct knowledge into how much time each team member assigned to this project.

Reviewer 3:
Project resources are sufficient, the reviewer said.

Synthesis and Characterization of Polymer-Coated Layered SiOx-Graphene Nanocomposite Anodes: Donghai Wang (Pennsylvania State University) - es147



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This project, the reviewer said, is well-designed and targets both Si-anode (Si-C nano-composite) and binder to attack the battery cycle life and electrode kinetics.

Reviewer 2:

Calling the project an excellent example of applying innovative materials techniques to develop high-performance electrode components, the reviewer also noted that, like most of the associated research projects, there is an absence of cost analyses for the synthesis methods and resultant materials.

Reviewer 3:

The reviewer regarded approaches for development of silicon anodes as new and unique. Boron doping, the reviewer said, is very interesting, the boron-doped Si-C offering 575 mAh/g versus the Si-C level of 323 mAh/g at 6.4 A/g. The reviewer also noted the lower charge transfer resistance of B-doped Si-C and the enhanced rate capability of Si-C composite.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Saying the investigators have done an excellent job on preparation of meaningful materials, the reviewer felt a more concentrated effort on merging the independent components into an electrode would have helped the program.

Reviewer 2:

This project has achieved some good progress, the reviewer stated, although capacity retention and charging efficiency appear still to be a big challenge, especially at low rates. It may be interesting, the reviewer conjectured, to see the impact of Si-C ratio in the composite on electrode performance.

Multifunctional binders with mechanical, ionic, and semiconducting functionality have been developed, the reviewer observed, and Si2TiN seems to be a good candidate.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The PI has brought together some excellent researchers from different organizations to work together on this project, the reviewer said.

Reviewer 2:
Good collaboration was shown, the reviewer said, although in common with most presentations, the investigator had not clearly indicated what elements came from which collaborator.

Reviewer 3:
The collaboration with other researchers is good, said the reviewer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer felt the proposed work is reasonable and speculated that it may be interesting to see the impact of Si-C ratio on composite electrode performance in the future work.

Reviewer 2:
The reviewer observed that each task is well-aligned with previous work and felt it would be beneficial if the investigator begins evaluating multi-component systems (electrodes) utilizing the materials developed.

Reviewer 3:
Measuring surface interactions of functional polymers and Si composites and synthesizing new functional binders with acidic and semiconducting functionalities are good approaches, in the judgment of the reviewer, who also said postmortem analysis is needed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The goals of this project are highly relevant to DOE objectives, in this reviewer’s view.

Reviewer 2:
The research addresses the need for development of high specific-capacity anode materials for use in plug-in electric vehicles (PEVs), the reviewer stated, thus the focus on development of high-performance materials is appropriate, and the approach kept in mind the needs driven by PEV applications.

Reviewer 3:
This reviewer stated that the project reduces the use of petroleum.

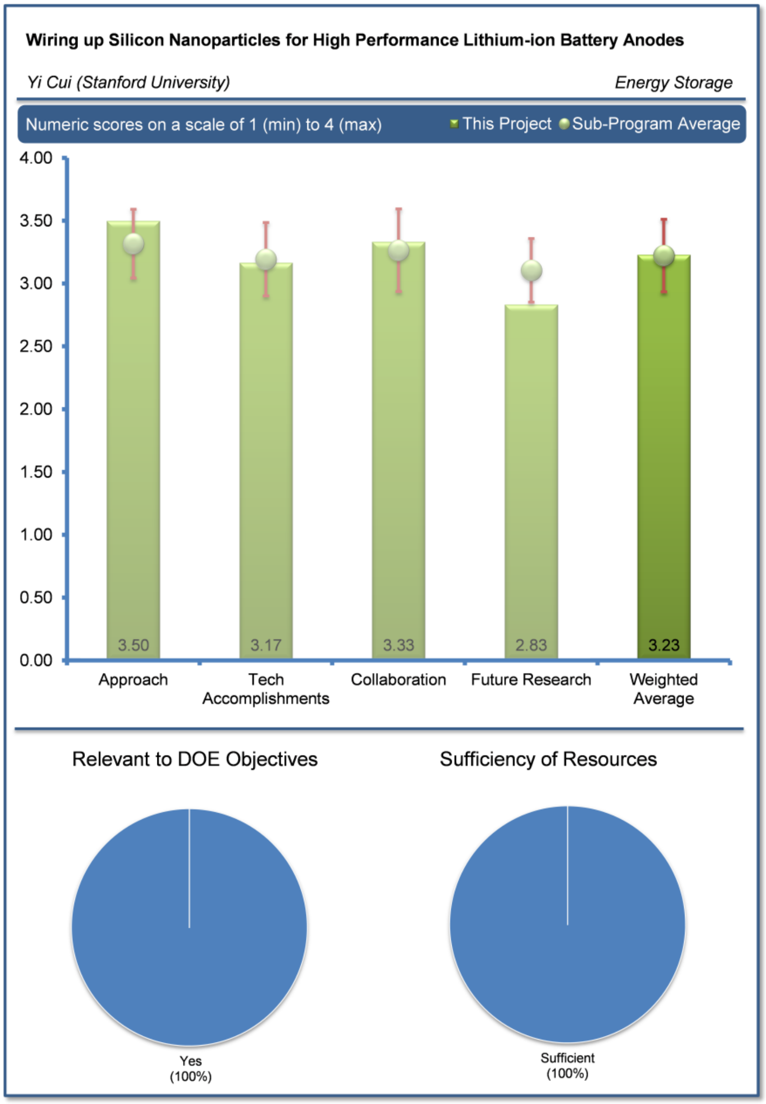
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
There are sufficient resources for this project, said the reviewer.

Reviewer 2:
The reviewer identified no issues and called the program well managed.

Reviewer 3:
Sufficient resources are available, the reviewer felt.

Wiring up Silicon Nanoparticles for High Performance Lithium-ion Battery Anodes: Yi Cui (Stanford University) - es148



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This project is highly relevant to DOE objectives, in the judgment of the reviewer.

Reviewer 2:

The reviewer deemed the approach to be good.

Reviewer 3:

The project was well structured to address the major barriers, the reviewer stated, and the investigator recognized the need for high energy, cyclability, rate capability, and cost. A more structured approach to the cost analysis goals would have been beneficial, however, the reviewer said.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Terming the approach innovative and well-focused, the reviewer noted that the investigator applied different geometric approaches to address energy and cyclability. The research, the reviewer said, certainly suggests the next stage should be in effective electrode design, including binder selection and incorporation.

Reviewer 2:

This project has achieved numerous accomplishments, the reviewer said, but the low charging efficiency remains a challenge for the battery cycle life.

Reviewer 3:

The reviewer asked what the actual silicon loading is, noting that it has to be indicated, along with the current. Calling attention to Slide 8 of the presentation, the reviewer noted the importance of cost in making nanosilicon. While the source material is cheap, the question is processing cost, which should be addressed, the reviewer said. First cycle irreversible loss also has yet to be addressed, the reviewer noted.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
Excellent collaboration, the reviewer said.

Reviewer 2:
The PI has numerous collaborations with different institutions to work on this project, the reviewer noted.

Reviewer 3:
The reviewer said it was clear in the research presented that the teams were well coordinated.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer believed the project team may need to address the charge efficiency challenge in the future work.

Reviewer 2:
The reviewer considered that an area on which the investigation needs to place significant focus is improvement of the coulombic efficiency over the first 50-100 cycles. This was an issue of great concern to the reviewer, since the electrode as shown would not be practical in a Li-ion cell otherwise.

Reviewer 3:
The reviewer inquired about the selection of micro-sized Si anodes with long cycle life.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This project is highly relevant to DOE goals, the reviewer said, and is targeting on attacking high anode design for battery applications.

Reviewer 2:
The team correctly identified the key needs for viable high-energy PEV cells, and addressed each in this project, the reviewer stated.

Reviewer 3:
This reviewer stated that the project reduces the use of petroleum.

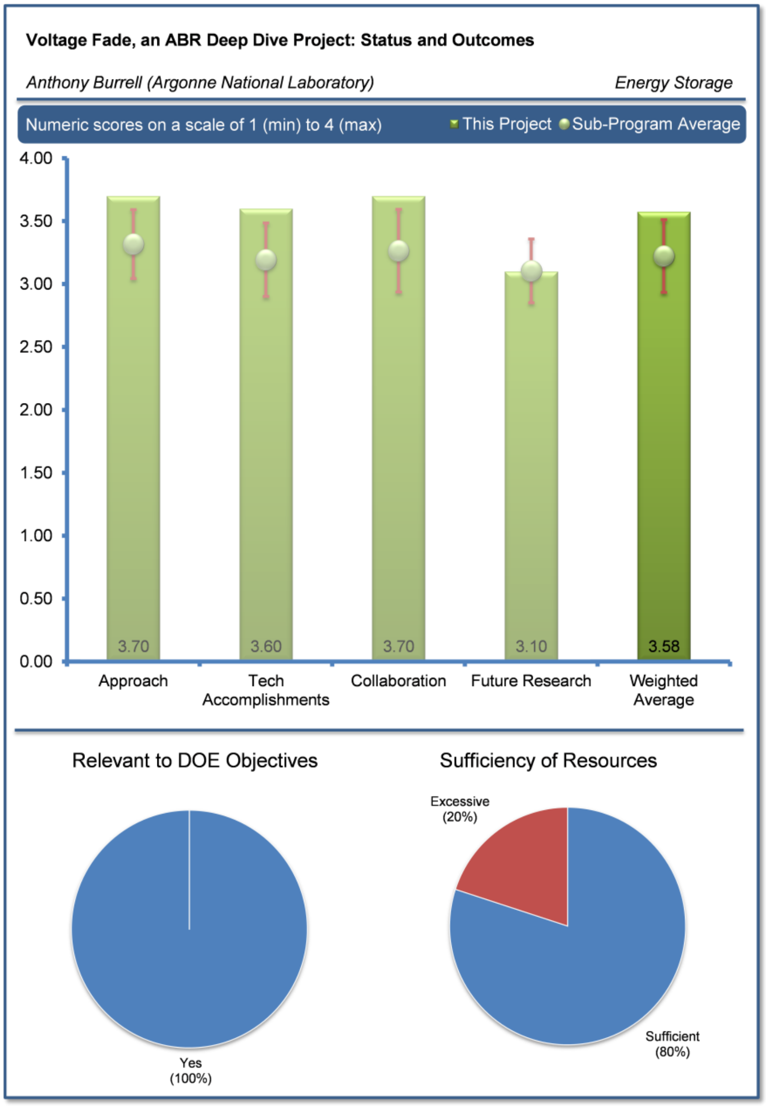
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
It appears, the reviewer said, that there are sufficient resources for this project.

Reviewer 2:
The reviewer commented that the resources were well balanced.

Reviewer 3:
The project has sufficient resources, in the reviewer's opinion.

Voltage Fade, an ABR Deep Dive Project: Status and Outcomes: Anthony Burrell (Argonne National Laboratory) - es161



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This is an excellent approach to address the problem of voltage fade in layered-layered oxide material on a fundamental multidisciplinary level, in the view of this expert.

Reviewer 2:

The team approach has been remarkable, in the opinion of this reviewer. The investigators clearly stated, the reviewer said, that voltage fade is intrinsic to these materials. Critical to a workable solution, in the reviewer's opinion, is to find a way by which some capacity can be traded for a lower capacity fade.

Reviewer 3:

In the opinion of the reviewer, the decision to form a large team to work on this key project has been validated by the tremendous success of the team in answering the key questions about the fade of the layered-layered cathode. The reviewer deemed this an extremely impressive effort, involving all disciplines and many organizations in many locations. The reviewer noted that there are many cases in which large teams burn through prodigious amounts of funding, but still really do not answer the key questions. Thus, the reviewer found the successful accomplishments of the project team very gratifying and felt that it shows that the DOE's confidence in this approach was well-placed. The program was obviously extremely well managed and a credit to the staff, the reviewer concluded.

Reviewer 4:

The reviewer characterized the presentation as an overview of the deep-dive program directed toward understanding, and potentially solving, the voltage fade problem of the LMR-NMC materials, using a team approach at ANL. To this end, the reviewer noted, an array of characterization techniques, electrochemical methods, systems and materials modeling were used, leading to a consensus among the ANL scientists about the causes and interactions between the observed hysteresis and voltage fade due to structural changes observed in several candidate materials. However, the reviewer expressed concern about the possibility of groupthink being an outgrowth of this type of approach, especially since there was very little involvement by other institutions (Oak Ridge National Laboratory being the primary exception). In view of the considerable work all over the world on LMR-NMCs, the reviewer said, there should have been opportunities to collaborate formally or informally outside of ANL, to serve as verification or repudiation of the theories that were developed.

Reviewer 5:
The project work would make significant short-term gains in battery materials, the reviewer stated, by stabilizing and improving known materials so they could see wider commercialization. The reviewer deemed it good that the protocol makes fade more likely and any solution should be robust.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
Overall, the reviewer said, a great deal was accomplished, showing that the team approach directed toward understanding a specific problem (voltage fade) worked well. After two years of effort, the details of the structural evolution of the LMR-NMC materials are better understood, although, the reviewer went on, it is clear this difficult problem cannot be solved, only mitigated. The question now, in the reviewer's opinion, is whether the steps taken to mitigate voltage fade (e.g., lowering the charging voltage limit during cycling and/or reducing the excess Mn content) also lowers the energy content to the degree that the LMR-NMC materials are no longer competitive against other cathodes like NCA. Although raw materials costs are lower for LMR-NMC than for NCA, the reviewer observed, if special electronics, coatings, and etc. are needed to get the former to work as needed; this may raise the overall cost.

Reviewer 2:
Calling the overall program's progress massive, the reviewer noted that it was all self-supporting, interlinked and reviewed. The reviewer deemed it excellent to pull in the major conclusions early and equally valuable to show what does not make a difference (e.g., coatings) and separating out confusing elements such as impedance.

Reviewer 3:
In the judgment of the reviewer, the project's excellent results reveal most of the underlying mechanisms and lead to a fundamental understanding. Limits and potential of the material are much better predictable and strategies/next steps can be reasonably defined, the reviewer said.

Reviewer 4:
The project team has basically answered the question about voltage fade, including showing what will not work to resolve the matter and pointing the way to what might work, the reviewer said. Accordingly, the reviewer went on, the team has greatly advanced the science behind the layered-layered material with a degree of thoroughness not usually attained in academic or industrial labs. Moreover, the reviewer added, the team has done this in a relatively short period of time. Personal experience, the reviewer said, has indicated that while having more money and people is helpful, it does not always guarantee a fast answer, especially in fundamental studies such as these. The reviewer noted some suggestions would be offered in the Proposed Future Research section, but said that, in fact it is hard to improve upon this team's work.

Reviewer 5:
Noting that the investigators' array of techniques to study the problem from different angles, the reviewer said integration of those results has produced a better understanding of the problems. It seems clear, the reviewer said, that voltage fade is unaffected by coatings and additives, and is a property of the LMR-NMC materials. The reviewer expressed hope that, based on those findings, the project team will be able to find a workable solution. Synthetic efforts should not be discounted, the reviewer concluded.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer cited this as probably the best example of true collaboration in personal recollection and called the project's management excellent, noting that these are not easy cats to herd into a real team.

Reviewer 2:
The reviewer noted outstanding coordination throughout the different teams.

Reviewer 3:
The reviewer cited impressive cooperation within the Voltage Fade Project which is delivering excellent results due to the input and cross-linking of the results of individual work.

Reviewer 4:
This has been an extremely impressive effort, the reviewer said, involving all disciplines and many organizations and locations. The reviewer termed the teamwork shown among the modelers, chemists, electrochemists, etc., as simply outstanding for the most part and called credit to both the management and the individuals involved. The project, the reviewer said, should serve as a role model for the DOE and other organizations on how to tackle thorny, difficult technical problems that are poorly understood. The reviewer's sole only complaint was about a perceived disconnect between the modeling work at Berkeley by Persson and the modeling and mechanistic studies elsewhere in the program. The two groups appear to have conflicting theories, the reviewer said, with the ANL group seeming to discount or ignore the modeling efforts at Berkeley. Finding no intrinsic problem with this, the reviewer nonetheless saw no attempt by either group to actually resolve any differences. If there is a disagreement, the reviewer urged it be resolved as a team, using science, logic and data.

Reviewer 5:
The deep-dive project clearly was a team effort among ANL scientists, to the point, the reviewer said, that it is difficult to fairly assess the contributions of individuals to the overall program. In a side note to program managers, the reviewer said that if a program is designed as a team effort, the entire team should be reviewed as a whole, rather than having separate reviews for each participant. Noting that the only outside collaboration was with ORNL on neutron diffraction experiments, the reviewer expressed a desire to have seen more formal or informal collaborations with researchers outside of ANL, since work on the LMR-NMCs is carried out at many places throughout the world. Collaborations with outsiders, the reviewer said, can serve as a needed check against groupthink in interpreting results.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The deep-dive project is ending this year, the reviewer noted, and future work is focused on wrapping up the project. A number of items listed in the Future Plans slide made it sound to the reviewer like work may continue in a different context (e.g., in a different program). If this is the case, the reviewer felt someone needs to take a hard look at the costs and benefits of studying these materials further versus investing some effort in other approaches or alternative materials that are competitive in terms of specific energy (e.g., improving cycle life of NMCs cycled to higher voltages).

Reviewer 2:
The authors and teams have honestly disclosed the issues related to voltage fade, the reviewer said, but unfortunately, it is becoming clear what not to do (coating, use of certain additives, etc.) to resolve this issue. It will now become more urgent to focus on workable solutions, the reviewer stated and synthetic efforts should also be pursued.

Reviewer 3:
The reviewer expressed a desire to see a similarly large attack devoted to seeking ways to stabilize the phases (not all paths were ruled out, the reviewer noted) or to encourage reversibility rather than fade.

Reviewer 4:
Excellent results should be objectively reviewed in order to determine the real potential of the material to meet DOE targets on battery energy density for xEV, the reviewer said, and eventually to define next development projects to realize the potentials. The reviewer urged a careful look at other targets like power density and in particular safety. The question of the voltage window usable in xEV application should be addressed, the reviewer said.

Reviewer 5:

Acknowledging DOE's goals of thousands of cycles for a PHEV battery, the reviewer expressed the opinion that some of the approaches to other aspects of fade could realize cycle life that was at least in the 100-300 range. This, the reviewer said, would be good enough for many consumer applications, especially as each cycle would be longer than that for a typical Li-ion cell. Establishing what the best cycle life could be using these approaches may be enough to start its being commercialization, the reviewer conjectured. Apart from the monetary aspects, the attention this would get from cell makers would greatly increase the number of researchers working to optimize the material, the reviewer continued, and leveraging the large staffs of the commercial enterprises might be the best way to address the problems for longer cycling that DOE needs. The reviewer called for a clearer effort to delineate the best cycle life currently achievable, even without fixing voltage fade. Plans to study the activation cycle are good, the reviewer said, but a critical gap seemed to be the need to quickly test and evaluate Tarascon's work on using ruthenium (Ru) and tin (Sn) doping to stabilize the cathode material. Finally, the reviewer again urged resolution of the perceived modeling disconnect between ANL and Berkeley.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The project is very relevant to the DOE objective of petroleum displacement, since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification, the reviewer stated.

Reviewer 2:

Yes it is, the reviewer affirmed succinctly.

Reviewer 3:

Yes, the reviewer said, the project helps advance a high-energy material to commerce. Moreover, it was devised at DOE, the reviewer added.

Reviewer 4:

The project helps to make available high-capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles, said this reviewer.

Reviewer 5:

This group, the reviewer said, has marshalled a huge array of resources to address the key problem with the layered-layered materials that has remained unanswered for almost 10 years and has provided a detailed and credible insight into this key material.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

Costs were not broken down by individual investigator efforts for this project, the reviewer noted, and $4 million over two years is a more-than-healthy investment to make in the study of materials that are extremely problematic, due not just to voltage fade, but to other issues as well (low tap density, low rate capability, etc.). One could reasonably question, the reviewer opined, whether some of the money would have been better spent on development of other materials and materials discovery and spread out to other institutions, as well. The reviewer expressed a desire to have seen a more comprehensive comparison of the LMR-NMC materials to other possibilities (high-voltage spinel, high- capacity stoichiometric NMCs, materials containing two lithium ions per formula unit, etc.). Compare materials not just on gravimetric capacities, the reviewer urged, but also on densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise specific energy and energy density), stage of development, projected timeline to commercialization, etc. Only with this information, the reviewer asserted, is it possible fairly to assess whether this was money well spent. At the beginning of this program, the reviewer said, the argument could have been made that it was worth investing effort in LMR-NMCs because of the promise of high specific energy. Two years later, in the opinion of the reviewer, it is less clear that a similar, intensive effort is warranted in the future, since mitigating the voltage fade results in a lower specific energy and the materials still have other problems as well.

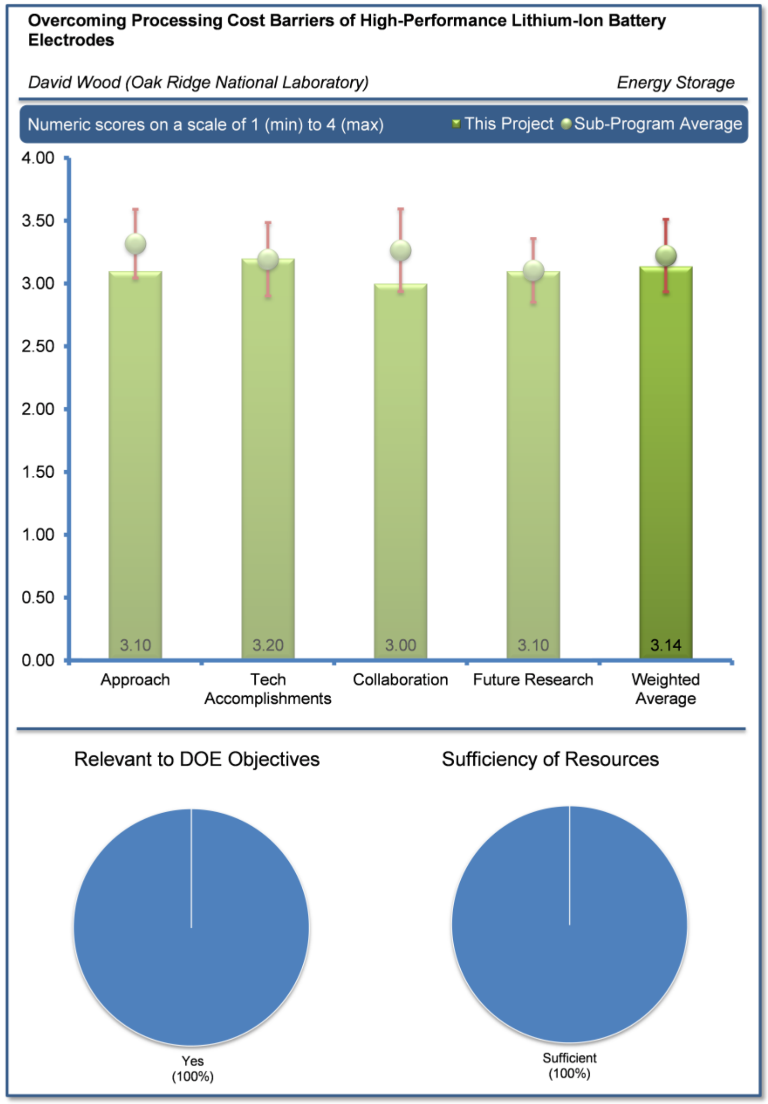
Reviewer 2:

The project had lots of cash, but because it was driving a very large amount of research, the reviewer noted (citing personal experience) that this is appropriate.

Reviewer 3:

This team approach, the reviewer noted, has of course demanded lots of time from many staff members and other research has naturally had to take something of a back seat. The reviewer approved of this choice, saying it was extremely effective. Going forward, the reviewer expressed the belief that this team can wind down and go back to doing more individual projects. In spite of this project's great success, the reviewer cautioned DOE not to let such a large team effort continue unless it is clearly still needed for this or some other critical problem. Sometimes, the reviewer noted, such large teams acquire a life of their own instead of breaking up when the job is done, or more correctly, when it is done sufficiently that the large team is no longer needed to work on it.

Overcoming Processing Cost Barriers of High-Performance Lithium-Ion Battery Electrodes: David Wood (Oak Ridge National Laboratory) - es164



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The team has accomplished the milestones for the first half of fiscal year (FY) 2014, the reviewer said, and is on track to complete the project on time (i.e., September 30, 2014). The reviewer described the main objective of the project as being to reduce the manufacturing cost by replacing NMP processing with water-based chemistry for all active materials, such as the $LiFePO_4$ cathode, the NMC 532 cathode, the ConocoPhillips A12 graphite anode, the NMC 532 and LMR-NMC cathodes and the Superior Graphite anode.

Reviewer 2:

Avoiding use of toxic solvents is key to helping reduce costs and addressing a number of scale-up issues, the reviewer noted, adding that limitations on the use of water are being, or have already been addressed. This work is also helping to significantly reduce electrode processing costs and, indirectly, reduce current collector volume by producing thicker electrodes, the reviewer stated. The other key barrier addressed in this research is financial, the reviewer said, calling attention to Slide 8 which the reviewer felt nicely showed the key inputs to cost and their reductions achieved as a result of this research. Further identification of pathways that would drive down costs down to $300/kWh would be desirable, the reviewer went on, but given the number of manufactured elements in a battery, this is not straightforward.

Reviewer 3:

The project is focused on transitioning electrode manufacturing to a water-based solvent system and the approach seems logical and measured, the reviewer said, as this is a process development activity much more than pure technology development. The evaluation of cell performance based on the process changes appears to be going well, the reviewer observed, calling Slide 8 detailing the cost improvement targets a welcome addition to the project, as this is in fact the actual goal of the work.

Reviewer 4:

Most of the gain is from thicker electrodes, which is not really new, the reviewer said. The project attacks processing problems, but these are not the big manufacturing barriers, in the reviewer’s opinion. Expressing a desire to see proof of cost savings in actual application, not at hand scale, the reviewer said there is a need to move well past coin cells noting that full pouches were mentioned only once in the presentation. Also, the reviewer said, there should have been a full-scale electrode maker deeply involved from the start.

Reviewer 5:

Comparison of full cells using water- and NMP-based LiFePO4 cathode and NMP-based CP A12 graphite anode shows comparable performance except for 1% less capacity retention in water-based cathode, the reviewer observed, asking if performance of the water-based anode formulation could be compared, also.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The research has accomplished much in regard to water-based electrode preparation the reviewer said, calling this progress and the accompanying energy reductions noteworthy. The research is also poised to be successfully commercialized from the lab because of its large benefits and compatibility with existing equipment, the reviewer concluded.

Reviewer 2:

The team has established technology for aqueous processing of electrodes by blending colloidal and surface science with manufacturing science (coating, drying, etc.), the reviewer said. The team has demonstrated cycling performance in full coin cells and a 3-Ah pouch cell with water-based NMC 532 and CP A12 and has down-selected optimal waterborne polyvinylidene difluoride (PVDF) latex binder and determined optimal secondary drying protocol for aqueous processing the reviewer went on. The reviewer encouraged the project team to document and publish its findings in the open literature at the end of this project, especially those on water-based NMC 532/graphite electrodes. The team should also address whether aqueous corrosion is a problem for positive electrodes and methods of mitigating any such corrosion, the reviewer recommended.

Reviewer 3:

Milestone progress appears to be on track, observed the reviewer, who cautioned that, while the work at this level is very encouraging, its translation to large-scale, commercial processes, including different source materials etc., is still a large challenge.

Reviewer 4:

The project team has made good progress in all work streams, especially for the cost of the program, the reviewer judged. But the reviewer found it troubling that these electrodes have never been tested at high power, which is a major concern in thick electrodes and with new methods, since power really tests the cell's ability and durability.

Reviewer 5:

Noting that the capacity fade ranges are reported at 12-36% within 400 cycles, the reviewer said it would be desirable to compare the data for NMP-based cathode versus water-based cathodes.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

It is unclear from the publications and presentations by the project team what the value of this largest open-access battery R&D facility in the U.S. is to industry, in the opinion of this reviewer. The reviewer then asked if there were publications from the industrial partners.

Reviewer 2:

The reviewer observed that the project team has engaged a number of industry and laboratory partners, who appear to have helped in much of the material selection and loadings. The reviewer inquired about the current status of the licensees, but understood that, given the fluid nature of the situation, it may have been best not to comment in greater detail on this point.

Reviewer 3:

The list of collaborators appears broad and well-targeted, the reviewer said, although some direct feedback from partner organizations could be useful in validating the effectiveness of the program.

Reviewer 4:

The project has the right type of partners, although the reviewer would have preferred larger firms. The reviewer said it was unclear that there was much interaction with the battery partners, as only ANL is described as a close association.

Reviewer 5:

The reviewer felt there was excellent collaboration and coordination with other national laboratories and industries, but recommended adding academic research centers for some validation testing and fundamental studies.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The proposed future work is well thought out and logical, in the opinion of the reviewer.

Reviewer 2:

The closeout activities planned for the next couple of months represent a key process to transition this research from the lab to industry, stated this reviewer.

Reviewer 3:

Documentation and publication should be emphasized in the future work, the reviewer said, since the project is near its end.

Reviewer 4:

Calling the proposed future work the right work, the reviewer found it troubling that the scale-up supplier was not known and should have been involved from the start. There remains a lot to get done in four months, the reviewer noted.

Reviewer 5:

The project ends on September 30, 2014, the reviewer noted, finding it doubtful that the task on full cell fabrication and testing using water-based formulations for both anode and cathode materials can be accomplished in the time remaining.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

Reducing the cost for cathode material is essential, as it is for binders, and cathode materials are more expensive, the reviewer noted, calling this a highly relevant project for reducing the manufacturing costs of lithium-ion batteries.

Reviewer 2:

If project findings are true, a 20% reduction in battery costs would accelerate their deployment and ultimately the displacement of petroleum, said the reviewer.

Reviewer 3:

Cost improvement is a major requirement in the ongoing efforts to commercialize Li -ion batteries, the reviewer said and proliferation of these concepts into the commercial world will be a key goal.

Reviewer 4:

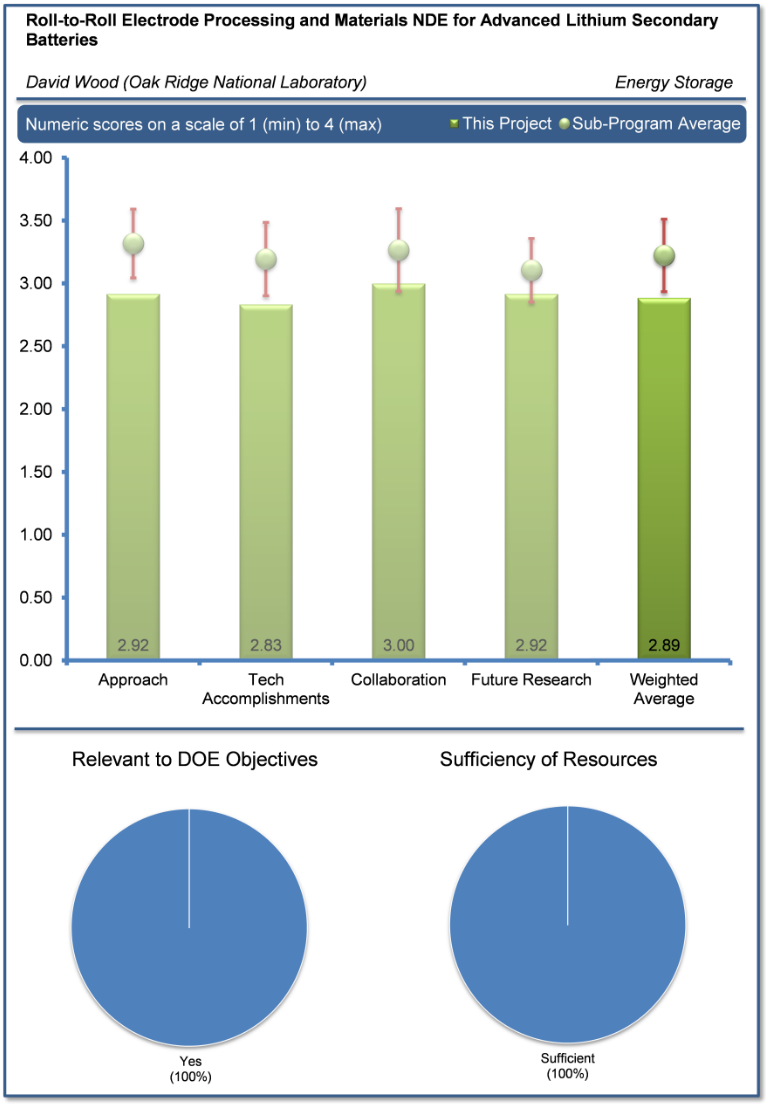
This work could help in manufacture but is really better aimed at U.S. Environmental Protection Agency (EPA) efforts to eliminate solvents, in the view of the reviewer.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that resources seem sufficient to distribute samples to partners, confirm the cost metrics, and ultimately make this work the new baseline by which to measure improvement.

Reviewer 2:
It is not clear, the reviewer felt, whether the team has already advanced enough to produce water-based anode formulations. If it has, the project could be finished in the prescribed time. Otherwise, it could require additional time and resources, the reviewer said.

Roll-to-Roll Electrode Processing NDE for Advanced Lithium Secondary Batteries: David Wood (Oak Ridge National Laboratory) - es165



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The project has employed a very methodical approach to improving cathode manufacturing scrap rates through advanced, on-line measurement systems, the reviewer stated, calling it vitally important that the validation for this as a critical, real-world, process issue be in place to demonstrate that coating improvement is a significant issue in commercial manufacturing. Given that assumption, the work here is well organized, highly detail-oriented and methodical, in the reviewer's opinion. The reviewer further expressed the belief that all reviewer comments from the previous year should remain a priority, since this is a highly complex subject and understanding which defects have which effects, as well as co-development of techniques to identify defects, is an extremely ambitious goal. These comments are simply a note on the scope of the project and should not reflect negatively on the capability of the group, which appears quite competent, the reviewer concluded.

Reviewer 2:

The team has evaluated several non-destructive evaluation (NDE) techniques for roll-to-roll lithium-ion battery (LIB) electrode processing, including cross-web laser thickness measurement, in-line X-ray fluorescence (XRF) and infra-red (IR)thermography, the reviewer observed. The results, the reviewer noted, are based largely on deliberately introduced metal contaminants and other intentionally introduced defects, such as pinholes, blisters, large agglomerates, and divots. During the final phase of the project (remainder of FY 2014), the team will scale cell testing of different coating defects to 1-Ah pouch cells for identifying which types of defects are critical to cycle life. It seemed to the reviewer that without knowing which kinds of defects are critical to cycle life, the approach of using deliberately or intentionally introduced defects is questionable, since these artificial defects may be unrealistic. The results obtained so far in this project may therefore not be meaningful, the reviewer felt. The project, in the reviewer's opinion should have started with identifying actual defects in commercial cells that are critical to cycle life before gathering data on deliberately or intentionally introduced defects.

Reviewer 3:

The reduction of scrap rates and increased utilization of active material directly reduces final manufactured costs, the reviewer pointed out, so addressing these issues sensibly reduces manufacturing costs. This topic is very important, the reviewer said, and expressed disappointment in the presentation of the research and the opinion that a better-scoped project would more clearly enunciate this value proposition. It does not appear, the reviewer went on, that any milestones or metrics speak to the progress toward meeting the 75%

recycle rate mentioned as the main objective. Also, the reviewer said, while all the research activities appear to address the issue broadly, they are again divorced from this top-level objective. The reviewer found this perceived disconnect between the approach and method, although not large, to be disconcerting. The project, in the reviewer's opinion, should have been scoped to have research efforts roll up quickly to the material and financial cost savings, and the awarded score reflects this oversight in the experimental design.

Reviewer 4:
The reviewer said the project had defined a limited set of defects to evaluate, established battery performance losses due to these defects and evaluated new concepts for detecting them in-process.

Reviewer 5:
Reducing scrap and thus lowering cost is a good aim, the reviewer said, and improved quality control (QC) and thus get more uniform cells is, also. The reviewer would have preferred a wider selection of collaborators, including more domestic battery makers and some end users on the team.

Reviewer 6:
The data shows excellent results, the reviewer opined, with full cells made using TODA H5050 cathode and Graphite A12 anode at a high voltage range of 4.7-2.5V having capacity of over 200 mAh/g up to 25 cycles, the reviewer observed. Cathodes, such as $Li^{1+}xNiCoMnO_2$, show high capacity at 4.7 V but capacity fade is also severe. The reviewer was unclear on how capacity fade was improved at higher voltage.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The technical accomplishments are quite good, in the opinion of this reviewer.

Reviewer 2:
The results are based largely on deliberately introduced metal contaminants and other intentionally introduced defects, such as pinholes, blisters, large agglomerates, and divots, the reviewer noted. Without knowing which defect shapes, sizes, and compositions are critical to cycle life, the results obtained using deliberately or intentionally introduced defects may not be meaningful to the goal of developing non-destructive testing (NDT) techniques for quantifying the effects of different defect types on rate performance and cell lifetime of real-world lithium-ion batteries, the reviewer said.

Reviewer 3:
The reviewer questioned how the project can be only 75% complete if all FY 2014 milestones are on track, and whether this is a result of the no-go decision made last year. NDE of manufacturing processes should be quickly transitioned to industry partners, in the opinion of the reviewer, who said it is unclear that this has been done. This milestone was said to be completed in FY 2013, the reviewer observed, but no further comment was made on the subject. Getting to a pass/fail metric with some statistical significance would be huge in assessing and mitigating the risks of battery production, the reviewer said, and asked if there will be enough data to support this, referring to Slide 26. The correlation between defects and cycling data is starting to emerge, the reviewer noted.

Reviewer 4:
The project has elucidated how different types of electrode defects relate to battery performance losses, the reviewer said, and has begun to determine which detection methods may be effective for controlling processes and reducing scrap.

Reviewer 5:
Understanding the role of defects is being advanced with this program, according to this reviewer, who reiterated that the larger goal of quantifying and detecting defects is very ambitious.

Reviewer 6:
Progress seems okay, the reviewer felt, but when half the progress for the year is receiving and installing equipment and establishing methods, it has not been a banner year. The reviewer approved the no go decision, calling it honest. The project team showed that defects cause fade, the reviewer said, but did not find that surprising. The team was also able to make some optical method progress in partnership with NREL, the reviewer observed, expressing the hope that it was just hard to get the machines in and up to speed. The reviewer noted no measure of progress toward the goal of reduced cost.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
There were excellent collaborations with other labs and industrial partners, in this reviewer's judgment.

Reviewer 2:
The project has effectively blended collaborations with electrode material suppliers with equipment producers to accomplish its goals, in the opinion of the reviewer.

Reviewer 3:
Calling it very late in the project to be identifying an industrial partner to scale selected QC methods, the reviewer said industrial partner(s) should have been brought in earlier to comment on their capabilities and offer insights about deployment feasibility during the experimental design phase. Project collaborative activities could potentially be considered much higher if impact upon the partners' manufacturing lines (listed on Slide 17) was discussed, the reviewer commented.

Partners, and especially battery partners, in the reviewer's judgment, do not have obvious contributions other than discussion (which is not really collaboration). Work with NREL is more like partnership, the reviewer added, and only collaborations with national laboratories were described by the speaker as strong.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This group consistently puts excellent thought into their technical direction, the reviewer said.

Reviewer 2:
The proposed future work is appropriate, the reviewer said, expressing the hope that it will be done on time, too.

Reviewer 3:
It is important to connect in-line monitoring data with battery performance data made using electrodes from the coater, the reviewer said and important to understand what the feedback loop control parameters are. It is also important to understand the extent of variations used as quality control for battery electrode fabrication using the produced coatings, something that needs to be elaborated, in the reviewer's opinion. The reviewer felt it was not clear why in-situ XRD and transmission electron microscopy (TEM) studies are important in this particular project.

Reviewer 4:
Identification of the sizes, shapes and types of defects critical to cycle life should have been done at the start of the project and should be a main effort before the end of the project, the reviewer said.

Reviewer 5:
Without an industrial partner, the reviewer was unsure how the commercialization is expected to proceed, noting that Slide 18 says one is still being identified. The reviewer was given to think the time frame for commercialization may be overstated and was also unsure

that enough data was available to support a pass/fail metric. The project team appeared to this reviewer to still be doing significant research which, while important, does not necessarily belong in the project closeout.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
Scrap reduction and improved manufacturing processes will clearly drive down battery costs, the reviewer said, calling it a good piece of low hanging fruit to be targeting.

Reviewer 2:
Market acceptance of battery-powered vehicles will require outstanding quality control in low-cost electrode manufacturing, the reviewer stated.

Reviewer 3:
Defect analysis can ultimately improve quality and cost of Li Ion batteries, the reviewer said.

Reviewer 4:
The project, which is aimed at a good goal – reducing manufacturing cost and improving quality – is the only scrap reduction program the reviewer is aware of in DOE’s battery work.

Reviewer 5:
This project has high relevance in understanding whether we can improve our battery manufacturing process through in-line monitoring, the reviewer said.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

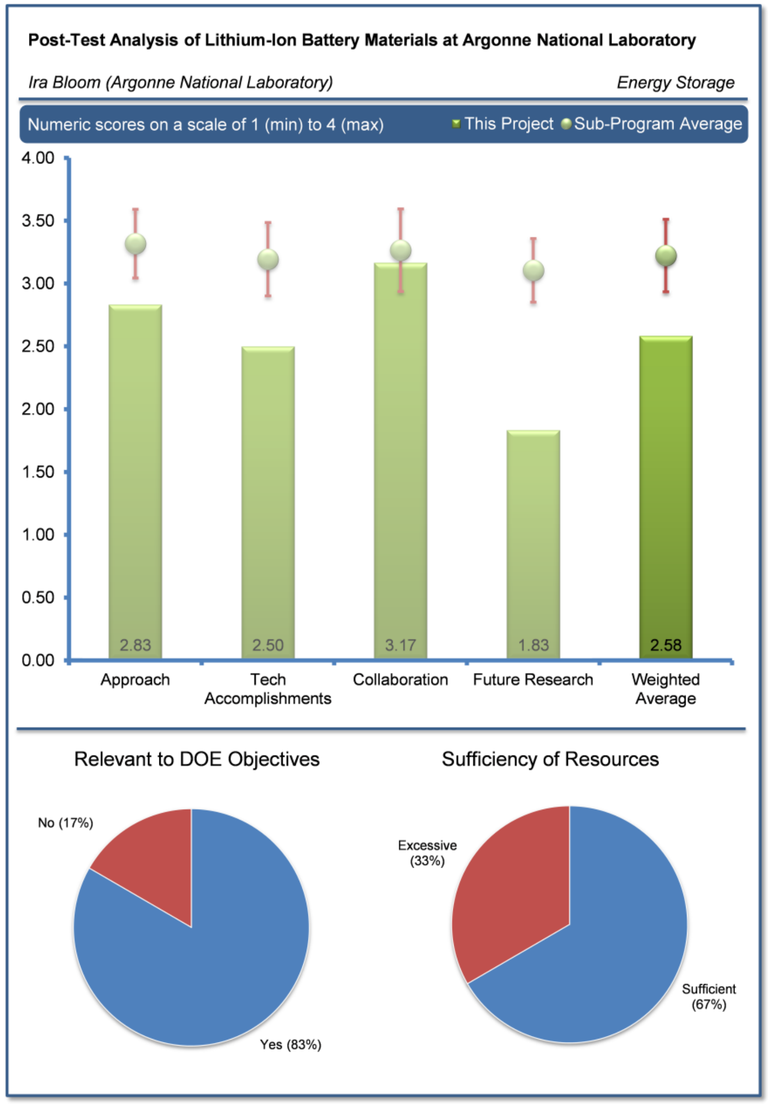
Reviewer 1:
The potential financial/manufacturing impact of this work is large, the reviewer said, and accordingly it is critical to the continued deployment of batteries into the vehicle marketplace.

Reviewer 2:
The principal investigators have access to adequate amount of facilities and resources to complete the project, in the judgment of this reviewer.

Reviewer 3:
The reviewer observed that no mention was made of program activities that would not be accomplished because of lack of resources.

Reviewer 4:
Because the program is basically over, the reviewer felt this question is not important right now.

Post-Test Analysis of Lithium-Ion Battery Materials at Argonne National Laboratory: Ira Bloom (Argonne National Laboratory) - es166



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that ANL has established outstanding capabilities for post-test analysis of lithium ion battery materials. The facility is available to help DOE's ABR, Batteries for Advanced Transportation Technologies (BATT) and USABC Programs and to help industrial battery developers better understand life-limiting mechanisms.

Reviewer 2:

The reviewer thought that the post mortem analysis of Li-Ion batteries after a use profile seems like a good contribution to the overall knowledge base of Li Ion chemistry. The approach appears rigorous and focused and is likely to add to our overall knowledge base. The reviewer felt that it is critical to both develop the techniques as well as the knowledge the project provide and this appears to be a well thought-out goal of the program.

Reviewer 3:

The reviewer pointed out that this is diagnostic work, but it was pitched as helping to inform rational research and design. As it progresses along it does not appear to have successfully completed (or begun) this second element to any significant degree.

The reviewer's rating reflected that much of these tests had already been performed in other laboratories. The key step forward would be in identifying what tests are truly diagnostic and worth of limited resources (time and money).

The reviewer recommends a clear focus on identifying key diagnostic tests and expediting this process to accelerate the feedback loop of rational design.

Reviewer 4:

The reviewer reported that the project has good infrastructure for Li-S, Li-Air, and Li-ion battery assembly facilities with well-equipped instruments.

Reviewer 5:

The reviewer regarded the concept to the approach to be fairly good in terms of trying to do tear downs and analysis to understand failure mechanisms in cycled cells, but the reviewer had major problems with the way this was being carried out. The reviewer first emphasized that this type of work was absolutely critical to the program. Also, it was actually very hard to do properly, especially when working with such air-sensitive materials. Having said that, the reviewer felt this presentation was simply awful from start to finish.

The reviewer listed eight specific problems, details of which follow. The first issue commented on by this reviewer was the inability to study cells at high state of charge – apparently for safety reasons. The reviewer would have thought the laboratory could have found a way to do this safely, especially for small cells. The reviewer added that maybe discharging them first could be the norm, but the reviewer would have thought that one would have to at least by exception look at charged cells to really understand what was going on.

The second issue commented on by this reviewer was the finding of lithium metal – if that is what it was – on a cell discharged to 2.0V was clearly very strange. The PI did not seem to find this odd, which in itself was something the reviewer found odd.

The third issue commented on by this reviewer was the inability to distinguish metallic lithium from lithium salts. This was a critical failure since metallic lithium was a clear sign of a cell malfunction. Offhand, the reviewer would have thought this could be gleaned just by placing a small sample in water and checking the solution for Li/F/P ratio, maybe also titrate for LiOH.

The fourth issue commented on by this reviewer was the lack of washing and even more so, the lack of a washing protocol. The PI seemed to think the cell submitters should work this out but, but this was clearly his job. Looking at a surface coated with salt in such excruciating and time-consuming detail seemed pretty pointless.

The fifth issue noted by this reviewer was determining the volume of gas (fluid immersion, inject a known amount of a reference gas, etc. The sixth issue commented on by this reviewer was whether the project team could not say anything about the FTIR peaks in terms of chemical bonds. The seventh issue commented on by this reviewer was where the origin of the fluoroethane. The eighth issue commented on by this reviewer was a lack of electrolyte analysis – just a gas analysis.

The reviewer went on to say that, this work, if done correctly, should cycle back and dictate future cell trials. For example, to determine where the fluoroethane comes from, a cell could be made with a non-fluorinated binder or a non-fluorinated salt to see if that stops the formation of flouroethane. The reviewer expected that this kind of work could provide rich rewards if done thoroughly, but opined that this was not the way to do it.

The reviewer suggested that it should be done like competing product analyses. It does require a tremendous amount of work, even on one cell; the project did not appear to have even started to analyze the cathode or separator for defects in the cell(s) the team looked at. The reviewer wondered if maybe resources were an issue, but the results of this program were in the reviewer’s view likely to be worthless unless major changes were made to the program.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer felt that the program was beginning to provide insight into common cause degradation mechanisms which should be valuable to the overall understanding of battery life.

Reviewer 2:

The reviewer stated that the ANL facility for post-test analysis of lithium ion battery materials had been used for a wide range of projects for collaboration with researchers working on DOE programs and industrial partners.

Reviewer 3:

The reviewer reported that there had been good progress with the original objectives. However, it would be good to recognize the most important objectives in terms of desired understanding in terms of post-test analysis.

Reviewer 4:

The reviewer thought that the approach was admirable, but so far little had been determined that informed failure mechanisms.

Reviewer 5:
The reviewer indicated that the example given drew major concern about the drying and decomposition of electrolyte salt on electrode not adequately considered in analysis.

Reviewer 6:
The reviewer categorized the results as mostly just data, no real interpretation, which was the single biggest complaint. The reviewer opined that this PI needed to step up, take ownership of this task, and really understand what was being found. Just passing on data back to the cell submitter is an abrogation of responsibility. The reviewer suggested that instead of relying on looking for patterns in lots of cells, to look at the few cells the project had and to start using chemical knowledge, partners, etc. to speculate on mechanisms and create plans to test the hypotheses. The reviewer stated that some of the results were highly dubious (metallic lithium in a discharged anode).

Question 3: Comments on Collaboration and Coordination with other institutions:

Reviewer 1:
The reviewer cited excellent collaboration with cell manufacturers.

Reviewer 2:
The reviewer thought that there was excellent collaboration with industrial partners and others within national laboratories.

Reviewer 3:
The reviewer said that for this research the project has reached out to USABC, DOE and ANL to gather end of life cells to test. This was a positive step but a broader group would be desired. The reviewer further stated that the project has also attempted to make their resources and capabilities available to the broader battery community.

Reviewer 4:
The reviewer observed that collaboration appeared to be within the DOE community, although many other collaborators were listed, but not discussed. The reviewer considered it important for both the technique protocols and the information gained from these techniques is brought to the wider community.

Reviewer 5:
The reviewer reported that the project was at least getting cells from people, but the PI did not seem to have much knowledge of the cell history (over the wall mentality). While this may not actually be the case (hard to tell in the time allowed), it at least appeared to this reviewer that the PI needed to get more connected to the cell design and testing to fully understands what to look for in the cells and devise better ways to analyze samples and understand what it means – especially the latter.

The reviewer felt that there should be a clear plan for each cell worked out with the team so that the PI knows what to look for in each and why. To do a proper teardown and analysis is so time-consuming that one cannot possibly run every analysis on every cell. The reviewer did not see any evidence of such a plan, which was considered crucial to make effective use of this PI's efforts.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer felt sure there was a plan for forward work. However, it was not provided, therefore the unfortunate low score.

Reviewer 2:
The reviewer said the future research plan was not provided in the slides.

Reviewer 3:
The reviewer reported that no future work was described.

Reviewer 4:
The reviewer indicated that the work needed to get back to helping to inform battery researchers of the key technical barriers that needed to be addressed from both a material and manufacturing perspective.

Reviewer 5:
The reviewer mentioned earlier that it was important to refine the objectives in terms of type of desired understanding.

Reviewer 6:
The reviewer asserted that the presenter did not really say much except that testing on a lot more cells and looking for patterns would start. The reviewer totally disagreed with this approach and recommended that the team meet and figure out ways to do this better before the project wastes time analyzing another cell.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that failure prevention is key to maintaining high energy battery systems that have long lifetimes. The project as pitched would do this. However, the reviewer felt its implementation has fallen short.

Reviewer 2:
The reviewer felt that without post-mortem analysis progress in improving battery performance is a blind operation doomed to move slowly.

Reviewer 3:
The reviewer believed that improvement in post mortem analysis is a worthy goal in improving our knowledge base.

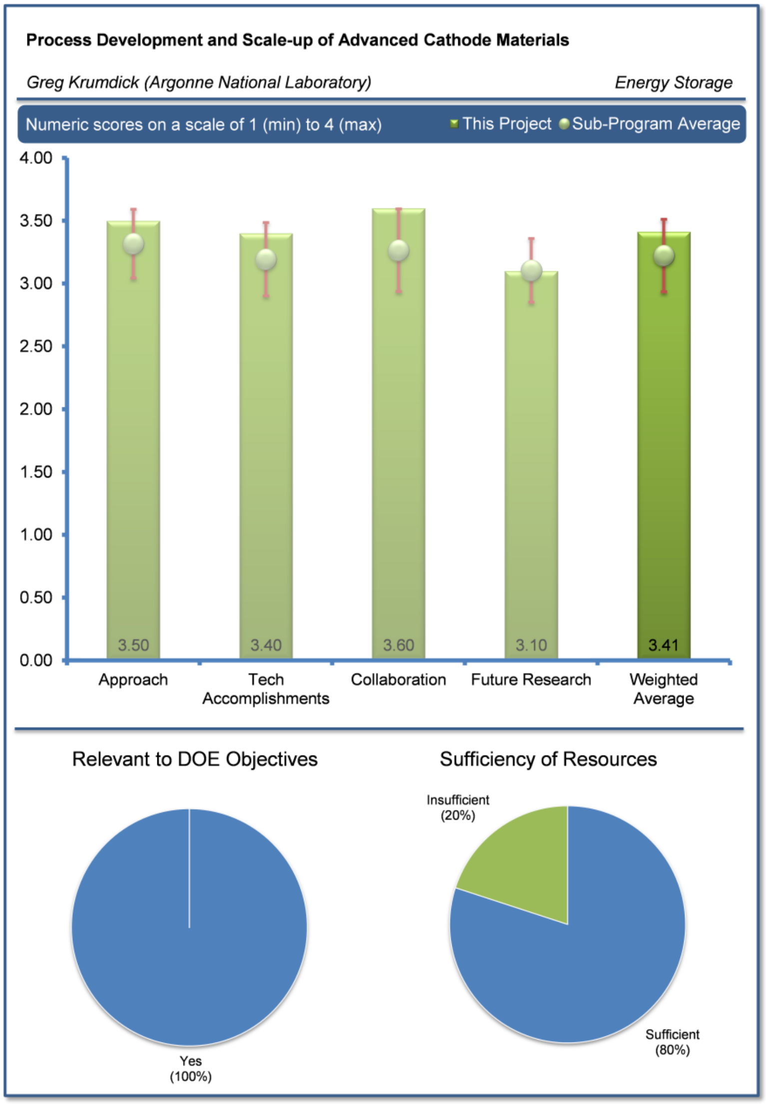
Reviewer 4:
The reviewer indicated that this work should be highly relevant and critical to making progress. However, unless it undergoes a major shakeup, it will just generate large amounts of useless data.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer relayed that there did not appear to be any milestones, so could only judge this to be an inefficient use of limited resources.

Reviewer 2:
The reviewer declared that until this work program was completely revamped, no more money should be invested in any of this work. If and when properly directed and carried out, it will actually require a lot of resources, maybe even more than currently assigned. The reviewer concluded that the project was a long way from where it needed to be to justify any funding.

Process Development and Scale-up of Advanced Cathode Materials: Greg Krumdick (Argonne National Laboratory) - es167



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer felt that the approach was useful and met the objectives. However, there was little understanding of why scale-up resulted in synthesis of suboptimum electrolyte or active materials.

Reviewer 2:

The reviewer believed that the program had taken a well-considered approach to identifying targets and systematically characterizing synthetic products to meet a complex set of requirements.

Reviewer 3:

The reviewer found the technical approach to be well thought-out and competent, but respectfully suggested a concern about the place of this research within the community. There are a number of very large, multinational corporations who are in the business of supplying large scale amounts of cathode material and have incentive to provide lower cost, high quality materials as time goes on. The reviewer considered that finding a productive “niche” of DOE sponsored work in this area that complements the work in the community, or adds some specific value to the work of the community was perhaps a challenging task. If the goal is to provide advanced materials to the community in lieu of the sometimes difficult availability from commercial suppliers, this could be a worthy goal. If the goal is to “compete” at the process development level with the large multinational providers, the reviewer suggested that this might not be a very worthy goal.

Reviewer 4:

The reviewer asserted that the researchers have a clear understanding of the throughput limitations to scale up. Process optimization can be a never ending process, but they have put clear limits and are rationally targeting two materials per year to scale to multi-kilogram quantities. It appeared to the reviewer that the project team was currently slightly behind its target pace, but some of that might be expected to be the result of delays during start up.

The reviewer reported that the project team has clearly identified processes that could be scaled to larger quantities, and is targeting key steps to determine which factors are most important.

The reviewer commented that the only big thing is that the queue of materials to be optimized should already be clear. The next handful of materials should already be on the table, so that the input of industrial partners can be sought and if necessary brought on board.

Reviewer 5:
The reviewer suggested that target material number four should be identified. The reviewer recommended the design of experiments methods should be used for experiments involving a large number of parameters (e.g., Slides 8 and 10). The reviewer felt statistical data analysis should be used to see whether the 20% improvement in capacity at cycle 140 by 1% Al_2O_3 coating is statistically significant.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer found that thoughtful execution of synthetic methods has led to scale-up of complex materials. The reviewer commented that inorganic synthesis in a continuous process is a particularly difficult and noteworthy accomplishment.

Reviewer 2:
The reviewer saw that the techniques being developed appeared to be showing promise as to their ability to produce advanced material concepts.

Reviewer 3:
The reviewer asserted that detailed understanding of fundamentals (i.e., effect of porosity, aspect ratio, and particle size distribution on tap density or effect of side-reaction on type of impurities in electrolyte) could benefit this project.

Reviewer 4:
The reviewer reported that the project has successfully scaled up two materials and are nearly completed with a third, all of which were of interest to industrial partners. The reviewer's demerit is for the belief that this research will not be able to finish an as yet unknown material by the end of FY 2014.

The reviewer noted in an aside that it would be ideal if there was a metric that tracked the impact of this process scale up work, potentially something that shows to what degree studies in the field have been accelerated due to the larger volumes of consistent starting material. The reviewer recognized that this was a non-trivial issue, but would likely make a strong case for this research.

Question 3: Comments on Collaboration and Coordination with other institutions:

Reviewer 1:
The reviewer considered this to be a strong point of this research. The team and their industrial capabilities have even been sought by other companies who have brought in outside funding. The reviewer recognized this as a clear DOE programmatic goal.

Reviewer 2:
The reviewer claimed that collaborations within and between laboratories plus with the external customers were very good.

Reviewer 3:
The reviewer reported that partnerships were primarily focused on collaboration with other national laboratories. Expanding this field may increase program relevance.

Reviewer 4:
The reviewer noted that there is no collaboration with any commercial cathode material suppliers, which may or may not be the goal, but is noticeably absent.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the planning, while logical in process, should have a more transparent process. The cathode material field, while evolving, generally has coalesced around several targets. The reviewer suggested that prioritizing these targets will help get more usable and broadly applicable testing data into the hands of researchers who will then be able to make appropriate decisions on the direction of research they take.

The reviewer concluded that it is key that the broader industry has a stake in what is being scaled up to maximize impact of the large quantities of material that will be available as an output to this research.

Reviewer 2:
The reviewer felt that the evaluation of emerging manufacturing technologies in particular seemed like a worthy goal of the group.

Reviewer 3:
The reviewer saw that goals appeared simultaneously ambitious and well considered.

Reviewer 4:
The reviewer could not see any clear path on how to decide the next project plus any critical-path analysis because the scope of objectives was very broad. Both could help with streamlining of activities toward objectives of the VTO.

Reviewer 5:
The reviewer asked if target material number four will be necessary as part of the future work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer felt this project should help domestic industry to quickly and inexpensively have access to new R&D materials for their developmental activities for making better and more cost competitive energy storage systems.

Reviewer 2:
The reviewer said that scale-up up of new materials would lead to more rapid identification of incentives and concerns for these materials by enabling extensive evaluation under more rigorous protocols.

Reviewer 3:
The reviewer concluded that careful management of the goals of the group would result in a program with a legitimate piece of relevance in the overall field.

Reviewer 4:
The reviewer pointed out that battery technology would only have an impact at scale, and thought that this work was a key step to making technologically advanced batteries at scale.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer judged that allocation of resources appeared to be adequate although details were not discussed. It would be interesting to the reviewer to know where the bottleneck is and how it can be resolved.

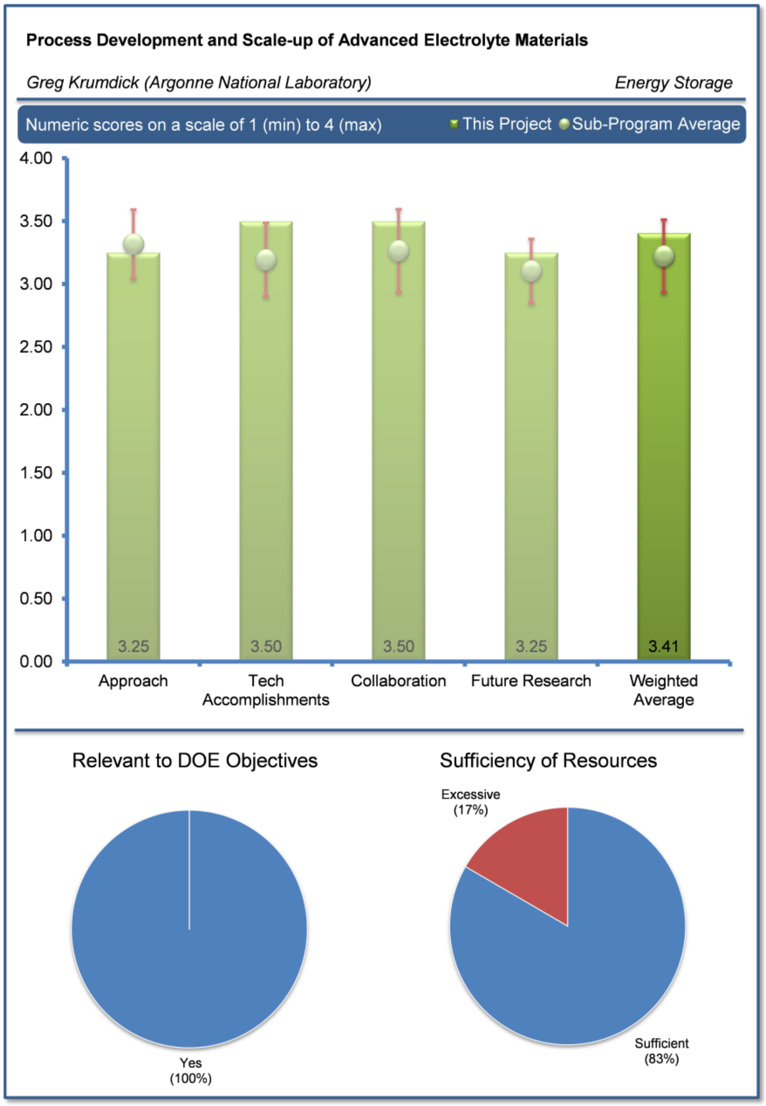
Reviewer 2:

The reviewer reported that this team looked to be progressing at just behind their proposed rate of two materials per year. The reviewer recommended that with optimization there be inherent scope limitations to maintain this rate until there is greater certainty in the selection of cathode materials.

Reviewer 3:

The reviewer concluded that the program had identified the quantity of materials that were likely to result at the current resource level. Increasing resources could potentially increase the number of materials that would become available from these scale-up efforts.

Process Development and Scale-up of Advanced Electrolyte Materials: Greg Krumdick (Argonne National Laboratory) - es168



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the scale-up and process development look good, but many of materials appear to be very expensive. The reviewer wondered about the cost target and any other concern such as toxicity and environmental issues.

Reviewer 2:

The reviewer found a disciplined, staged approach, which was unfortunately low on contact and partnership with industrial maker.

Reviewer 3:

The reviewer considered process scale-up to be a critical issue, and is being directly addressed in this research. However, the commenter indicated that more work needs to be done in prioritizing which chemicals/materials are scaled-up. The reviewer thought that, given the investment in each one, efforts need to be made in concert with battery researchers to select materials with the greatest impact not available (in volume or quality) elsewhere. The project evaluator requested to have greater context to the material selection process as it is clear the researchers understand how to do process scale-up.

Reviewer 4:

The reviewer relayed that the group is responsible for developing synthesis schemes for promising electrolyte components such as salts, additives, shuttles etc. The commenter indicated that the capability appears to be sound, and that appropriate dissemination of the materials could clearly aid in the development of advanced electrolyte formulation concepts. The reviewer recognized that there has perhaps always been a question as to whether there is enough band-with in terms of the variety of synthesis approaches available to ensure that the most efficient approach is being used for each individual molecule. However, the reviewer stated that if the goal is fairly restricted to the ability to provide promising molecules, the results seem useful.

Reviewer 5:

The reviewer described that this project is about scaling-up production of electrolytes and make these materials available to various researchers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer acknowledged that this group has taken on an extremely challenging set of goals and has accumulated an equally impressive list of accomplishments. The commenter also noted that the evaluation of new materials was greatly enhanced by the availability of this scale-up work.

Reviewer 2:
The commenter noted that research continues to optimize processes for a number of high-priority electrolyte targets. The commenter agreed that this work is crucial in moving the field forward. The materials chosen are all high-priority targets and the reviewer generally agrees with their selection.

Reviewer 3:
The reviewer reported that it appears that a great deal of work has been carried out, but requested that the researchers to please not forget about the cost.

Reviewer 4:
The reviewer described that several interesting molecules were developed and provided for external testing. The commenter offered that, without an alternative source, this provides a useful service in the overall improvement of understanding to the community.

Reviewer 5:
The reviewer stated that the PIs made important progress with scaling-up a number of electrolyte materials and made them available to a number of researchers. Also, important finding were made in terms of the role of impurities.

Reviewer 6:
The reviewer said that the progress in nice, but for the funding one would also expect a lot of progress. The commenter pointed out that there were a diverse set of activities and progress on many fronts; however it was not clear to this person what the real meaning to industry and consumers is in terms of cost.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer recognized that the researchers extensively provided sample materials to various organizations.

Reviewer 2:
The reviewer praised that the growing list of collaborators is a good start. Even so, the commenter suggested that there is a continued need for collaboration to do two things: 1) help with standardizing the work in this field, and 2) prioritizing work to push materials into commercial production.

Reviewer 3:
The reviewer commended that this team has collaborated effectively with a diverse group of participants to make contributions in many areas of battery performance.

Reviewer 4:
The reviewer explained that the project collaboration scheme is complex, as there is collaboration on priorities, collaboration on testing and characterization, and ultimately in the decision making associated with both the technical and commercialization viability. The commenter offered a general comment that the visibility on the overall process of how materials are chosen, prioritized and dispersed would be a worthwhile endeavor. The reviewer acknowledged that this is not necessarily the responsibility of this particular group.

Reviewer 5:

The reviewer indicated that the researchers work with many people and there is give-and-take with partner contribution to the work at ANL and vice-versa.

Reviewer 6:

The reviewer simply stated that there was good interaction with a number of researchers.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that prior to launch scale-ups, that the researchers should consider many other aspects beyond the functionality.

Reviewer 2:

The reviewer summarized that two key recommendations that appeared to be chief among the future research directions, as proposed by the team, are: 1) a need to better align this work with modeling efforts, and 2) clarify selection process. The reviewer highlighted that the consistent availability of high-quality materials will help to standardize research and data collection. The commenter stated that the ability for modeling experts to take this large quantity of data and create workable simulations could potentially accelerate development efforts. Thus, working with the modeling community to assess their data needs, would dramatically increase the impact of this research.

The reviewer asserted that the selection process is key to the impact of this work. The project evaluator also recognized that process development is a strength of this research team, but offered that it is clear their expertise lies outside of the battery community. The reviewer proposed that inviting feedback from the wider community and prioritizing targets will get stakeholder buy-in that means this research will move the needle.

Reviewer 3:

The reviewer explained that the need for this activity is underscored by the continued demand for more materials.

Reviewer 4:

The reviewer stated that as this project is a bit of a (highly technical) service, so the future research is basically more of the same as an ongoing activity, which the reviewer agreed was a good thing.

Reviewer 5:

The reviewer simply stated that the planned future research was appropriate.

Reviewer 6:

The reviewer stated that even though there has been good progress in terms of scaling-up production of several electrolyte materials, it is not clear whether there is any new knowledge in terms of scale-up techniques. The commenter noted that the role of impurities was discussed in terms of battery performance, but proposed that it would also be important to discuss the relationship between the scale-up and the amount of impurities in the materials produced.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer explained that there is a valley of death gap between laboratory and commercial scales, with much of this resting on choosing the right materials to carry forward. The commenter stated that larger quantities of choice electrolytes will enable the testing that commercial entities desire to make true investment decisions that will yield the next generation of batteries.

Reviewer 2:
The reviewer agreed that the scale-up up of new materials will lead to more rapid identification of incentives and concerns for these materials by enabling extensive evaluation under more rigorous protocols.

Reviewer 3:
The reviewer confirmed that electrolytes are a clear priority in the improvement of cells. If no other source of development of exotic fine chemicals is available, this is a critical activity.

Reviewer 4:
The reviewer stated that the electrolyte is a big cost of, and barrier to, higher voltage and capacity maintenance both, so the work is definitely relevant.

Reviewer 5:
The reviewer commented that scale-up research is crucial for translating new materials discovery to marketplace.

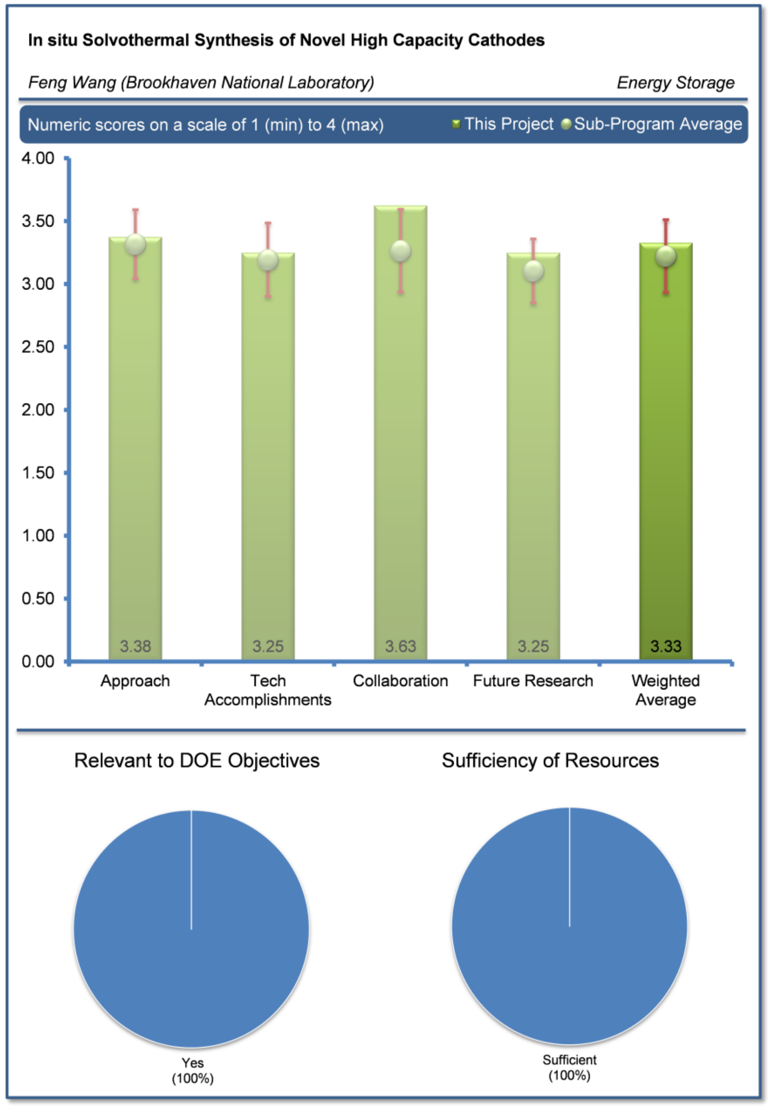
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer responded that the number of materials being synthesized seems reasonable for the current funding levels. The reviewer also suggested that there should be a clear future transition to industry funding (perhaps by a consortia of companies, or by research groups who purchase these chemicals.) The commenter emphasized that this statement is a future desire, and not a comment on the current funding levels.

Reviewer 2:
The reviewer claimed that the facility seems to have sufficient resources for the proposed research.

Reviewer 3:
The reviewer indicated that $1.0 - 1.5 million a year for an electrolyte development project is a lot, as there are complete cell programs running for less. The commenter noted that while the researchers have a lot of work to do, it seems like this cost was not required.

In situ Solvothermal Synthesis of Novel High Capacity Cathodes: Feng Wang (Brookhaven National Laboratory) - es183



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that while the approaches for in-situ studies on synthesis and other diagnostic tests are novel, this person was not sure about those on high capacity cathodes.

Reviewer 2:

The reviewer noted that the approach was to develop new cathode compounds via controlled synthesis. The commenter explained that the approach also involved structural evolution of intermediates using in-situ reactors, coupled with time resolved XRD to identify reaction intermediates and reaction pathways to develop the capability to "dial-in" desired compounds and material properties. The reviewer stated that the experience will provide the insight to predict structure, etc., using the synchrotron X-ray facility and tracking of the lithium transport.

Reviewer 3:

The reviewer noted that in-situ XRD/XAS can provide critical information about synthesis reactions in real-time, which ultimately will be used, to develop useful phase diagrams.

Reviewer 4:

This reviewer observed that the objective is to develop high-capacity cathodes, including Cu-V-O compounds, Li(Na)VPO5Fx, Li-V-PO4 and Li-Fe-Mn-PO4. The approach, as reported by this person, is based on developing in-situ solvo-thermal synthesis to establish structure-property correlations and perform diagnostics for performance loss. The reviewer explained that the in-situ synthesis enables controlled synthesis of cathodes of desired phase and properties and is based on a combination of specialized in-situ reactors and time–resolved XRD probing for quantitative understanding of structure/phases during syntheses as well as during further lithiation-delithiation cycling. This reviewer further commented that the approach adopted here is useful in the development of new materials, but the choice of the cathode materials is not as beneficial. The reviewer added that the Cu-V-O system is not new, while the Li-Fe-Mn-PO4 system is sufficiently mature and has low specific energy.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that advanced X-ray techniques were used to synthesize new alpha-CuVO, $LiFeMnPO_4F$, and $LiVPO_4$(-X) cathode materials. An in-depth structural and electrochemical analysis of new high capacity cathode materials was also performed.

Reviewer 2:

The reviewer commented that in-situ XRD/XAS methods were developed and demonstrated; however, the analysis for identifying structures and crystallinities during the synthesis process have not been fully explored.

Reviewer 3:

The reviewer claimed that the diagnostic and the in-situ analysis data are extensive and quite useful; however, the reviewer criticized that the results from the new types of high capacity cathodes are not significant. The commenter asserted that cathodes with such low voltage and with so many plateaus are not attractive.

Reviewer 4:

This reviewer stated that good progress has been made towards developing the solvo-therml synthesis of ε-CuxV2O5 (ε-CVO) cathodes using in-situ XRD techniques and understanding their structural changes and limitations for extended cycling. Further, procedures were developed for the synthesis of α-CuVO compounds with new structure using both hydrothermal and solid state reactions, which were shown to give high capacity of 350 mAh/g with some cycling stability. The reviewer continued that these synthetic methods were also extended to two other cathode systems, LiFeMnPO4 and Li(Na)VPO5F, and gathered useful structural information from in-situ XRD and EXAFS on these materials. Overall, opined this reviewer, these studies are interesting from an academic perspective, but do not add much value from the application perspective. The materials do not seem to meet the high specific energy/energy density requirements of the ABR.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that the team comprises the best of the relevant laboratories.

Reviewer 2:

The reviewer reported there were extensive discussions and collaboration with the BATT program as well as external partners.

Reviewer 3:

The reviewer opined that this is a good, collaborative project involving interactions with several laboratories and universities.

Reviewer 4:

The reviewer simply noted that a long list of international collaborators were included.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the future work will continue the synthesis of new compounds and the characterization of high capacity cathodes with emphasis on polyanion-type materials.

Reviewer 2:

The reviewer agreed that the proposed future works are a logical step; particularly, on exploring the phase diagram research.

Reviewer 3:

The reviewer suggested that more focus on in-situ and other diagnostic studies, and much less emphasis on synthesis, should be given.

Reviewer 4:

The reviewer reported the following future plans: continue the investigation of $Li(Na)VPO_5Fx$ cathodes to further explore the phase diagram in the space of temperature and Li concentration, emphasizing that this would be done via in-situ ion-exchange studies; develop new polyanion-type ternary and quaternary lithium vanadium phosphates cathodes (i.e., Li-V-PO_4 cathodes); investigate the new α-

CuVO cathodes further and test them in Seeo's polymer electrolyte; and develop advanced diagnostic techniques for studies of synthesis reactions during preparation of cathode materials and lithium reactions in electrodes. This person concluded that while these plans are consistent with the previous activities of this project and help ABR in developing new synthetic options for material development, the materials themselves are not that promising.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer pointed out that having a good understanding of the synthesis and failure mechanisms are critical for the development of state-of-the-art cathodes.

Reviewer 2:

The reviewer agreed that the fundamental approach for identifying and developing new compounds is essential for success of the DOE programs.

Reviewer 3:

This reviewer commented that low specific energies and high costs are the limitations of the current Li-ion batteries for EV applications. The reviewer indicated that several engineering improvements have contributed to a marginal increase in specific energy recently, but new high specific materials are desired to fill the gap. This person further explained that state of art cathode materials provide capacities of only approximately160 mAh/g, which is about half of the capacities possible from the carbon anodes. The reviewer observed that the present project is aimed at developing new cathode materials with significantly higher specific energy.

Reviewer 4:

The reviewer said develop high capacity high voltage cathode for Li-ion batteries.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

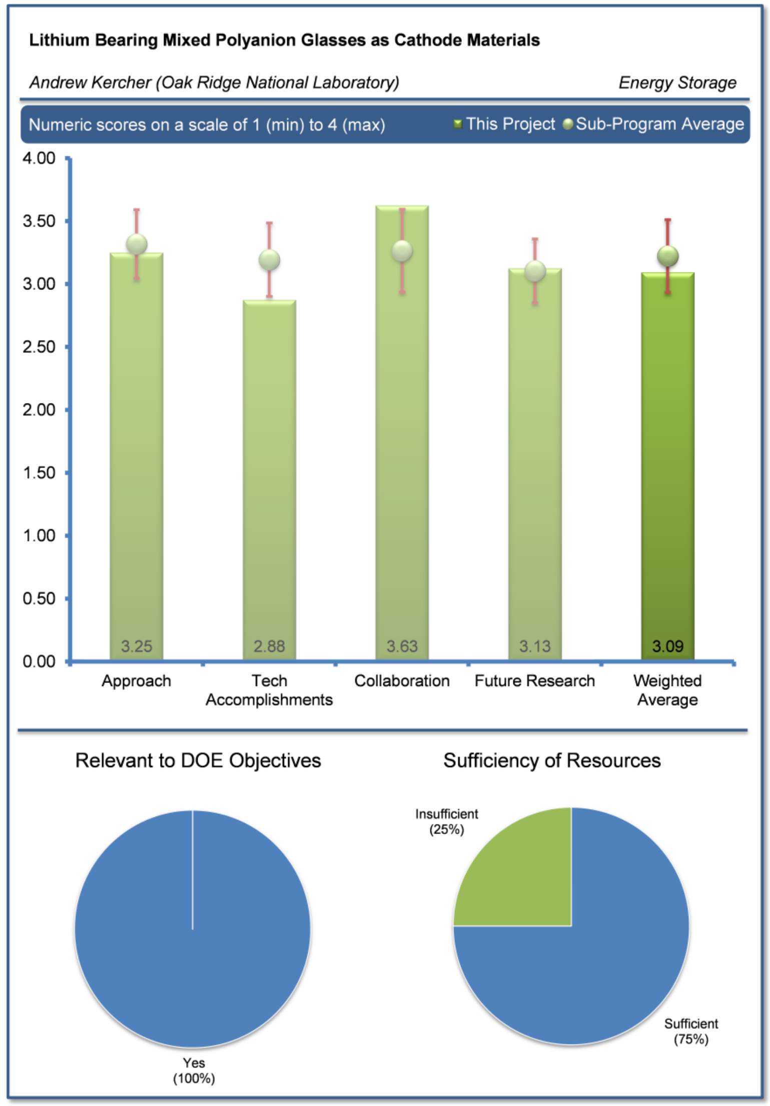
Reviewer 1:

The reviewer stated that the resources are adequate.

Reviewer 2:

This reviewer stated that resources are adequate for the scope of the project.

Lithium Bearing Mixed Polyanion Glasses as Cathode Materials: Andrew Kercher (Oak Ridge National Laboratory) - es184



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that although this is a high-risk project, it has the potential of characterizing a new class of materials for their suitability as cathode materials. The commenter noted that approaches to tailor the voltage as well as the conductivity are certainly obvious and should remain the focus of the work. The reviewer also voiced that studies with inexpensive raw materials and low-cost processes should be always kept in mind.

Reviewer 2:

This person indicated that mixed polyanion glasses are expected to alleviate the problems faced with traditional crystalline polyanion cathodes (e.g., $LiMnBO_3$, $LiCoBO_3$, and Li_2CoSiO_4), such as poor conductivity and irreversible phase transitions. The reviewer noted that the objective here is to synthesize and mixed polyanion glasses in the phosphate family containing a variety of transition metal cations to have specific energies exceeding $LiFePO_4$. The reviewer specifically identified vanadium substituted iron phosphate glasses [i.e., $Fe_4(P_2O_7)_3$ with 30-50% vanadate], which was shown to dramatically improve the specific capacity and rate performance. The approach is consistent with the objectives of this project as well as the goals of the ABR program. The reviewer commented that the approach is well integrated with the other materials-based efforts and appears feasible.

Reviewer 3:

The reviewer summarized that the approach is to synthesize and characterize electrochemical properties of polyanion cathode. The reviewer asked whether the carbon coating can be applied to polyanion cathode materials for improving the performance like $LiFePO_4$.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that reasonably good progress has been made in synthesizing and evaluating the vanadium substituted iron-phosphate cathodes in glass state. High capacities have been realized at lower voltage involving glass state reaction or reduction to Fe. However, this reviewer observed that the cycle life for the second reaction is rather poor. In addition to the iron phosphate glasses, several other multi-electron redox cathodes such as Mn and Co-bearing polyanion cathodes were synthesized and evaluated, but this reviewer reported that the expected high capacities are yet to be realized in laboratory tests. Overall, the reviewer commented that the benefits from the mixed polyanion glass compounds are not significant compared to the crystalline analogs or other cathode options under the ABR program.

Reviewer 2:

The reviewer expressed that the first series of glasses that were synthesized were interesting, but the reviewer was quite curious to see how the particle size affects the charge/discharge capacities. Also, the commenter asked whether it possible to carbon-coat the materials to augment the electrical conductivity. The reviewer asked if the authors with synthesize the materials predicted by the simulations and try to analyze whether there is any agreement between the model and actual materials.

Reviewer 3:

The reviewer stated that only limited experimental results were demonstrated. It was not clear to this person what new significant understanding on polyanion cathodes has been gained from this study.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer acknowledged that there is an excellent synergy among all of the collaboration partners.

Reviewer 2:

The reviewer stated that the PI has developed collaborations with BNL on X-ray diffraction and Northwestern University on modeling.

Reviewer 3:

This reviewer noted that there are good on-going collaborations with Massachusetts Institute of Technology (MIT) and Northwestern University on the XANES characterization and modeling of these cathode materials, respectively.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer recommended that the researchers please not focus too much on extensive cell making and testing. Rather, the reviewer suggested focusing on more new materials and identifying their characteristics and failure modes.

Reviewer 2:

The reviewer stated that if the PI believes that the ion diffusivity is the limiting factor, then experiments, such as EIS and NMR, should be designed to probe this issue.

Reviewer 3:

The reviewer reported that proposed future research involves continued development of a series of mixed polyanion glasses as a function of polyanionic substitution. The plans, continued this reviewer, are to synthesize, characterize, and perform electrical testing on at least four different glass cathode compositions with theoretical specific energies exceeding LiFePO4. As an example, this reviewer noted LiMn (½P2O_7 + ½ V_2O_7) with greater than 800 mWh/g theoretical capacity and LiCu(½PO_3 + ½VO_3)$_3$ with greater than 600 mWh/g theoretical capacity. The reviewer explained that equilibrium voltages for the glass-state conversion will be determined using galvanostatic intermittent titration technique. Though these studies look promising in principle, the reviewer indicated that practical specific energies will not be attractive because of the low capacities and voltages for the second reaction. The reviewer concluded that proposed studies are logical, but will fall short of addressing the technology barriers.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer opined that the limited range and higher cost of the Li-ion batteries are serious impediments for their use in electric vehicles. High energy density electrode materials will result in improved specific energy for Li-ion cells, increased range for the vehicle, as well as reduced overall cost for the battery. The reviewer further noted that state of art cathode materials provide capacities of only approximately160 mAh/g, which is about half of the capacities possible from the carbon anodes. This person identified a need to develop new cathode materials of higher specific capacities, possibly with multi-electron redox processes, which is being addressed in this project.

Reviewer 2:

The reviewer simply stated the project was aimed at developing high capacity and high voltage cathode for Li-ion batteries.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

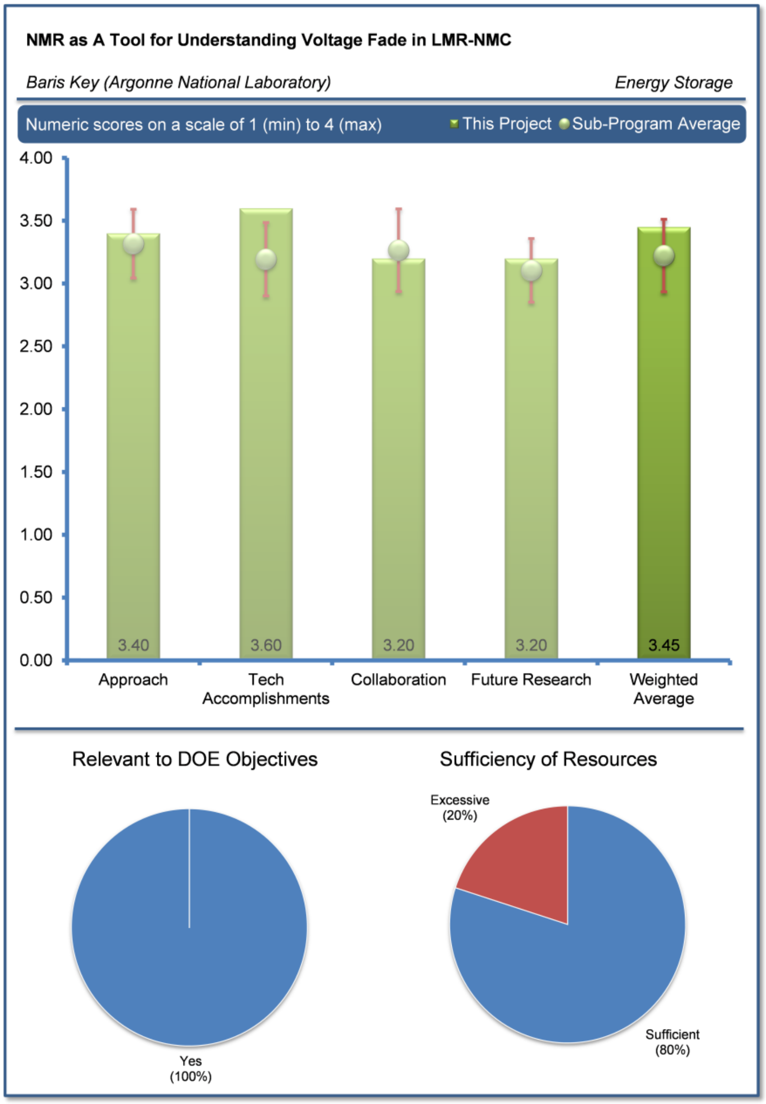
Reviewer 1:

The reviewer asserted that since it is a new class of materials with good opportunities, they would have funded it at a higher level.

Reviewer 2:

The reviewer indicated that resources are adequate for the scope of the project.

NMR as A Tool for Understanding Voltage Fade in LMR-NMC: Baris Key (Argonne National Laboratory) - es187



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded that the approach was very good; NMR is one of the few tools we have to directly observe the local environment of Li-ions in materials, since Li is nearly transparent to X-rays. The commenter explained that disordering of the LMR-NMC materials could be directly observed using NMR, and Li-ions in different environments were quantified as a function of state-of-charge and cycle number. It was particularly interesting to the commenter to see direct evidence of Li in tetrahedral sites in the cycled electrodes.

Reviewer 2:

The reviewer emphasized that this mechanistic work has the most chance of identifying the problems source and fixing it. The commenter noted that the project is well-aligned with DOE's goals of getting vehicles with high driving range in the field.

Reviewer 3:

The reviewer commented that a very good analytical approach was used to reveal the mechanisms along the structural change of the layered-layered material under charge and discharge.

Reviewer 4:

The reviewer affirmed the good use of NMR to look at the local Li environment. The commenter highlighted that this provides information that cannot be attained in other ways, so complements other techniques. The commenter also noted that the technique can be used to study both domain types in the layered-layered cathode material. The reviewer explained that the technique helps to show what is really going on and samples a decent amount of the sample, so data are likely representative of the majority of the material.

Reviewer 5:

The reviewer suggested that at some point it should be very interesting to correlate the NMR data with Extended X-Ray Absorption Fine Structure (EXAFS) and additional theoretical calculations to see if it is possible to find or formulate general rules that can be used by the experimentalist as guidance for their research efforts.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer affirmed that the project made good progress and accomplishments. The commenter explained that pristine and cycled materials were both examined as a function of state-of-charge and cycle number. The reviewer explained that the NMR and materials modeling work were complementary, with the experimental observation of tetrahedral Li being corroborated by DFT calculations.

Reviewer 2:

The reviewer praised that the authors have done a very good job with this sophisticated technique. The project evaluator suggested that it should be of interest to study also at least one standard material, such as NMC 111 or NMC 523, so the researchers can build and have a more wider "database" in relation to the Li behavior of these oxides.

Reviewer 3:

The reviewer highlighted that the return of Li to a disordered state is an important observation. The commenter offered that the role of transition metals migration is also important. The reviewer explained that these were all found with a lot of work completed and well-interpreted. The reviewer also recognized the researchers' nice insight on the mechanism and the reason it slows down with time.

Reviewer 4:

The reviewer noted that the researchers showed transition metal migration as the cathode cycles. The commenter also reported that the researchers eliminated hydrogen insertion as a cause of voltage fade. The reviewer summarized that the researchers provided an excellent interpretation of the data via difficult analyses, squeezing all they can from the data.

Reviewer 5:

The reviewer pointed out the very good results that give valuable insight into the structural changes along cycling.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer recognized that the deep dive project really was a team effort. The NMR work was particularly well-coordinated with the electrochemical characterization (Abrahams), the materials modeling work (Adir), and with other efforts at ANL. The reviewer indicated that there was some coordination with ORNL on neutron diffraction experiments, but otherwise not much was done with other institutions. The commenter said that it would be have been nice to have seen a project like this opened up more to other national labs and universities to avoid the risk of "groupthink."

Reviewer 2:

The interaction with a synthetic group should continue; it is very important.

Reviewer 3:

The reviewer stated that as with others good collaboration with a big team.

Reviewer 4:

The reviewer acknowledged the excellent cooperation within the Voltage Fade Project.

Reviewer 5:

The reviewer stated that the project has good linkage with ab-initio modelling at ANL and leverages other work like XRD data. The reviewer, however, cautioned that the project seems disconnected from ab-initio modeling work by Berkley (Persson, Project Number es091).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated that the deep dive project is ending this year and that some future plans are focused on tying up loose ends, but others (e.g., providing local structural information to guide the synthesis work) sound like they are carrying over to other projects focused on the LMR-NMC materials.

Reviewer 2:
The reviewer praised that the future study using EPR is a great idea. This person also acknowledged that the study of the activation and first discharge of these high capacity powders is very important. The reviewer suggested that it should be interesting to study more established NMC cathode powders to contrast those results with the new high capacity powders.

Reviewer 3:
The reviewer explained that the future plans are to extend the investigation to different compositions of transition metals, and eventually dopants to further support the other experimental teams.

Reviewer 4:
The reviewer agreed that the researchers are targeting the right things. The commented offered that it would be especially good to better understand the first cycle activation of this material, which seems to be very poorly understood.

Reviewer 5:
The reviewer simply stated that the future plans are in the right direction, but need definition.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed this work is very relevant to DOE objectives of petroleum displacement since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification.

Reviewer 2:
The reviewer explained that the project has enabled DOE premier work in the past and supports range/durability in applications to vehicle.

Reviewer 3:
The reviewer commented that the project helps to make available high capacity cathode materials in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:
The reviewer commented that the project provides a new window into the structure of the cathodes as they charge and discharge.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

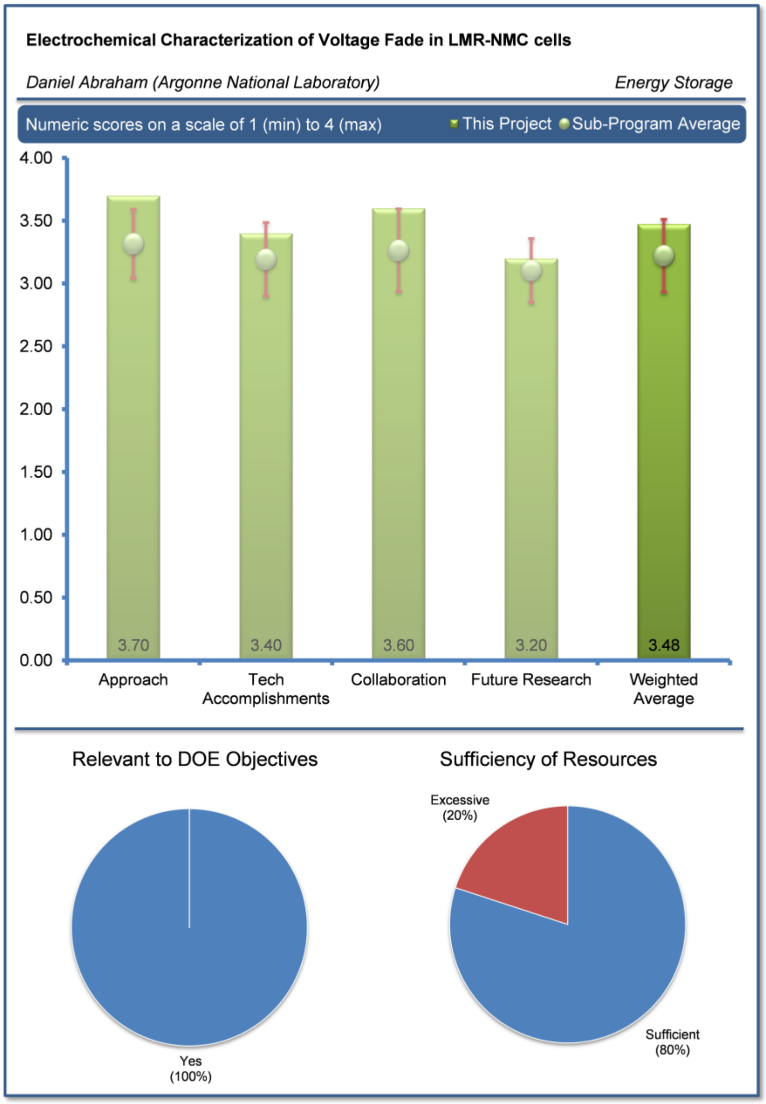
Reviewer 1:
The reviewer explained that the costs were not broken down by individual investigator efforts for this project. The commenter explained that $4 million over two years is a more than "healthy" investment to make in the study of materials that are extremely problematic, not just because of the voltage fade issue but because of other issues as well (low tap density, low rate capability, etc.). The reviewer suggested that one could reasonably question if the money would have been better spent on development of other materials and materials discovery and be spread out to other institutions as well. The reviewer would have liked to have seen a more comprehensive comparison of the LMR-NMC materials to other possibilities (high voltage spinel, high capacity stoichiometric NMCs, materials containing two

lithium ions per formula unit, etc.). The reviewer also requested the researchers should compare materials not just based on gravimetric capacities, but also densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise energy density), stage of development, projected timeline to commercialization, etc.; only with this information is it possible to make a fair assessment on whether this was money well-spent or not.

Reviewer 2:

The reviewer could not say, and noted that this information was not provided.

Electrochemical Characterization of Voltage Fade in LMR-NMC cells: Daniel Abraham (Argonne National Laboratory) - es188



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the approach was very good. The commenter suggested that this talk should have come first in the schedule, as it was directed towards demonstrating and defining the problem of voltage fade in the LMR-NMC materials through a series of electrochemical experiments. The project evaluator described that periodic short current interrupts during cell charge and discharge were used to estimate the degree of voltage fade due to structural changes during cycling, and to distinguish this from voltage changes due to rising cell impedance. (The long time required to approach equilibrium, particularly at the end of discharge, means that it is only an approximation, however). The reviewer explained that LMR-NMC materials were compared to NCA and NMCs, which undergo much less true voltage fade during cycling to high voltage limits, clearly demonstrating what the problem is with the former set of materials.

Reviewer 2:

The reviewer reported that the authors have presented a very good work using sophisticated techniques, such as high resolution electron microscopy and neutron diffraction, where a spinel structure has been clearly identified. The commenter proposed that it should also be important to also more traditional NMC powders to clearly distinguish them from these new high capacity type materials.

Reviewer 3:

The reviewer highlighted that life is an important barrier for these advanced cells, perhaps the most important at present. As a result, a relevant and standard test is key to unravelling the mystery of why there is fade and droop.

Reviewer 4:

The reviewer described that the approach involved systematic electrochemical methods to provide insight of the voltage fade mechanism. The commenter reinforced that comparison with standard materials and extension to long cycle numbers is most valuable.

Reviewer 5:

The reviewer applauded the excellent use of interrupts and other electrochemical techniques to spot and understand changes in the cell electrodes as these helps to divide and address the different causes of fade separately. In particular, the commenter stated that the electrochemical characterization work was very thorough. The reviewer indicated that the PI used a wide range of techniques and looked at the effect of many variables on both performance and the electrochemical behavior in great detail. Overall, the reviewer praised the very nice and useful work.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated the accomplishments and progress were very good. The commenter noted that there were some very useful and practical information regarding what can be done to ameliorate the voltage fade, such as decreasing the upper voltage limit during cycling, including a chart provided to show the effect of this on specific energy. The reviewer explained that while the LMR-NMCs cycled to lower voltages are still very attractive, alternatives like NCA (or high voltage NMC if capacity fading can be fixed) appear to be competitive. The reviewer also expressed that it was also good to see neutron diffraction (ORNL) used to detect Li in tetrahedral sites in cycled samples.

Reviewer 2:

The reviewer applauded that the authors have shown tremendous progress. The commenter suggested that it could be that as a byproduct of the author's efforts the battery research community may gain additional insight on the behavior of more traditional cathode powders, and also find some mitigating strategies for the voltage fade phenomena.

Reviewer 3:

The reviewer recognized the significant progress made on what causes the problem. The commenter noted that it was hard to parse out what the researchers did, and what others did, but that is the measure of good collaboration. The reviewer noted that there is sufficient progress to be ready to end soon. The commenter pointed out that it was an important step to separate the impedance from the fade. The commenter suggested that the researchers show that the ex-situ data will be at a lower voltage due to relaxation relative to in-situ work.

Reviewer 4:

The reviewer stated the results were very interesting and clearly showed the potential, and limitations, of the Li-rich NMC materials.

Reviewer 5:

The reviewer recognized the researchers' excellent use of interrupts to show how slowly the materials come to equilibrium (slow transition metal migration), especially at high states of charge. This commenter also noted that the work showing lack of benefit on voltage fade when changing the surface (ALD, coatings etc.) is important negative information that is consistent with the other findings of the team. The reviewer also pointed out that the reference electrode work was also a key element of this program. The project evaluator highlighted the good understanding of the role of the counter-electrode on cell behavior (LTO versus lithium metal versus carbon), but cautioned that they did not see any problems with the system the researchers are using, as they obviously fully understand the implications of the choice of the counter. The commenter mentioned that the researchers clearly showed the effect of charge and discharge voltage limits. Finally, the reviewer simply recognized that a lot of work was done, and applauded the very nice progress.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer affirmed that the deep dive project really was a team effort. This person described that the electrochemical effort was really central to defining the problem and providing guidance to the characterization efforts at ANL. The commenter also described that the project was coordinated with ORNL on neutron diffraction experiments-, one of the few in this program that utilized outside institutions. The commenter suggested that it would be have been nice to see a project like this opened up more to other national labs and universities to avoid the risk of "groupthink."

Reviewer 2:

The reviewer applauded that the project was a true collaboration, with the researchers working with the partners to advance on all fronts. The commenter proposed that the collaboration could only be improved with more collaboration outside the team.

Reviewer 3:
The reviewer acknowledged the strong collaboration with other groups was clearly shown.

Reviewer 4:
The reviewer confirmed the excellent cooperation within the Voltage Fade Team.

Reviewer 5:
The reviewer simply stated that the project included a great team approach.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer recounted that this deep dive project is ending this year, so the future work is focused on wrapping up loose ends, and providing data to the battery community (presumably in the form of presentations and publications).

Reviewer 2:
The reviewer stated that the future plans are appropriate given that the work is ending. The reviewer thought that it is absolutely critical to show that the protocol, which was legitimately developed without the knowledge gained in the program, does not draw conclusions that would be different if there was not an infinite supply of Li.

Reviewer 3:
The reviewer summarized that the future plans will continue to determine the final capacity, energy density and power capability in the final "stable" configuration. The researchers will extrapolate this, as well as the remaining hysteresis, to the final application in a xEV and define benefits compared to hi-Ni NMC.

Reviewer 4:
The reviewer noted the good future plans. The commenter proposed that, if the researchers have time, they could also look into developing a better understanding of the activation cycles.

Reviewer 5:
The reviewer encouraged the researchers to study additional layered oxides. The commenter suggested that the authors may find some general rules that may help to better understand more traditional cathode powders.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed the research is very relevant to DOE's objectives of petroleum displacement, since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification.

Reviewer 2:
The reviewer pointed out that this is based on previous DOE funded work that could make a difference in the battery market, and the present work attacks the current biggest barrier to implementation in the market.

Reviewer 3:
The reviewer described that the project results will help to make available high capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:
The reviewer simply stated that it is obviously critical to understand the electrochemistry of these electrodes.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer explained that the costs were not broken down by individual investigator efforts for this project. The commenter explained that $4 million over two years is a more than "healthy" investment to make in the study of materials that are extremely problematic, not just because of the voltage fade issue but because of other issues as well (low tap density, low rate capability, etc.). The reviewer suggested that one could reasonably question if the money would have been better spent on development of other materials and materials discovery and be spread out to other institutions as well. The reviewer would have liked to have seen a more comprehensive comparison of the LMR-NMC materials to other possibilities (high voltage spinel, high capacity stoichiometric NMCs, materials containing two lithium ions per formula unit, etc.). The reviewer also requested the researchers should compare materials not just based on gravimetric capacities, but also densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise energy density), stage of development, projected timeline to commercialization, etc.; only with this information is it possible to make a fair assessment on whether this was money well-spent or not.

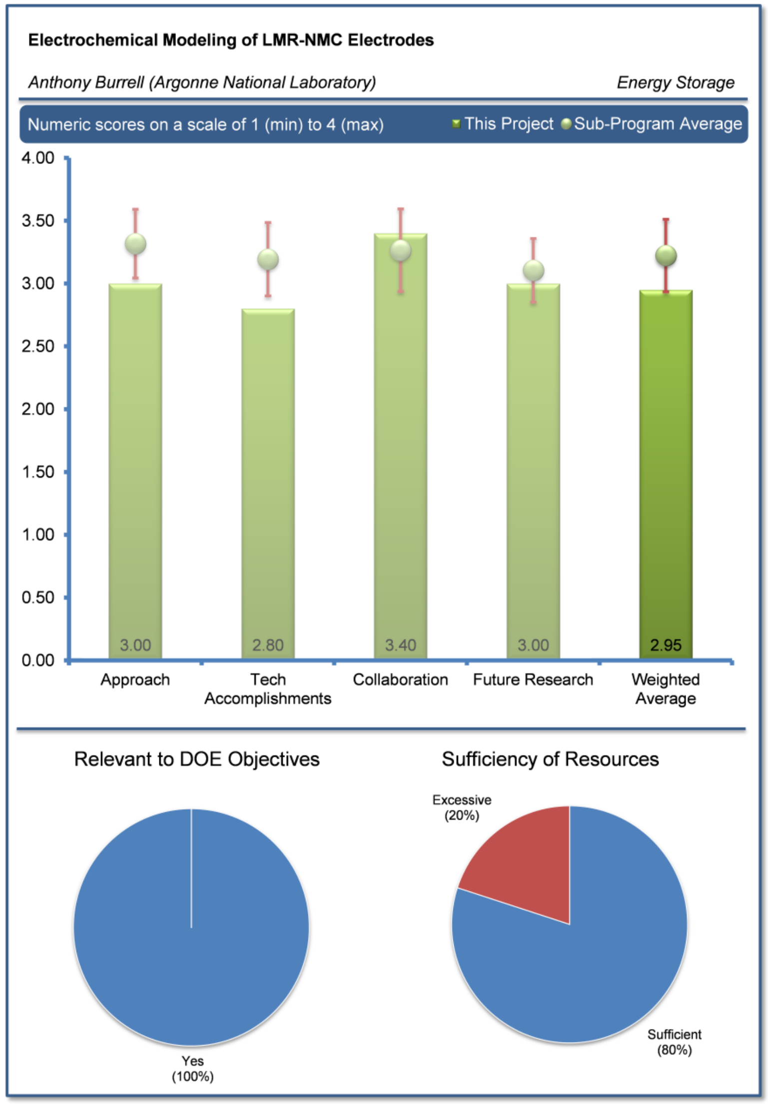
Reviewer 2:

The reviewer observed that a lot of work accomplished, so the project was a great use of the funds.

Reviewer 3:

The reviewer could not say, and noted that this information was not provided.

Electrochemical Modeling of LMR-NMC Electrodes: Anthony Burrell (Argonne National Laboratory) - es189



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that system modeling on cells containing LMR-NMC cathodes was carried out using Dualfoil (the Newman program that is used to simulate intercalation in batteries). The commenter noted that this can yield valuable information for well-behaved conventional systems, but the complicated behavior of the LMR-NMC cathodes proved to be very challenging. The reviewer explained that the existence of hysteresis and phase changes means that several time constants need to be used to model the data and experiments need to be slow enough so that equilibrium can be achieved.

Reviewer 2:

The reviewer commented that the electrochemical modeling, coupled with experimental results, validate the results that were presented by the group.

Reviewer 3:

The reviewer noted that the modeling approach is useful, but makes progress only when it is tightly and interactively tied to experimental groups; therefore, being part of this team makes this approach more productive.

Reviewer 4:

The reviewer said that the modeling approach follows standard principles and equations. The commenter explained that the high number of parameters are adjusted by fitting to experimental results. This person suggested that this could be reduced by trying to determine physical parameters in separate experiments.

Reviewer 5:

The reviewer praised the good leveraging of referenced cell work. However, the reviewer said that the approach taken is seems basically a fitting exercise; thus, even if it can fit the data, the reviewer asked what does it really tell us. The commenter proposed that maybe more insight could be gained by modeling the phases separately and linking them to the ab-intio modeling work. The commenter concluded by stating that, as usual, this PI does a nice job of checking for consistency of the models by fitting a variety of cell data on different types of tests.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer strongly encouraged exploring additional synthetic routes to produce layered-layered materials with stabilized spinel component. The commenter also strongly encouraged the researchers to investigate mitigating strategies.

Reviewer 2:
The reviewer reported that the results are representing well the fitted experimental data, though the capability to forecast effects has not yet been shown.

Reviewer 3:
The reviewer pointed out that several models were completed and were compared to results in experiments. The commenter noted that there was good agreement to the experiments, though this is fitting and not prediction, so a good agreement is expected. The reviewer concluded by stating that hopefully the approach will be useful in engineering an attack on the fade problem.

Reviewer 4:
The reviewer criticized that the "black box" approach of Dualfoil to modeling this complicated system was somewhat disappointing in the results it yielded. The commenter explained that hysteresis and voltage fade introduced a lot of complexity into this system, which was really developed for simpler dual intercalation systems. The commenter acknowledged that the researcher did indicate that a prediction that current should fall and then rise after long times during a voltage step was confirmed experimentally.

Reviewer 5:
The reviewer reported that the work was able to predict some phenomena that were later observed experimentally, but overall the reviewer questioned the usefulness of this model. With such a complicated material and so many parameters to adjust, the resulting model seems to be largely to be a fitting exercise. The reviewer stated that they look to modeling to explain what is going inside the cell and material. So just fitting data does not do much for this commenter, even though they know people obsess about getting the "fit" right. The reviewer did note that the same model can apparently fit multiple types of test data and this adds to its credibility.

Bottom, line the reviewer thought that this project this is a valiant effort, but the end result was not worth it in their view. While the reviewer reported hating to sound defeatist, maybe this material is just too complex to create a truly useful model of the whole material. The reviewer did, however, think that this work has been useful in highlighting the importance of the cell history that is especially important for this system because it has such long relaxation times before the systems fully recovers on rest. This also indicates that performance testing of this material will likely be a much stronger function of the precise test regime than for other systems. Thus, the project evaluator proposed that a wider array of tests may be required to check for good/bad things that will happen in real-world usage that would otherwise be hidden if one only runs the standard accelerated tests on the cells.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer reported that the researchers were able to give teammates reasons for their observations, and obviously got lots of needed data from them.

Reviewer 2:
The reviewer simply acknowledged the excellent cooperation within the Voltage Fade Team.

Reviewer 3:
This reviewer observed that collaboration seems to be good.

Reviewer 4:

The reviewer explained that this deep dive project was a close collaboration among (mainly) ANL scientists and was clearly a team effort. The reviewer would have liked to have seen more consultation with researchers outside of ANL to avoid falling into the trap of "groupthink." The commenter reported that the work is being carried out in many groups throughout the world on these materials, and interactions with these researchers would have added valuable perspective.

Reviewer 5:

The reviewer described that the researcher works with electrochemists and cell makers very well to leverage their experimental data. The commenter acknowledged that getting data from referenced cells is critical to their work - and to others in separating out anode and cathode behavior. The commenter stated that the PI can also model these basic electrochemical tests (such as differential capacity plots). The reviewer explained that the PI was able to run the model on real-world tests to predict the actual battery performance seen by the experimenters. The project evaluator explained that modeling work like this also helps highlight to the experimenters/ab-intio modelers what it is that they do not know; this can be very useful in getting them to fill those gaps with their own fundamental experimental/modeling work.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer simply stated that suitable plans were presented.

Reviewer 2:

The reviewer stated that this deep dive project is ending this year, so the future work is directed towards wrapping up loose ends.

Reviewer 3:

The team effort demonstrated during this work seems to be continuing as shown by the authors during their presentation. This reviewer suggested that the authors should explain in more detail the assumptions involved in the models and calculations.

Reviewer 4:

The reviewer suggested that the model should be tested by forecasts of certain effects (at fixed data set) to be checked afterwards by experiments. The commenter also requested that the researchers try to determine as many physical parameters as possible by dedicated measurement of those parameters.

Reviewer 5:

The reviewer explained that this approach has to lump many variables together for the different phases. The reviewer suggested that maybe more insight could be gained by modeling the phases separately and linking them to the ab-intio modeling work rather than data from actual cells (or maybe to cell data for cells using the component phases if that were possible). The reviewer asked whether there any value/insight that can be gleaned from the parameters used to fit the model to the data. If not, the commenter stated that it is hard for them to really see that there is much value in this work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reported the work is very relevant to DOE's objectives of petroleum displacement since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification.

Reviewer 2:

The reviewer indicated that the layered material is a DOE-funded advancement, so this project enhances past work. The commenter also explained that the material is also a step forward that is just outside of making a real commercial impact due to droop and fade, and so this work if very much on point for putting more EVs and PHEVs on the road.

Reviewer 3:

The reviewer described that the project is focused on helping to make available high capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:

The reviewer stated that the project supports experimentalists to study "hot" cathode material, but the fitting nature of the model makes the reviewer question its utility.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

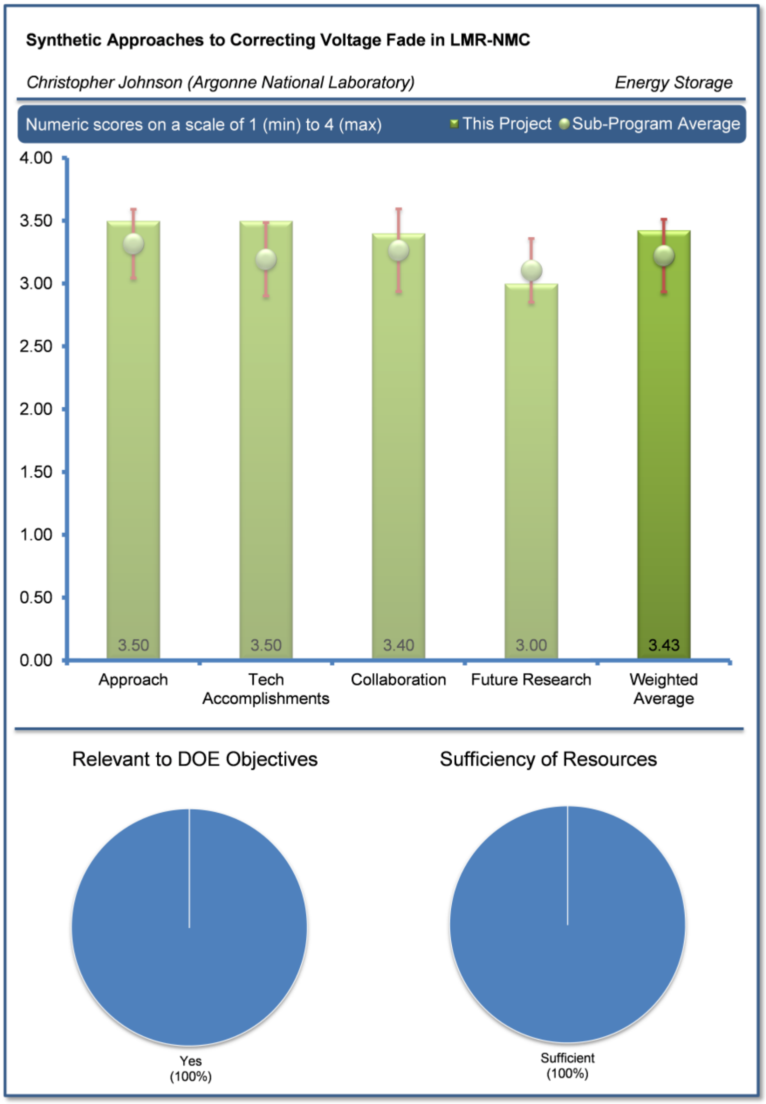
Reviewer 1:

The reviewer explained that the costs were not broken down by individual investigator efforts for this project. The commenter explained that $4 million over two years is a more than "healthy" investment to make in the study of materials that are extremely problematic, not just because of the voltage fade issue but because of other issues as well (low tap density, low rate capability, etc.). The reviewer suggested that one could reasonably question if the money would have been better spent on development of other materials and materials discovery and be spread out to other institutions as well. The reviewer would have liked to have seen a more comprehensive comparison of the LMR-NMC materials to other possibilities (high voltage spinel, high capacity stoichiometric NMCs, materials containing two lithium ions per formula unit, etc.). The reviewer also requested the researchers should compare materials not just based on gravimetric capacities, but also densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise energy density), stage of development, projected timeline to commercialization, etc.; only with this information is it possible to make a fair assessment on whether this was money well-spent or not.

Reviewer 2:

The reviewer could not really say, and noted that this information was not provided.

Synthetic Approaches to Correcting Voltage Fade in LMR-NMC: Christopher Johnson (Argonne National Laboratory) - es190



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted an excellent and comprehensive study. The reviewer added that it was interesting to see that the authors did not hesitate in taking a decision about the coating approach on voltage fade.

Reviewer 2:

The reviewer commended the good multi-tool, multi-discipline approach. The commenter acknowledged the rigor of maintaining same amount of Li, or fixing the rest of the structure as cations are changed, is a very good to answer this problem.

Reviewer 3:

The reviewer agreed that a good systematic experimental approach was used. The reviewer indicated that the link to theory/modeling to direct experiments were stated, but could not be seen.

Reviewer 4:

The reviewer recognized the excellent synthetic approaches and link to modeling efforts.

Reviewer 5:

The reviewer commented that the approach is quite broad and well-conceived. The only problem the reviewer reported seeing is the limitation of elemental substitution to the trivalent component (substituting Al, Ga, and Fe for Co). As the PI recognized, substitution of Ru for Mn has a major effect on the voltage fade. The commenter suggested broadening the search for substituents to those involving Mn with other tetravalent elements and in trivalent/pentavalent 1:1 combinations. The reviewer mentioned that work by Tarascon has suggested that Sn-Ru mixtures have a major effect on reducing or eliminating voltage fade in similar lithium-rich composite materials, which gives emphasis to this type of study.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer pointed out that although major effects to solve voltage fade have not resulted from the work so far, a number of relevant studies have eliminated factors as having any important effect on voltage fade. This includes the effect of synthesis method, synthesis conditions, relative compositions among Li, Ni, Mn, and Co. The correlation of the ratio of Co/Mn as causing an increase in voltage fade was not convincing to the reviewer, as it appeared that the result is within the range of error. The reviewer also suggested that a regression analysis of the data be carried out to test the reliability of this important conclusion.

Reviewer 2:

The reviewer stated that the PI clearly explained the issue involved with voltage fade. The reviewer opined that the increased understanding of this phenomenon should be able to push forward mitigation strategies to the voltage fade issue. New synthetic strategies and better understanding of the cations movement while cycling these materials should be continued.

Reviewer 3:

The reviewer summarized that the project is pulling many threads of research together the main causes seem to be largely defined. The commenter acknowledged that this required a lot of work to complete like coatings, doping, and synthesis investigations. The reviewer remarked that the sol gel method was a very good choice of ways to look at the ion species impact.

Reviewer 4:

The reviewer recognized the extensive and meaningful results that clearly showed that voltage fade is a reproducible and imminent feature of the structure and only depends a little on the synthesis route or specific composition.

Reviewer 5:

The reviewer commended the nice synthetic work. The commenter explained that the researchers looked at quite a wide variety of synthetic methods, and the lack of affect does support their contention that the problem is innate to the material itself. While this work shows that surface coatings do not affect the voltage fade, the commenter indicated that it does show promise for reducing some of the other causes of fade. The reviewer reported that while the researcher acknowledged the DOE's goals of thousands of cycles for a PHEV battery, it seems to the reviewer that some of the approaches to the other aspects of fade could realize cycle life that was at least in the 100-300 cycles range. The commenter suggested that this would be good enough for many consumer applications, especially as each cycle would be longer than that for a typical Li-ion cell. Thus, the commenter suggested that establishing what the best cycle life could be using these approaches may be enough to start it being commercialized. Apart from the monetary aspects, the reviewer indicated that the attention this would then get from the cell makers would greatly add to the number of researchers working to optimize the material. By leveraging the large staff of the commercial enterprises, this might actually be the best way to fix the problems for longer cycling that the DOE needs.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer agreed there was excellent cooperation within the Voltage Fade Team.

Reviewer 2:

This reviewer asserted that the authors are clearly coordinating their research efforts.

Reviewer 3:

The reviewer commended that the collaboration was excellent in team, but not much outside team. The reviewer said that was OK and the level of cooperation across the groups in such a huge team was pretty impressive.

Reviewer 4:

The reviewer affirmed that the collaboration among the ANL workers is exemplary. The reviewer felt, however, that additional collaboration with battery manufacturers (especially in the EV space) would be very useful to include to focus the future work on what would be acceptable performance in the various types of xEVs for this potentially valuable material. The reviewer acknowledged that this might move the program to include additional studies to truly evaluate the LMRNMC family in actual application tests of interest to manufacturers. The commenter offered that this is especially valuable in a large team effort such as this to accelerate the implementation of the material in actual cells as the work continues.

Reviewer 5:
The reviewer stated that there was a good link to some modeling efforts, but criticized that the modeling at Berkeley by Persson (Project Number es091), where they largely seem to discount the dumbbell mechanism, seems to have been ignored.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer offered that if the voltage fade issue cannot be easily resolved, that developing mitigating strategies should be strongly encouraged. The reviewer expressed that these type of powders are too important for the future of high capacity Li-ion cells.

Reviewer 2:
The reviewer agreed that it was too strong to conclude that a fix is unattainable. The commenter suggested that the focus needs to be how to “fix” the problems identified here, so the fade is eliminated.

Reviewer 3:
The reviewer criticized that some of the proposed next steps are not target-oriented, as shown by some other groups. The commenter suggested that a new focus could be to find a synthesis route to produce the material in the structural configuration, which was found to be the stable one (after several hundred cycles).

Reviewer 4:
The reviewer agreed that it was critical to look at doping with Ru, Sn, etc. that Tarascon has apparently published. The commenter was glad to see this is planned, but emphasized that reproducing, and even understanding better, Tarascon's work needs to be a top priority for this project and especially this PI.

Reviewer 5:
The reviewer stated that they would like to see an expansion of the substitution work to tetravalent ions. The reviewer requested seeing a better validation of the spinel component in the LLS materials as suggested by the PI.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed the project is highly relevant.

Reviewer 2:
The reviewer commented that the DOE work will be enabled and the energy of cells could be increased over today’s normal cell if this problem is solved.

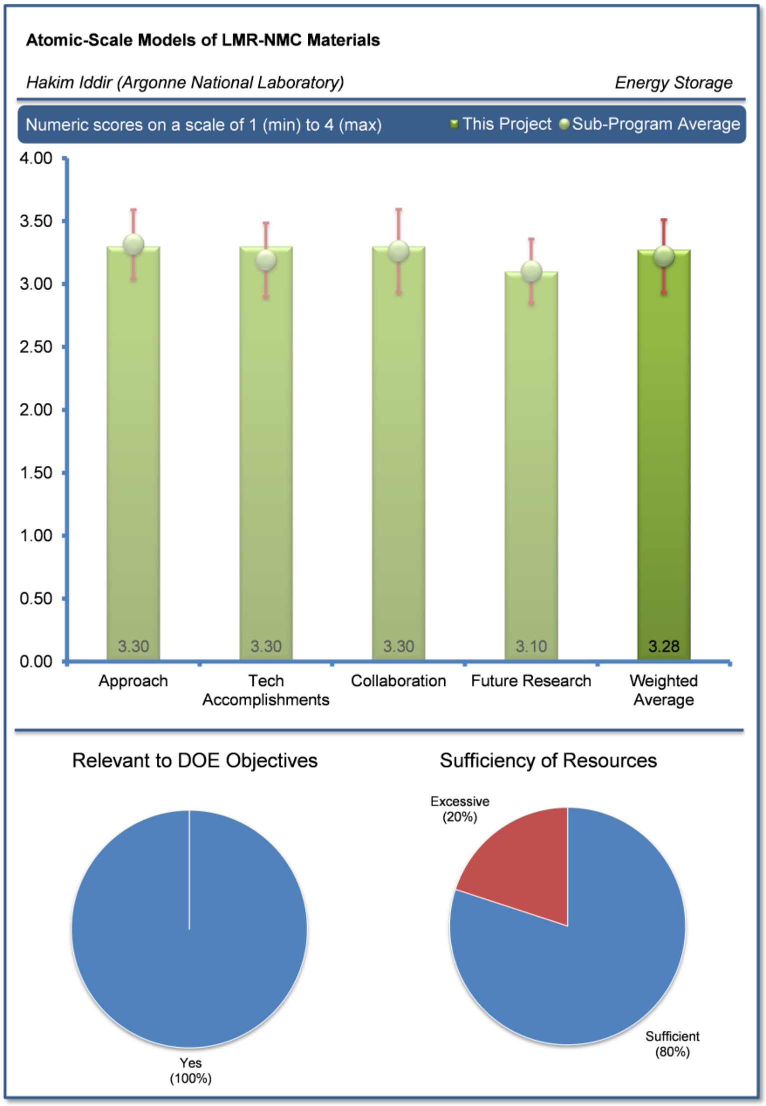
Reviewer 3:
The reviewer stated that the project will help to make available high capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:
The reviewer agreed that the project is very important in establishing what does, and equally important what does not, help voltage fade.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that it was hard to say, and noted that this information was not given.

Atomic-Scale Models of LMR-NMC Materials: Hakim Iddir (Argonne National Laboratory) - es193



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that a first principles modeling of materials was used to understand their behavior. The commenter noted that although there are some limitations to using density function theory (DFT) GGA+U on materials with mixed conductivities, when done judiciously, useful insights can be obtained. The project evaluator state that focusing on a composite Li_2MnO_3-LCO material is closer to the real-world LMR-NMC material than pure Li_2MnO_3 (which behaves much differently), but it would have perhaps been more relevant to look at a Ni-containing composite instead, since that is what is being proposed for use.

Reviewer 2:

The reviewer reported that the approach followed by the authors, where theoretical calculations were coupled with experimental results, was excellent and of high quality.

Reviewer 3:

The reviewer stated that the researchers used a good approach that was a key to the team's success.

Reviewer 4:

The reviewer remarked that it was important approach to couple the experimental results with the first principle simulations. The commenter mentioned that regarding oxygen vacancies model was calibrated to experiment. The reviewer asked if it was possible to simulate the kinetics of the oxygen release.

Reviewer 5:

The reviewer praised the good use of modeling to understand the important aspects of this complex material and the good comparison with NMR and X-Ray Absorption Near Edge Structure (XANES) studies. The commenter, however, was concerned about the apparent disconnect with similar modeling at Berkeley on Li_2MnO_3 phase.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that calculations indicated that there is a tendency for phase separation to occur in the Li_2MnO_3-LCO system, with domains in ribbons. The commenter explained that Co is oxidized first, which is perhaps not too surprising (one might expect Ni to oxidize first in an LMR-NMC, however, so this is something different about the chosen system). One surprising result the reviewer noted was the prediction of tetrahedral Mn^{5+} as an intermediate during the cycling. Mn^{5+} is somewhat unstable and may easily disproportionate to Mn^{7+} and Mn^{3+} or Mn^{4+} (particularly if an acidic component is present in the electrolytic solution). The reviewer remarked that it would have been nice to confirm or deny this experimentally, perhaps by using some kind of optical spectroscopy.

Reviewer 2:
The reviewer stated that the theoretical calculations provided by the authors showed that the tetrahedral site for Mn is favored by 0.21 eV over the octahedral site, and they mentioned that this difference is the driving force behind Mn migration. The reviewer asked whether there is any qualitative rule that can explain that trend. The commenter suggested better overlap between Mn and oxygen atoms and/or less repulsion between Mn cation with other metal cations.

Reviewer 3:
The reviewer mentioned that it was useful to know that thermodynamics would drive phase segregation. The commenter stated that the indication of vacancies and Mn movement interaction points to the mechanism in experiments and underpins it with the needed energetics to have confidence it is the mechanism. The reviewer also stated that the long range order in Li interface on long aneal was then seen in experiment.

Reviewer 4:
The reviewer reported that the model has been fully-implemented and the delivered results are showing accordance to the experimental findings.

Reviewer 5:
The reviewer commented that the ability to predict NMR and other experimental data is very important in adding validity to their modeling work, but more importantly it enables the team to really understand the experimental data and figure out what is going on with this very complex cathode material.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that this deep dive project was a close collaboration among (mainly) ANL scientists, but was clearly a team effort. The reviewer would have liked to have seen more consultation with researchers outside of ANL to avoid falling into the trap of “groupthink.” The reviewer acknowledged that work is being carried out in many groups throughout the world on these materials, and interactions with these researchers would have added valuable perspective.

Reviewer 2:
The reviewer simply noted the good and fruitful collaboration with experimentalists.

Reviewer 3:
The reviewer commented that, as with partners, the project is a well-integrated collaboration among many partners.

Reviewer 4:
The reviewer acknowledged the excellent cooperation within the Voltage Fade Team.

Reviewer 5:
The reviewer agreed that, in general, the collaboration seems to be excellent; describing that the researchers are working with NMR, XANES studies, etc. However, the reviewer saw an apparent disconnect and maybe even a fundamental disagreement with the modeling work at Berkeley by Persson (Project Number es091). The reviewer stated that if there is a disagreement between the groups, then that is fine, but resolve it as a team using science, logic, and data. The reviewer suggested that maybe they were wrong, but they got the distinct impression that a “Not Invented Here” syndrome may be in play at the ANL team.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer simply stated the future plans were adequate.

Reviewer 2:
The reviewer explained that this deep dive project is ending this year, so the future work is directed towards wrapping up loose ends.

Reviewer 3:
The reviewer reported that the theoretical calculations suggested that Mn migration as the main problem with this type of powders. The commenter proposed that it should be of great interest to study that mechanism further, so solutions or partial mitigation strategies can be proposed. This reviewer noted that it could be of great interest if, in the future, the authors qualitatively explain why, or which, is the driving force behind the generation of oxygen vacancies. The reviewer explained that a better understanding of its mechanism may open the door to new mitigation strategies for the voltage fade issue.

Reviewer 4:
The reviewer agreed that the plans are okay, but the reviewer wondered whether the researchers could model the effect of Ru and Sn doping that Tarascon has reported reduces voltage fade.

Reviewer 5:
The reviewer asked whether there was a possibility to extend the model to other compositions or dopants. The commenter also asked whether there was the possibility to identify the/a final 'stable' configuration after cycling as shown by experimental groups.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that the project was very relevant to DOE's objectives of petroleum displacement since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification.

Reviewer 2:
The reviewer commented that the project would make vehicles or MP3s go further or longer. The reviewer also mentioned that the project supports DOE work that created this material in the first place.

Reviewer 3:
The reviewer agreed that the project will help to make available high capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:
The reviewer stated that fundamental modeling like this can provide key insights to these complex and very important material that cannot be attained experimentally.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

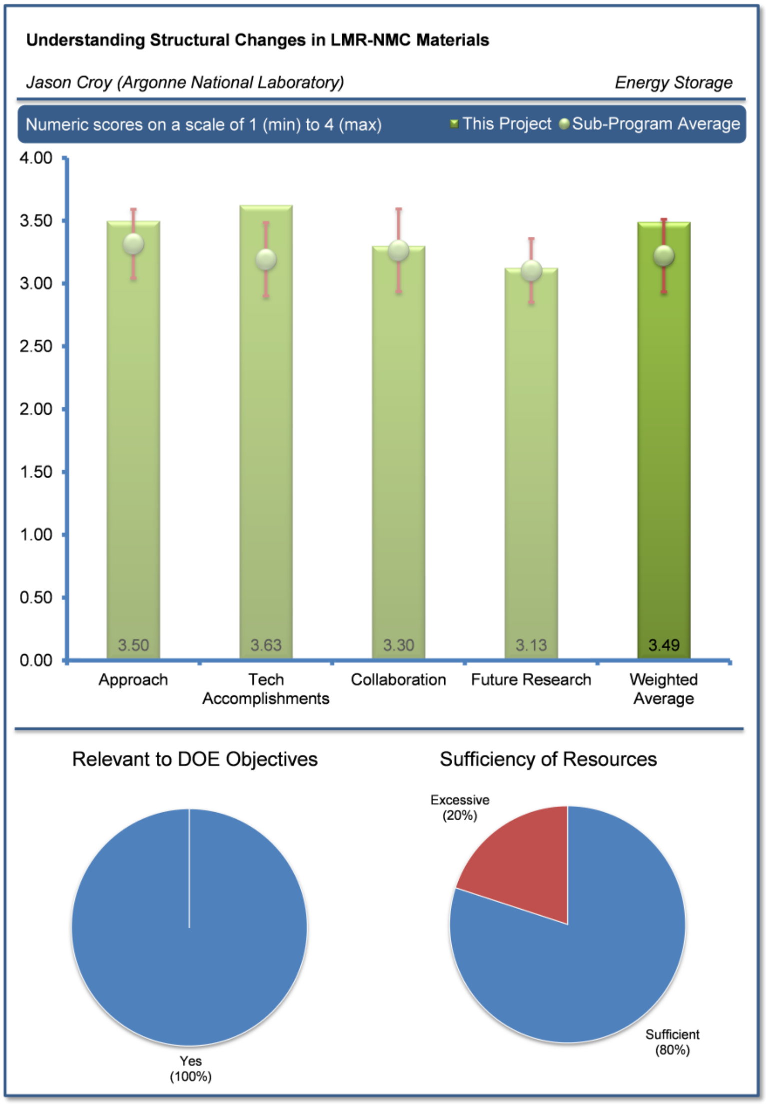
Reviewer 1:
The reviewer explained that the costs were not broken down by individual investigator efforts for this project. The commenter explained that $4 million over two years is a more than "healthy" investment to make in the study of materials that are extremely problematic, not just because of the voltage fade issue but because of other issues as well (low tap density, low rate capability, etc.). The reviewer suggested that one could reasonably question if the money would have been better spent on development of other materials and materials discovery and be spread out to other institutions as well. The reviewer would have liked to have seen a more comprehensive comparison

of the LMR-NMC materials to other possibilities (high voltage spinel, high capacity stoichiometric NMCs, materials containing two lithium ions per formula unit, etc.). The reviewer also requested the researchers should compare materials not just based on gravimetric capacities, but also densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise energy density), stage of development, projected timeline to commercialization, etc.; only with this information is it possible to make a fair assessment on whether this was money well-spent or not.

Reviewer 2:

The reviewer could not say, and noted that this information was not provided.

Understanding Structural Changes in LMR-NMC Materials: Jason Croy (Argonne National Laboratory) - es194



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer described that X-Ray Absorption Spectroscopy (XAFS) was used to investigate local structures of LMR-NMC cathodes. The reviewer agreed that this was a good method for detecting changes in local ordering in transition metals containing battery materials as a function of composition, state-of-charge, and cycle number, although the commenter indicated that the results were somewhat hampered by the inability to directly observe Li-ions due to their near X-ray transparency. For this reason, the reviewer suggested that the technique is best used in conjunction with other techniques (e.g., neutron diffraction, NMR, and etc.) to understand the full picture, as was done in this project.

Reviewer 2:

The reviewer expressed that this is an important effort that clarifies some of the problems associated with voltage fade. The reviewer inquired about the existence of any qualitative rule such as the ones used in organometallic chemistry that the authors can propose to explain the generation of oxygen vacancies.

Reviewer 3:

The reviewer applauded the nice technique used to look at the structure. The commenter pointed out that the researchers went past the structure to the energetics, which is the main problem, so this was a good way to study the part of the scope they were assigned.

Reviewer 4:

The reviewer praised the excellent analytical approach that was used to reveal the voltage fade mechanisms.

Reviewer 5:

The reviewer noted the good combination of modeling, electrochemistry, XANES, and EXAFS diffraction analysis.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer expressed that this work, which reflects efforts by both this PI and other team members, has shown excellent insight as to what is going on inside this complex cathode material. Overall, the commenter said that this has greatly boosted the battery research community's understanding and appears to have largely answered the key questions.

Reviewer 2:
The reviewer acknowledged that important findings such as the trapped Mn species in tetrahedral sites. The commenter stated that this type of information is critical so mitigating strategies can be developed. This reviewer observed good interaction with other groups that complement the project team's results. It could be of interest to better explain the uncertainty involved in the fittings of the EXAFS spectra.

Reviewer 3:
The reviewer reported that the researchers showed that distortion of matrix and Mn^{3+} occurs after cycling and also that the structure and oxidation state vary on charge and discharge at same voltage.

Reviewer 4:
The reviewer reported that substantial insight in structural changes during activation and first cycles have been elaborated.

Reviewer 5:
The reviewer explained that XAS, when used in conjunction with other techniques, can provide useful information about local structures and metal oxidation states. In pristine materials, there is evidence of segregation of Mn into Mn-rich regions. This is consistent with interpretation of the structure as being a "layered-layered" composite, but also with a solid solution having a flower pattern arrangement of cations in the transition metal layers. The commenter noted that different rates of cooling during synthesis did not result in substantial differences in XAFS patterns for one particular material with unspecified X, suggesting perhaps that it is a composite regardless of the cooling rate. The project evaluator also indicated that the transmission electron microscope analysis also seemed to show that it is a composite, but solid solutions with planar defects can look like a mixture of rhombohedral and monoclinic materials in some views, so this was not conclusive either. The reviewer agreed that it is certainly possible that some compositions are composites (e.g., Toda HE5050) and others are solid solutions, so it was best not to assume that all LMR-NMCs are the same. It seemed to this commenter that much of the XAFS data can be interpreted at least two different ways (e.g., Li_2MnO_3 in $0.5Li_2MnO_3 \cdot 0.5LiNi_{0.5}Mn_{0.5}O_2$ looks different from pure Li_2MnO_3; but the reviewer asked whether this was because it was influenced by the rhombohedral component or because it was not really a separate phase.)

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer explained that this deep dive project was a close collaboration among (mainly) ANL scientists, and was clearly a team effort. The reviewer would have liked to have seen more consultation with researchers outside of ANL to avoid falling into the trap of "groupthink." The commenter noted that work is being carried out in many groups throughout the world on these materials, and interactions with these researchers would have added valuable perspective.

Reviewer 2:
The reviewer described that, as with others in this team, great interchange and true collaboration was achieved in the team.

Reviewer 3:
The reviewer recognized the excellent cooperation within the Voltage Fade Team.

Reviewer 4:
The reviewer noted that this work seems to show good coordination and interaction with other groups and laboratories.

Reviewer 5:

The reviewer noted the excellent collaboration with experimentalists. The biggest concern the reviewer had was the apparent lack of collaboration with, and ignoring the modeling efforts at, Berkeley by Persson (Project number es091). The commenter asserted that the researchers' work suggests that the dumbbell model of Mn migration is incorrect, but the dumbbell model is the crux of the mechanism portrayed in this work. The reviewer explained that it is fine if there is a disagreement, but resolve it as a team using science, logic, and data.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that this deep dive project is ending this year, but some fairly comprehensive future work is planned, rather than just wrapping up the loose ends. This suggested to the commenter that work will continue on the LMR-NMC system in another context (a different project, for example).

Reviewer 2:

The reviewer suggested that studies to increase the cycle numbers might be of interest to follow behavior towards the 'stabilization' of structure (e.g., as shown by Abraham).

Reviewer 3:

The reviewer stated that it was good that the researchers are looking at the activation cycles. The reviewer indicated that they want to see the apparent disconnect between Berkeley and ANL resolved.

Reviewer 4:

The reviewer strongly encouraged the researchers to explore additional synthetic routes to produce layered-layered materials with stabilized spinel component; developing mitigating strategies were also strongly encouraged.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that the project is very relevant to DOE's objectives of petroleum displacement, since LMR-NMC materials are candidate cathode materials for high-energy batteries needed for vehicle electrification.

Reviewer 2:

The reviewer asserted that the project is needed to make a DOE-funded breakthrough material viable. The commenter also observed that the project would help with driving range for vehicles if it succeeds in fixing the voltage fade issue.

Reviewer 3:

The reviewer stated that the work helps to make available high capacity cathode material in order to increase battery energy density and meet DOE targets on xEV vehicles.

Reviewer 4:

The reviewer commended that the project has addressed, and largely resolved, the key issues in understanding the LLC material which is critical to this program.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

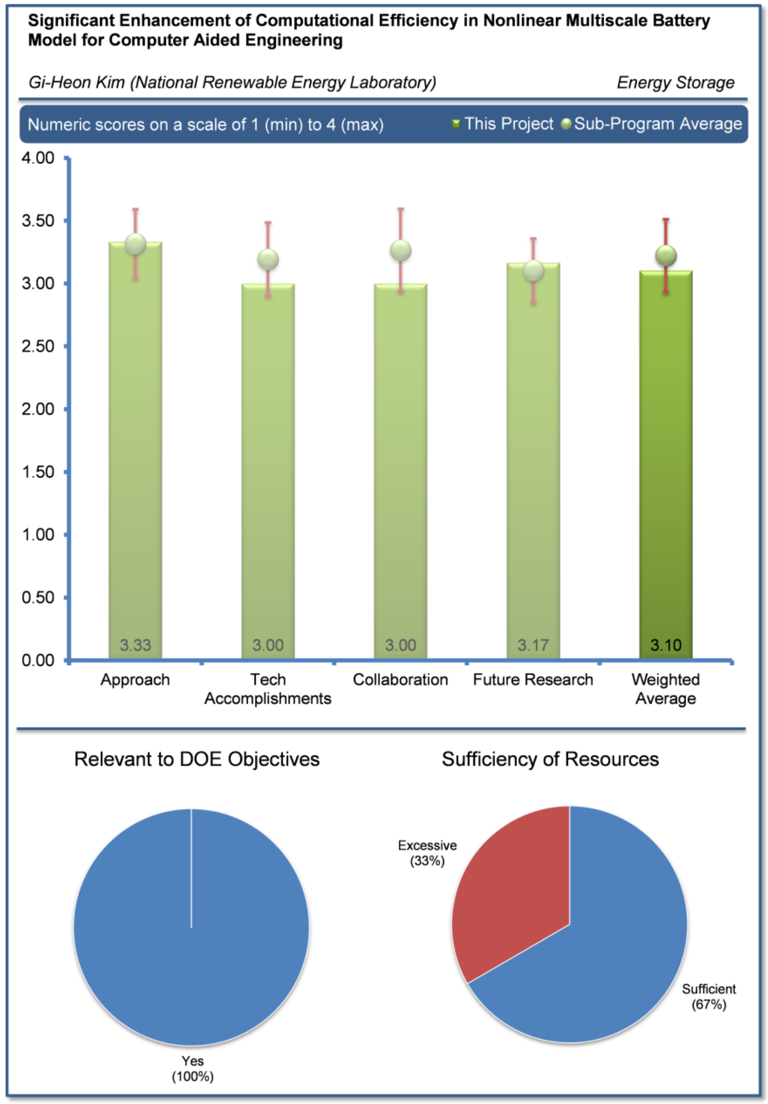
Reviewer 1:

The reviewer explained that the costs were not broken down by individual investigator efforts for this project. The commenter explained that $4 million over two years is a more than "healthy" investment to make in the study of materials that are extremely problematic, not just because of the voltage fade issue but because of other issues as well (low tap density, low rate capability, etc.). The reviewer suggested that one could reasonably question if the money would have been better spent on development of other materials and materials discovery and be spread out to other institutions as well. The reviewer would have liked to have seen a more comprehensive comparison of the LMR-NMC materials to other possibilities (high voltage spinel, high capacity stoichiometric NMCs, materials containing two lithium ions per formula unit, etc.). The reviewer also requested the researchers should compare materials not just based on gravimetric capacities, but also densities, rate capabilities, electrode formulations necessary to overcome rate limitations (a high carbon content will compromise energy density), stage of development, projected timeline to commercialization, etc.; only with this information is it possible to make a fair assessment on whether this was money well-spent or not.

Reviewer 2:

The reviewer could not say, and noted that this information was not provided.

Significant Enhancement of Computational Efficiency in Nonlinear Multiscale Battery Model for Computer Aided Engineering: Gi-Heon Kim (National Renewable Energy Laboratory) - es197



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer asserted that the presentation would have been significantly improved by the presenter not reading the text written on the slide; it would also be improved with less text. The commenter explained that the model seems to be essential to previous and related efforts by others (e.g., companies, national labs, and academia).

Reviewer 2:

The reviewer reported that this project is developing a Multi-Scale Multi-Domain (MSMD) model which will link battery physics across varied length and time scales. The commenter explained that the battery geometry will be resolved into three coupled computational domains to achieve high computational efficiency with a flexible and expandable modularized framework. The project goals include a greatly reduced computational load and the ability to resolve complex transport and kinetics which are often nonlinear interactions.

Reviewer 3:

It seemed to the reviewer to be a good approach to link battery physics at different length and time scales to eliminate some of the nested iterations to reduce computation time without compromising accuracy. The commenter noted that adaptive and nonlinear ROM were proposed to improve the accuracy with faster computation time, but explained that not enough details were provided to understand these modified ROMs.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the researchers seemed to have made great progress, given that the project was only 25% completed. The commented recognized that a 100 faster computation speed was claimed and the voltage profile seemed to match between the measured and simulation data. The reviewer proposed that more validation data should be provided to show progress toward mitigating instabilities caused by nonlinearity.

Reviewer 2:

The reviewer noted that the project is relatively new. The goals for the project were outlined: ROMs have limitations. The commenter described that a new technique using low-order which are adaptive to system evolution, are to be developed. In addition, the reviewer reported that a new ROM that does not fail under severe nonlinear conditions (with speeds comparable to current ROMs) will be designed. Multiple options of modular component models for various subsystems will also be constructed to avoid current limitations for various battery designs, environments and operating conditions. It was not clear to the reviewer how far the work on these topics has progressed. The project evaluator described that the presentation focused on the newly developed GH-MSMD framework that has been implemented, which links the particle domain model into the electrode domain model. The commenter observed that this framework removes the nested iterations, but retains the modular architecture thus achieving a significant enhancement in computational speed. Some data was made available regarding potential output/applications from the project - this included insight into how active electrode material particles respond under differing driving cycles (HEV versus PHEV). The reviewer recognized that the project is relatively new, but suggested that early validation with more developed models and experimental data would be welcome to verify that the new implementations do not skew the information obtained.

Reviewer 3:

The reviewer indicated that the presenter did not spend enough time presenting this. The commenter described that the results were on battery simulations, and did not address the computational efficiency improvements which are the main focus of the project. The reviewer criticized that the reviewer only noticed one number on one slide (i.e., 100 times improvement in computational time), but no discussion of what the computational efficiency was due to was provided.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer agreed that there seemed to be good collaboration with specific roles described for each team member.

Reviewer 2:

The reviewer stated that this project is led by NREL in partnership with ANSYS. The team of researchers will integrate the outcome models of ANSYS's battery simulation platform by providing ANSYS software engineering in support of the NREL researchers. The commenter stated that previous collaborations between these partners suggest that a strong fusion of their respective talents will be brought to the project tasks. The reviewer suggested that perhaps discussions with the teams developing the CAD tools for CAEBAT (i.e., CD-adapco, EC Power, and GM-ANSYS) would be welcome to ensure that the evolution of the computational models is understood by all and that feedback can be obtained as the work is done or beforehand.

Reviewer 3:

The reviewer suggested that it would be nice to have more academic contributions.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer explained that the future research will extend the GH-MSMD nonlinear multiscale framework to include cell domain models and subscale domain models. A Discrete Empirical Interpolation Method for the representation of the nonlinear functions will also be added to aid in retaining the use of ROMs. The commenter also indicated that metrics will be developed to evaluate the relative enhancement of the models and the framework will be incorporated into the ANSYS CAEBAT framework and the Open Architecture Software. Finally, the reviewer stated that validation of the model codes against the baseline full-order (slower) models will be done. The reviewer summarized that the proposed future work is well-aligned with the project's milestones.

Reviewer 2:

The reviewer proposed that the researchers should focus more on modeling of aging to show that the instabilities caused by nonlinearity can be mitigated with their approach, while not compromising accuracy.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer mentioned that battery physics-based computational models are often hampered by excessive computational expense due to transport and kinetic interactions which are often nonlinear; this project seeks to address these challenges.

Reviewer 2:

The reviewer agreed that this is a worthwhile effort to reduce the computation time without compromising accuracy. If successful, the reviewer said it should make the use of battery modeling more mainstream among battery engineers/scientists.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

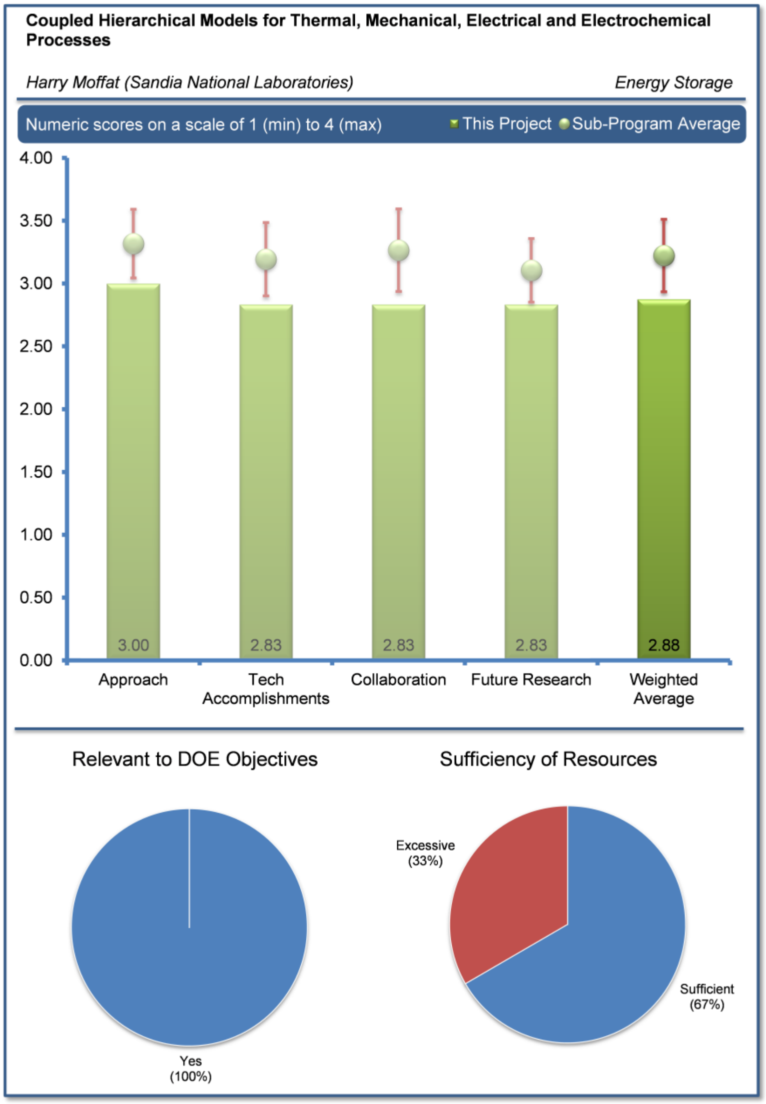
Reviewer 1:

The reviewer stated that the project should enable collaborations with universities at the $1.2 MM level.

Reviewer 2:

The reviewer indicated that no information about the resource availability was provided, so it was assumed that sufficient resources are available for the project's milestones.

Coupled Hierarchical Models for Thermal, Mechanical, Electrical and Electrochemical Processes: Harry Moffat (Sandia National Laboratories) - es198



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer liked the use of CANTERA to enable the incorporation of the various physics of kinetically-controlled phenomena.

Reviewer 2:

The reviewer described that the project will incorporate thermodynamic and kinetic properties from the literature into a CANTERA-based framework for cell-level chemistry/transport. The commenter also pointed out that models from Sandia National Laboratories' (SNL) Thermal Battery Program will be added to the CAEBAT architecture. Partial saturation and solid mechanics models will be added (to address gasification and stress-induced degradation). SEI models will be constructed that predict experimental autocatalytic temperature behavior. Microstructure calculations will be up-scaled to the macrohomogeneous scale. Finally, new models will be developed for thermal runaway processes. Unfortunately, reviewer criticized that the presenter did not sound overly confident in the proposed approach; it seems that significant challenges may complicate the work ahead.

Reviewer 3:

The reviewer described that the researchers proposed to simulate thermal runaways using predictive mechanisms derived from coupled electrochemical and thermal models. The commenter acknowledged that the researchers also had good idea to add side reactions and gas generations in their CANTERA electrochemical model. However, the commenter remarked that this might be very challenging since no one has a complete understanding of all the side reactions and gas generation reactions. The reviewer noted that the researchers' intent to use empirical exchange current and to use look-up table for their scale-up electrochemical heating seemed to contradict their mechanism based.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that later this year a go/no-go point will be the duplication of existing capabilities (from NTG and Dualfoil) with the CANTERA/1DElectrode framework within the CAEBAT architecture (incorporating an electrode object into CAEBAT). The commenter reported that accomplishments noted include: an electrode evolution model, the understanding of numerical issues associated with the work, and heat release capability. The reviewer explained that slides were provided for a collaborator at the Colorado School of Mines who is focused on providing more realistic electrode microstructure models rather than the simple spherical models of active material particles currently used. It was unclear to this person if the work shown is from some previous work, or if it was done as part of the present project. The reviewer summarized that for these more realistic models, pre-computed look-up tables will be used facilitate the determination of heat release.

Reviewer 2:

The reviewer explained that since this project was just kicked off, there was limited accomplishment, but the researchers need to show more thermal distribution data as a function of discharge rates.

Reviewer 3:

The reviewer said that not much progress since the project just started.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that the project is led by SNL with ORNL providing the CAEBAT Open Architecture Software and a researcher at the Colorado School of Mines providing upscaling of the pore-level models. Perhaps discussions with the teams developing the CAD tools for CAEBAT (i.e., CD-adapco, EC Power and GM-ANSYS) would be welcome to ensure that the evolution of the computational model is understood by all and that feedback can be obtained as the work is done or beforehand. Direct discussions with OEMs about their experience with thermal runaway and their desired output from a new model would also perhaps be fruitful.

Reviewer 2:

The reviewer observed good collaboration with various teams and that specific roles were described.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer explained that the future research includes implementation of solid mechanics, partial saturation, and pressurization models to enable multi-phase capability followed by the addition of SEI models, and a demonstration of the model's capabilities. The commenter highlighted that direct validation (preferably including blind evaluations) of the framework is necessary; otherwise the resulting framework will have little utility.

Reviewer 2:

The reviewer stated that the future work needed to be elaborated upon and to be specific on the “demonstrate capabilities” and “Integrate SEI models.” The reviewer further inquired about the SEI models and capabilities.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer explained that the project is more fundamental and does not have as direct a connection to battery operation, use and management, but, it could provide very important fundamental insights and understanding that will improve performance and control in the longer timeframe.

Reviewer 2:

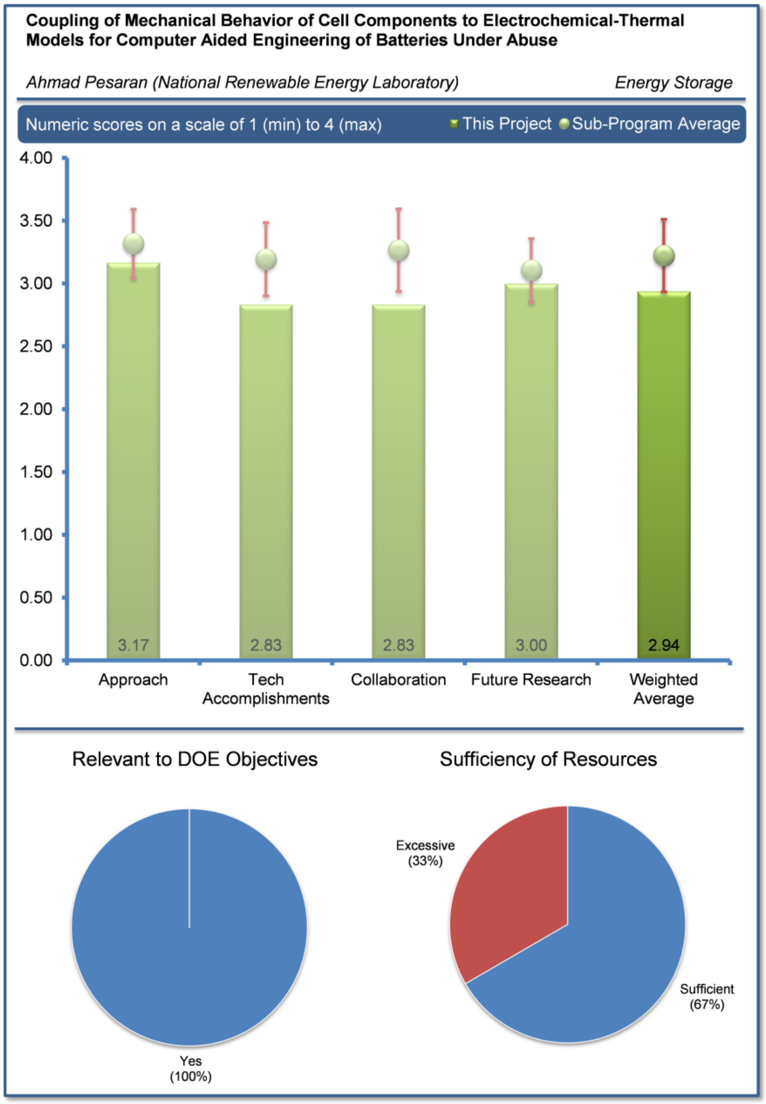
The reviewer described that the project goal is to address the causes and implications of thermal runaway in Li-ion batteries using a developed software package that can provide predictive mechanisms. The commenter affirmed that safety is a prime concern for large battery packs intended for transportation applications; thus, this project is well-aligned with DOE’s goals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that $1.5M per year is pretty high, but, the reviewer liked the collaboration with academia.

Reviewer 2:
The reviewer stated that little information regarding resources was presented. The presenter mentioned several times that they are the owner of the CANTERA open-source modeling package on which the project is based.

Coupling of Mechanical Behavior of Cell Components to Electrochemical-Thermal Models for Computer Aided Engineering of Batteries Under Abuse: Ahmad Pesaran (National Renewable Energy Laboratory) - es199



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the project was another in the set of highly needed technology progression into modeling of "Li-ion safety" in applications. The reviewer has a certain question as to the cell size and form factor frequented, particularly with MIT as a partner who has long term expertise in cylindrical characterization and crush modeling with uncertain transfer or validation toward large format and/or large module configurations.

Reviewer 2:

The reviewer stated that the approach was to couple the electrochemical-thermal (ECT) model with the mechanical deformation model to predict thermal response in a crush. However, since NREL's Abuse Reaction Kinetics (ARK) model for thermal ramp is empirically based, the thermal ramp response will depend on cell design, for example high power versus high energy. The reviewer added that the project team's bottom-up approach to build the cell thermal ramp rate from individual cell components heating rates was a good approach.

Reviewer 3:

The reviewer observed that the project will develop a model to couple the ECT behavior of a Li-ion cell with its structural behavior after rapid mechanical deformation using MIT's mechanical model. The reviewer stated that another model would also be developed to predict the thermal response of cells to thermal ramp. To do this, NREL's chemical kinetic abuse model would be transferred to the ANSYS CAEBAT-1 platform while including the actual internal geometry of cells. The reviewer commented that the modes would be compatible with CAEBAT-1 and the Open Architecture Software (OAS) developed by ORNL. The reviewer asked what the current limitations were of the MIT mechanical and NREL chemical kinetic abuse models. The reviewer also wanted to know if these limitations would hamper the extension of these models to these abuse tests. If so, the reviewer asked how this would be addressed.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the project team's data showed good correlation on the thermal ramp rate versus temperature ARC data with the simulation. The reviewer also said that it seemed reasonable to correlate resistivity with deformation during crush but it was not clear how the project team quantified deformation. The reviewer added that it was also not clear how the rate of resistivity change was used in the ECT model to predict thermal ramp during crush.

Reviewer 2:

The reviewer stated that a number of accomplishments were noted including the readiness to share the NREL Abuse Reaction Kinetics (ARK) model with ANSYS once the project team accepts the contract, the development of a user-friendly tool for parameter identification for the ARK model, a new enhanced anisotropic model of a cell jellyroll to aid in the coupling of the existing ECT model with the mechanical model, and compression testing of cells to obtain experimental validation data. The reviewer noted that one of the slides showed a tensile test on components of the electrode and separator assembly. Presumably there was no electrolyte present during the testing due to the solvent's volatility. The reviewer asked if the mechanical properties of the material would change significantly when soaked with electrolyte, for example, in a cell. The reviewer added that simulations were in progress to establish what parameters must be exchanged between the models. Some challenges and barriers were noted by the reviewer, including the difficulty of using the multi-layer puncture approach to capture damage zones created by different crush loads and orientations and the fact that model validation with experimental data may be complicated by the difficulty of matching.

Reviewer 3:

The reviewer could have rated this lower with not much progress. The reviewer was sorry to recognize the ANSYS issues as not necessarily trivial. The reviewer believed the NREL staff to be extremely competent and only hopes that the project team can get some forward synergy.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that there was good collaboration with various teams and specific roles were described, but it was not clear if there is a good feedback loop between validation at NREL and the simulation from the team members.

Reviewer 2:

The reviewer indicated that the team was led by NREL's Energy Storage Team with collaborations with NREL's High Performance Computing Team, MIT and ANSYS. ANSYS has still not accepted the contract to work with NREL on this project. The reviewer added that this may delay the accomplishment of the project's future milestones, although the presentation indicated that this may not be the case. The difficulty here was unclear to this reviewer because ANSYS must have agreed to this partnership early in the proposal process and ANSYS was working with other partners for the CAEBAT projects. Also, the reviewer said that the direct discussions with OEMs about their experience with thermal runaway and crush testing and their desired output from a new model would perhaps be fruitful.

Reviewer 3:

The reviewer referenced prior comments.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer listed the future plans: to transfer the ARK model to the CAEBAT-1 platform while maintaining OAS compatibility, validate thermal ramp abuse model with experimental data, and create and validate the couple mechanical deformation (crush)-ECT model and transfer it to the CAEBAT-1 platform while maintaining OAS compatibility. The reviewer added that interactions with other groups which conduct thermal runaway and crush testing may be helpful for obtaining relevant experimental data in a timely manner.

Reviewer 2:

The reviewer agreed with the proposed future work though, that the project team should expand their abuse modeling to other abuses such as impact, shock or over discharge.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

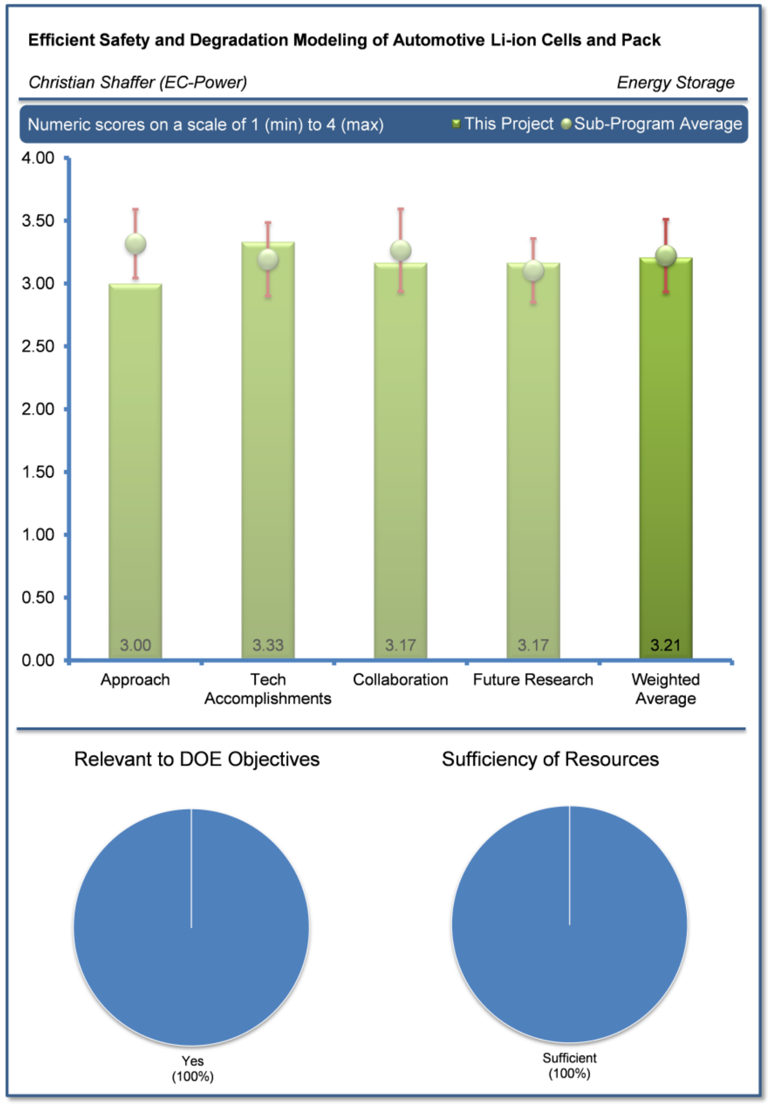
The reviewer said that the project addresses two battery abuse conditions (i.e., “crush” and “thermal ramp” runaway of cells). Given that safety is of paramount importance for transportation battery packs, the reviewer asserted that this project is highly relevant to DOE goals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that it was presumed that the team had the necessary resources to accomplish the proposed work.

Efficient Safety and Degradation Modeling of Automotive Li-ion Cells and Pack: Christian Shaffer (EC-Power) - es200



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the major barriers and fundamental objectives identified were excellent. A robust pack-level safety and abuse model and mechanism-based, fundamental models for predicting degradation are essential; however, the reviewer warned that the focus on nail penetration (NP) as the model abuse initiation mechanism is of concern (by project definition you are using the NP not as an internal short representation but rather a true abuse). The reviewer explained that NP has become difficult to reproduce consistently from a physical hardware point of view, some have used the term “unreliable” but design sensitive to say the least. The reviewer indicated that this was largely due to advancement in production designs as opposed to 15 years ago, some may call “gaming” the design to pass a J2464 test but these design mechanisms are somewhat successful in safety improvements. So if the validation mechanism and model are to be of NP abuse, then the reviewer might challenge the project to broaden the nail material and size definition and speed to real world boundaries especially before module or pack level validation. The reviewer said cynically, a 35 mile per hour nail shot could be a bit scary.

Reviewer 2:

The reviewer mentioned that the model development would focus on cell safety, abuse and lifetime. The reviewer stated that little information was provided about what needed to be done to accomplish this. The reviewer asked what challenges were associated with this model development. The reviewer wanted to know if this would be readily integrated into the CAEBAT platform and the OAS developed by ORNL. The reviewer added that the project would expand the existing extensive materials database (developed by Pennsylvania State University's Electrochemical Engine Center (ECEC) previously) to include NCA. Large format cells would be prepared for experimental testing of safety, abuse and degradation.

Reviewer 3:

The reviewer indicated that the project team proposed to use the ECT model to predict life and combine ECT with pack level shorting model to predict Li-ion battery safety associated with shorting from nail penetration. Also, the reviewer noted that the ECT should be predictive since it is not empirical based and is based on parameters extracted from the extensive materials database. The reviewer added that it is not clear if the pack level shorting model will be applicable to other shorting induced incidents such as crush.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the NCA experimental property measurements are underway. Algorithms have been developed to efficiently simulate nail penetration of multi-cell packs. The reviewer asked if this includes the mechanical deformation of the cells from the nail penetration. Simulations have been run comparing the heating effects for one large graphite cell and the equivalent of six smaller cells assembled together (same voltage, same total capacity) to determine the effect of the number and arrangement of the cells within a battery pack. The reviewer added that the experimental nail penetration testing is being conducted to measure the detailed electrochemical and thermal responses (not just the variation in temperature). The reviewer stated that the initial model has been developed for enhanced life and abuse evaluation. Current work is focused on implementing the refined mechanism-based, temperature-dependent predictive models. The reviewer wanted to know what the principal limitations are of the current model. The reviewer also asked if it will be difficult to validate the model due to challenges in comparing experimental and simulated safety and abuse data and if so, how this will be addressed.

Reviewer 2:
The reviewer explained that the project team added NCA to the materials database. This will enhance the usefulness of the ECT model since NCA is a popular Li-ion cathode material. The reviewer said that the project team also developed a predictive life model that is mechanism-based and provided limited validation data. The reviewer added that it is not clear if the project team included electrolyte degradation in their life model. The reviewer reported that it will be very useful to extend the life model to include both storage calendar life and cycle life at various temperatures.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that there were excellent and well balanced partnerships on this project.

Reviewer 2:
The reviewer reported that there was good collaboration, but that it was not clear what the role of their other team member, Pennsylvania State University, was in this project. The reviewer added that it was also not clear how much of the ECT simulation could be performed in the OAS architecture.

Reviewer 3:
The reviewer indicated that the project was led by EC Power with a partnership with Pennsylvania State University. The reviewer added that no information was provided about the strength of this collaboration. The "Collaboration with Other Institutions" slide indicated that ORNL will provide the OAS. The reviewer stated that EC Power already worked with ORNL for the es120 project, development of cell and pack level models for CAEBAT-10, presumably this is a straightforward relationship. Interactions with other groups which conduct nail penetration testing may be helpful for obtaining relevant experimental data in a timely manner and for feedback about the simulation results.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer was pleased to see that the NCA cathode was considered in this project.

Reviewer 2:

The reviewer listed the proposed future research as complete the NCA characterization, Conduct the nail penetration testing and validation for single cells and multi-cell packs and to continue development and validation of the models for life and abuse testing (accelerated life and overcharge testing).

Reviewer 3:

The reviewer agreed with the project team's proposed research, but suggested to expand the abuse modeling to include other abuses such as over discharge and crush.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

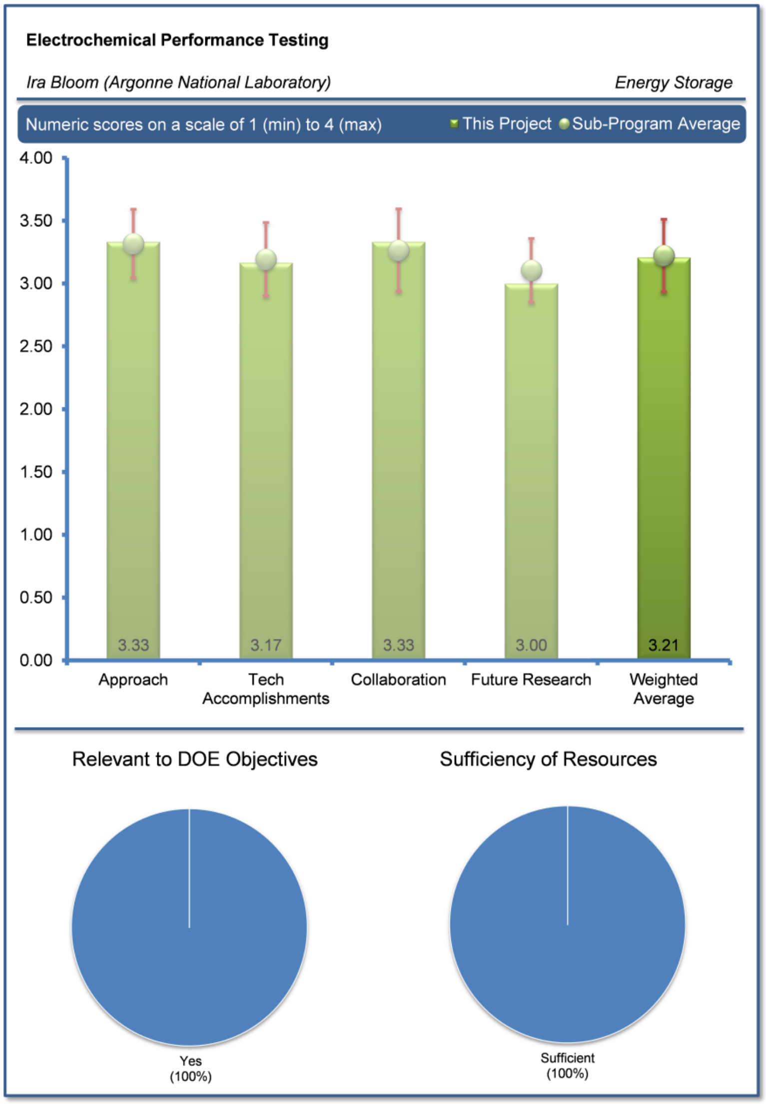
The reviewer stated that the goal of this project is to develop an efficient and robust pack-level safety and abuse model. The reviewer added that this will be a predictive, virtual tool with ECT coupling to assess, screen, predict cell, and pack design safety. Given that safety is of paramount importance for transportation battery packs, the reviewer said that this project is highly relevant to DOE goals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that it is presumed that all necessary resources are available for the project since no information is provided regarding this.

Electrochemical Performance Testing: Ira Bloom (Argonne National Laboratory) - es201



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the ANL's strong battery testing capabilities are derived from the laboratory's long experience in such testing and from being one of the key labs in setting up the protocols for battery testing.

Reviewer 2:

The reviewer indicated that the objective here is to provide DOE and the USABC with an independent assessment of contract deliverables of Li-ion cells from different developers for DOE/USABC, to benchmark external state-of-art battery technologies, and to project battery life. This reviewer added that standard USABC-developed testing methods are being applied to characterize cells, modules, and packs for determining performance at low temperatures (cold cranking), as well as cycle life and calendar life for projecting battery life. These results are being compared against the USABC goals to identify the gaps and shortfalls in the technology. Finally, continued the reviewer, these activities are being leveraged from similar activities in China to formulate consistent test protocols for EVs.

Reviewer 3:

The reviewer indicated that the ongoing work that ANL is doing in this area is very necessary and important. The reviewer added that the more recent integration of China Automotive Technology and Research Center (CATARC) collaboration is a great step in global standardization and comparisons. The reviewer fully supports this work and the very high level of ANL competence, though the reviewer was disappointed that this project was at the poster session without the PI present, leaving a technician to answer questions to only a very limited level and the reviewer came back several times.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted high quality, accurate measurements that characterize ANL's test data and the comparative data for China and United States tests used for this competency.

Reviewer 2:

Commensurate with a substantial funding being allocated for this project, this reviewer reported that several Li-ion technologies form different suppliers are being evaluated both at ANL and INL. It would be beneficial to the reviewer and to the community if the test results were briefly described. The reviewer indicated that test articles are mostly cells representing different technologies, with advanced anodes and cathodes, being developed for DOE. Although this reviewer acknowledged that it is important to perform independent verification of these "advanced technologies," the selection of the technologies for this expensive and elaborate testing is not well thought out. The reviewer opined that this project should be more selective to pick technologies of merit of any viability for integration into EVs, rather than just being a verification center for the advanced technologies. Substantial effort, as observed by this reviewer, is being expended on comparing the U.S. and Chinese test protocols because the differences do not seem to be significant and this project can stick to one USABC protocol to test the hardware either from the United States or from China. This reviewer further added that there is not much anyone can make out of the effects of fast charge, unless the chemistry (1 and 2) is spelled out. The reviewer strongly expressed uncertainty as to why this information could not be revealed if these are commercial cells.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed useful collaborations amongst DOE laboratories and with international partners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project team was well-known for extensive collaboration with various national and international laboratories and developers.

Reviewer 2:

This reviewer commented that the proposed future research involves continued support of the DOE and USABC battery development efforts by performing independent assessment of contract deliverables using standardized test protocols, and providing results and feedback to the contractors. Further, the reviewer explained that plans include completion of the comparison of the USABC and China test protocols and to complete the studies on the effects of fast charge. As mentioned previously, the reviewer suggested that the objective of this project should be much broader (i.e., to make a thorough assessment of the current and upcoming technologies and to identify "technology gaps and shortfalls") to guide DOE and USABC towards successful development of lithium batteries for EV applications.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that ANL played a key role like INL for battery testing and validation. The reviewer added that ANL set the standards for battery testing.

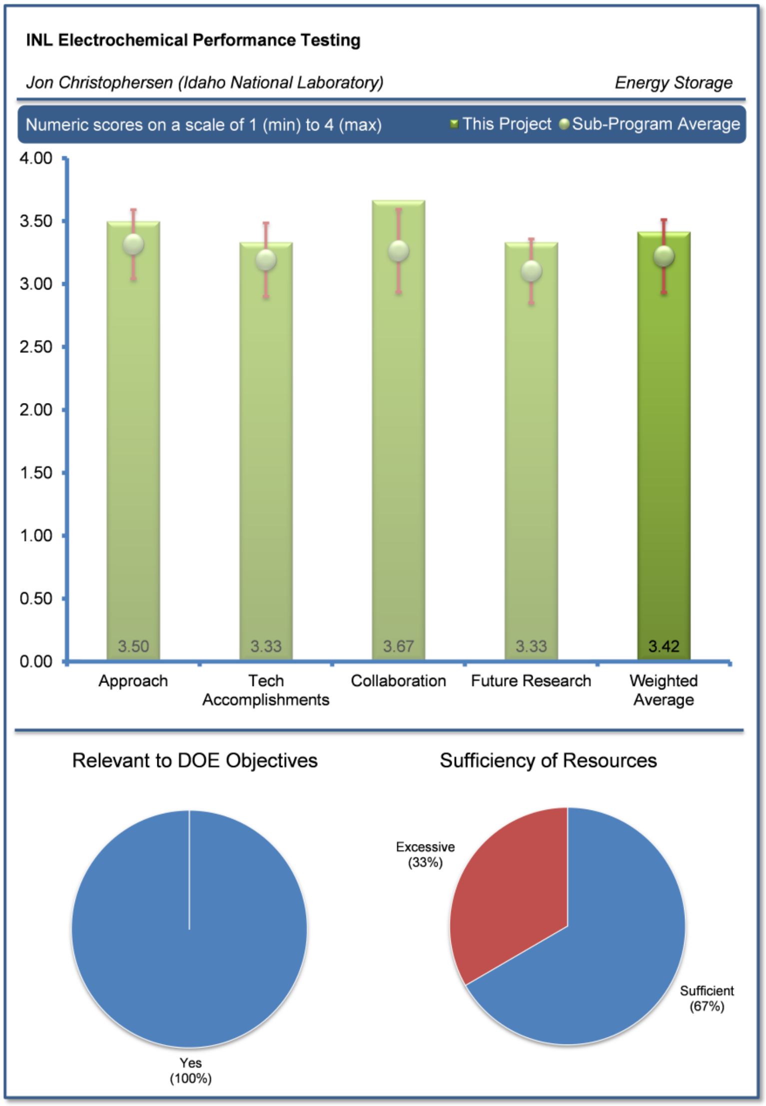
Reviewer 2:

The reviewer explained the importance of performing a detailed independent assessment of available Li-ion battery technologies to demonstrate the technology advancements for DOE, advise USABC on the applicability of the batteries, and enable a timely infusion of Li-ion batteries into electric vehicles. This reviewer further noted that various performance metrics need to be established based on the anticipated use, and verified both at cell and module level (i.e., power and energy densities, cycle life [1,000-300,000 depending on application], calendar life [15 years], and low-temperature performance). The reviewer asserted that this project is duly addressing this need with a concerted assessment both at ANL and INL.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer noted adequate resources for the scope of the project.

INL Electrochemical Performance Testing: Jon Christophersen (Idaho National Laboratory) - es202



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that INL represented the benchmark for battery testing and validation.

Reviewer 2:

The reviewer explained that the project objective is to provide DOE and the USABC with an independent assessment of contract deliverables of Li-ion cells from different developers for DOE/USABC, benchmark external state-of-art battery technologies, and project battery life. Other objectives reported by the reviewer are to develop advanced state-of-health assessment capabilities for Li-ion cells, to generate internationally accepted manuals for performance assessment of energy storage systems, as well as test and analysis protocols based on program targets and objectives. The reviewer summarized that the approach involves the following: testing both battery and ultracapacitor technologies in cells, modules, and full-size vehicle systems; developing advanced modeling and diagnostic tools; and exploring the basic issues of battery aging, performance, and prognostics in support of battery life estimation and state-of-health assessment capabilities using novel sensor technology. This reviewer asserted that the objectives and approach are consistent with the goals of ABR.

Reviewer 3:

The reviewer indicated that quality testing, validation, and analysis were critical to the successful integration and adaptation of xEV into transportation. The reviewer added that ANLs support of USABC was significant to meet the greater objective.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the results from INL tests were of high quality and this feedback received by the developers were of tremendous value in the case of their battery development.

The reviewer explained that extensive facilities were set up with multiple test stations for performance testing of cells and modules with environmental chambers and packs, and also for vibration testing of batteries. Several test articles (i.e., cells and packs from the deliverables) were tested in support of the DOE/USABC contracts, but the reviewer criticized that information on these cells/batteries was sadly missing in the presentation. The commenter proposed that it would have been useful to make a proper assessment of this effort and the technology development overall, if these findings (i.e., the test results from these cells and batteries) were published, especially if they are supported by DOE funds. The reviewer expressed that another noteworthy, though not entirely novel, accomplishment from this project was the development of a prototype 50-V impedance measurement box for assessing the changes in the EIS of cells in different architectures (i.e., series versus parallel) and as a function of calendar life at different temperatures. In closing, this reviewer noted that several manuals were published on the battery testing methodologies and performance simulations.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the collaborative effort of the national laboratories is critical to xEV success and, again, through USABC; it was a complete set.

Reviewer 2:

The reviewer reported that there was significant collaboration with many other national and other laboratories.

Reviewer 3:

The reviewer observed useful collaborations with other DOE laboratories (i.e., ANL, SNL, and NREL), USABC partners, and university partners were present.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer described that the proposed future research is to continue to support the DOE and USABC battery development efforts by performing performance tests on the existing and upcoming contract deliverables, and by providing the results and feedback to the contractors. The commenter also noted that the future plans include generating manuals for PHEVs, EVs, and micro-hybrid (48 VDC) batteries that incorporate the vibration system for batteries and to expand the battery-modeling capability. The reviewer highlighted that, together with the ANL's efforts (Bloom, et. al), this project is crucial in verifying of the performance of the current and emerging Li-ion battery technologies, for their successful infusion in electric vehicles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer observed that the INL plays an important role in benchmarking and testing cells and batteries from around the globe. In addition, the reviewer said that INL's contribution towards developing test manuals for various power sources cannot be overemphasized.

Reviewer 2:

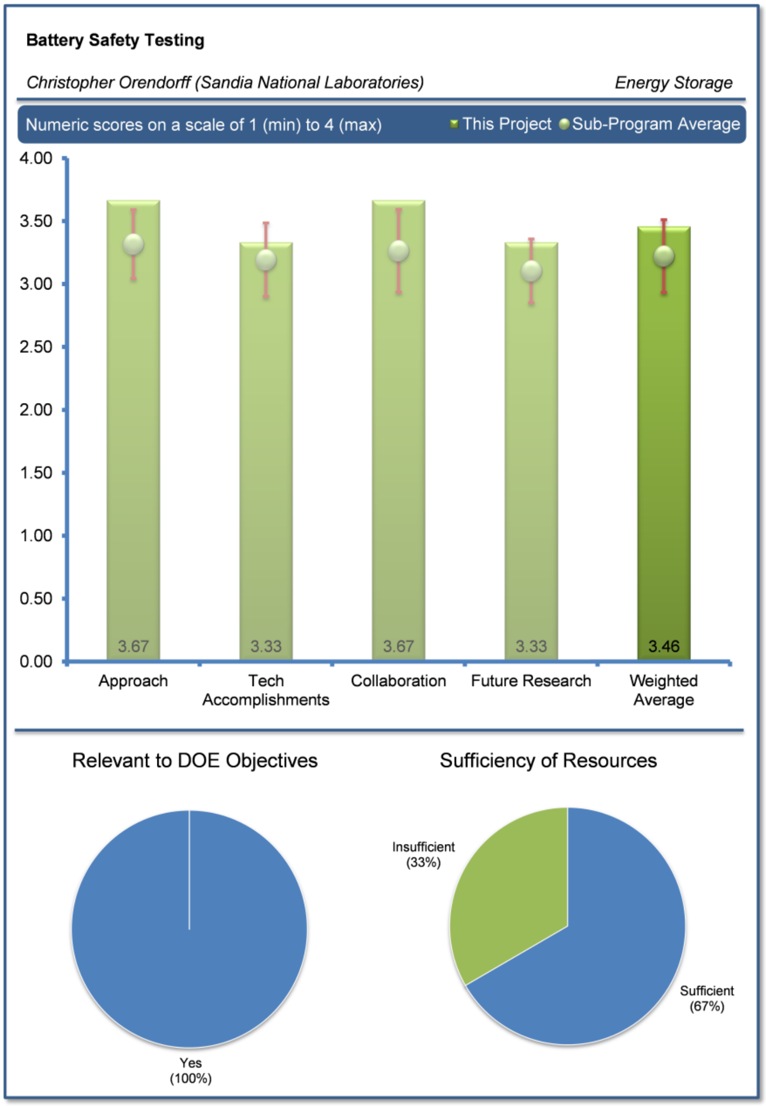
The reviewer explained that it is important to verify the various performance characteristics of different Li-ion battery technologies, i.e., the technologies being developed by DOE/USABC as well as the technologies developed elsewhere for their applicability in electric vehicles. The reviewer proposed that various performance metrics need to be established, based on the anticipated use and verified both at cell and module level, i.e., power and energy densities, cycle life (1,000-300,000 depending on application), calendar life (15 years), and low-temperature performance. The commenter confirmed that this project is fulfilling this need with a concerted effort both at INL and ANL.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the resources seem to be slightly excessive, although the scope of the project is fairly broad.

Battery Safety Testing: Christopher Orendorff (Sandia National Laboratories) - es203



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the SNL was uniquely qualified for and focused on carrying out abuse-testing with the highest degree of planning and thoroughness.

Reviewer 2:

The reviewer reported that this project was one of the national laboratory's key collaborative efforts to support USABC and the technology growth, through understanding abuse conditions and characterization.

Reviewer 3:

The reviewer explained that the project objective is to provide DOE and the USABC with a detailed assessment of the abuse tolerance of the contract deliverables of Li-ion cells from different developers for DOE/USABC per USABC testing procedures to evaluate single point failure propagation in multi-cell batteries, to understand the effect of aging on abuse tolerance, and to verify the mechanical model predictions on the crash-tolerance of EVs. The reviewer also stated that accelerated rate calorimetry work is being performed at the cell level to characterize different chemistries. The reviewer also reported that thermal and mechanical failures are being assessed in modules and battery packs with the elaborate and exclusive facilities set up at SNL for DOE and USABC. The reviewer described that these activities are well-integrated with other developmental activities and are consistent with the overall program objective to address the safety, which is one of the technical barriers. Unfortunately, the reviewer said that the results from these studies were being treated as confidential with the test articles developed for DOE (with DOE support), or even with commercial test articles.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that a significant number of cells, modules, and packs had been characterized with respect to their abuse-tolerance. The reviewer added that these results were extremely valuable feedback to the developers.

Reviewer 2:

The reviewer affirmed that good progress was being made in evaluating various cells and battery packs that were supplied as deliverables from the USABC program, as may be expected from the healthy funding allocated for this project. The reviewer explained that the test articles are mostly cells and multi-cell packs that represent different technologies, including some with advanced anodes and cathodes, which are being developed for DOE. In addition, the reviewer reported that the effects of aging in single cells and cell failure propagation paths in parallel series configuration were studied. Finally, the reviewer indicated that the test procedures have been developed for mechanical abuse and crash simulation tests were performed in support of mechanical models. One difficulty the reviewer had with the safety testing in general is that the safety events in field use are always different from the simulated abuse tests and the response is often difficult to predict.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that there was extensive collaboration with all relevant developers from inland and overseas.

Reviewer 2:

The reviewer acknowledged that there are useful collaborations amongst DOE laboratories and with USABC partners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that one area that SNL should improve its expertise was in the analysis of gases during and after abuse-testing. This was especially true for quantitative analysis of large format cells.

Reviewer 2:

The reviewer summarized that the proposed future research is to continue to support the DOE and USABC battery development efforts by performing abuse testing of contract deliverables, and providing the results and feedback to the contractors. Further, the reviewer noted that the future plans include propagation testing of batteries with increasing levels of designed passive and active thermal management to demonstrate the effectiveness of engineering controls to mitigate propagation and to determine the chemistry modifications and effects of aging on the thermal propagation. The reviewer also explained that the selected batteries will be subjected to dynamic mechanical testing for verifying the model and to demonstrate battery crashworthiness of EVs (for USCAR). The reviewer agreed that these studies will address the safety or abuse tolerance of Li-ion batteries, for a successful infusion of lithium batteries in electric vehicles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer observed that the SNL plays a very important role in the development of abuse-tolerant battery packs.

Reviewer 2:

The reviewer highlighted that, in addition to high specific energy and long life, adequate safety is an important requirement for Li-ion cells in EV applications. The reviewer explained that as newer chemistries are being developed, their safety characteristics are even less understood so warrant a systematic assessment of the emerging technologies both at the cell level and battery level. The reviewer specified that the abuse condition may be induced electrically, thermally, and/or mechanically to simulate failures that are occurring in the field. The project evaluator agreed that this project is duly addressing this need with a focused safety assessment under different abuse conditions of various technologies being developed by DOE/USABC.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

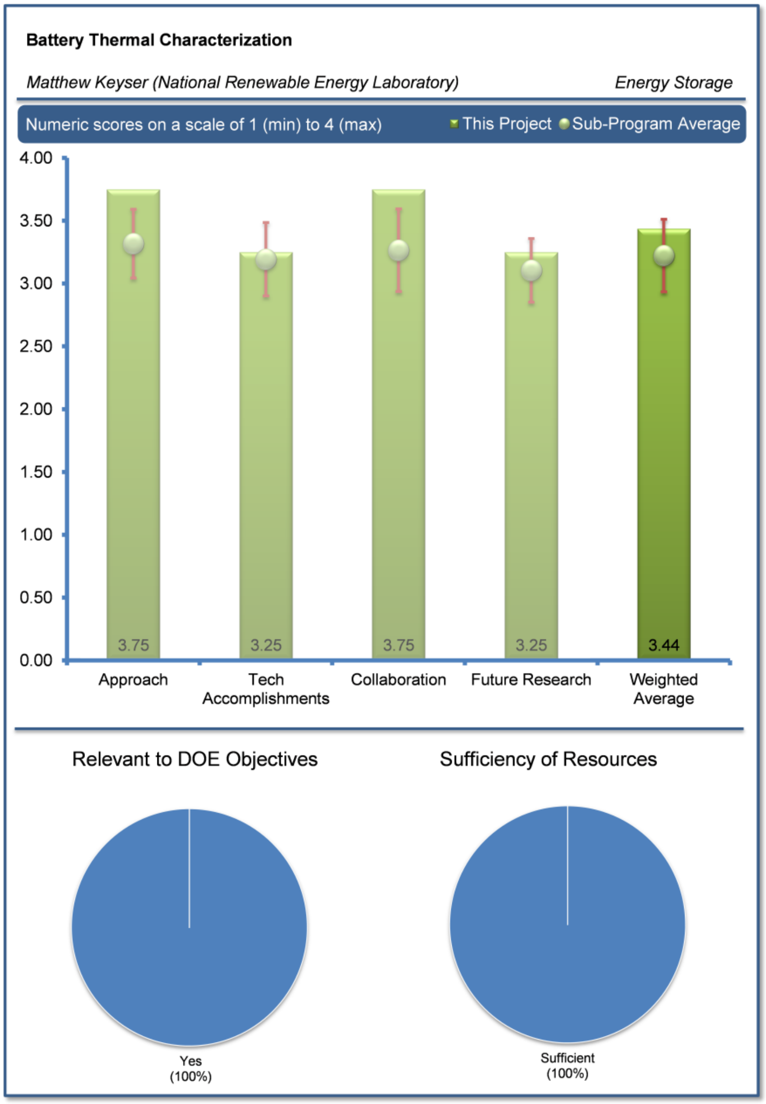
Reviewer 1:

The reviewer explained that additional funding could greatly accelerate needed propagation testing and development efforts.

Reviewer 2:

The reviewer simply stated that the resources are adequate for the scope of the project.

Battery Thermal Characterization: Matthew Keyser (National Renewable Energy Laboratory) - es204



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that NREL was the go-to laboratory for and the authority on thermal characterization of cells, modules and packs. The reviewer stated that NREL's approaches were innovative and well-organized.

Reviewer 2:

The reviewer indicated that the PI, an enthusiastic sort by the way, has taken the correct approach when looking at or observing useable ranges of the devices under evaluation. The reviewer hoped that did not curtail a greater objective to broaden the useable range for increased performance goals.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that NREL's test data was very comprehensive, has a high level of accuracy and reproducibility, thus furnishing valuable information to developers.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that there was extensive collaboration with various developers and laboratories.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

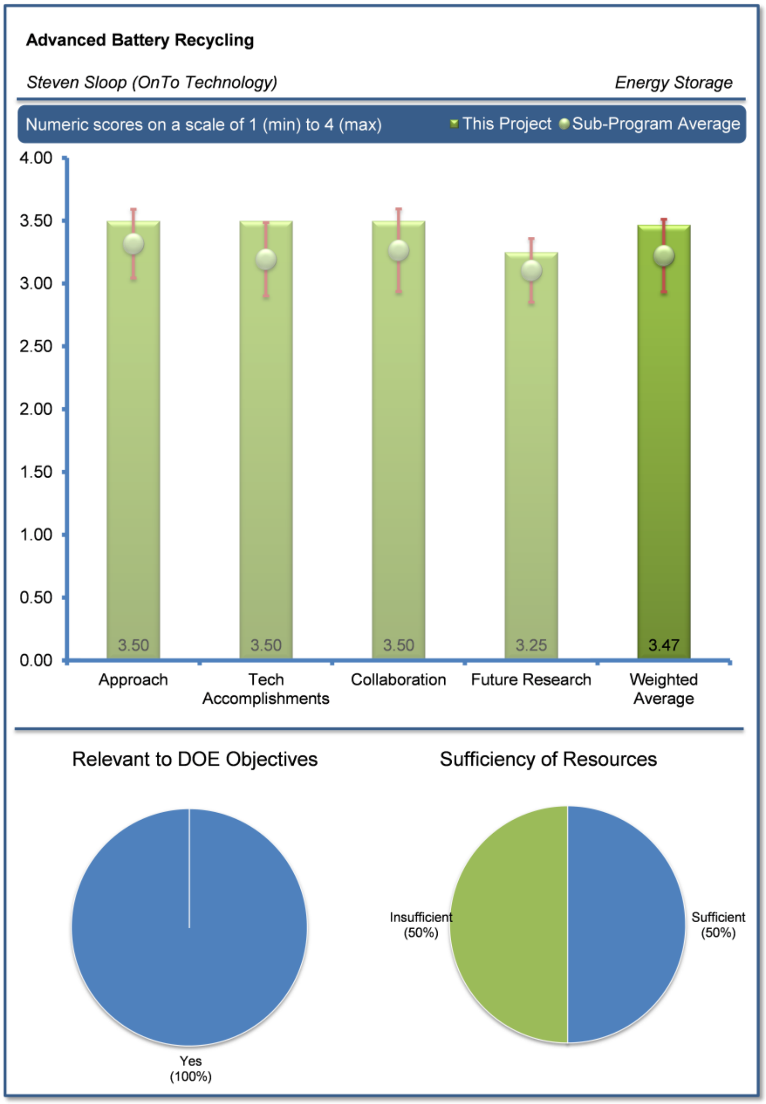
The reviewer said that again, NREL has developed time-tested methodologies for their work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that NREL served a critical role in the overall characterization and understanding of energy storage technologies.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
No comments were received in response to this question.

Advanced Battery Recycling: Steven Sloop (OnTo Technology) - es205



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the approach was innovative and clearly focused on achieving the specific objectives set forth by the proposal. The reviewer added that it would have been beneficial to have included more of a cost analysis task in the research, although this may be suitable for a follow-on activity.

Reviewer 2:

The reviewer reported that since not much was known about the process deployed to rejuvenate the materials, one could only make general comments that the approach seemed to be appropriate since it was achieving the target material through the recovery process.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the data seemed quite exciting, showing excellent recovery of the cathode capacity. Because of interest in the recovered capacities, the reviewer encouraged the authors to display the data in absolute terms without normalizing. The reviewer added that more comprehensive rate and capacity data should be part of the data collection package.

Reviewer 2:

The reviewer remarked that the accomplishments were impressive. The reviewer added that the majority of the program focused on process development, and that the data shown was encouraging. Also, the reviewer said that it would be helpful if the investigator could comment on the formulations and types of cathodes used in the study. The reviewer understood that most were NMC-type, but there were different NMCs, and many EV cells were currently blended with Lithium Manganese Oxide (LMO) spinel. The reviewer explained that the effect of such blends on this process and the optimum formulation of the resultant cathode product would be beneficial to the review.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the appropriate partners were involved as collaborators.

Reviewer 2:

The reviewer reported that the collaboration was very clear, which was essential for program success.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that high temperature storage and cycling should be part of future studies as well as transition metal dissolution studies. The reviewer added that it would be really interesting to see whether the material survived the second round of rejuvenation.

Reviewer 2:

The reviewer suggested that the future work should focus on stabilization and optimization of process, for control of material, repeatability. The reviewer added that the investigator should also provide a preliminary techno-economic analysis for the final process. This reviewer also wanted to know how effective such methods might be if they were applied to advanced anodes.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer pointed out that the importance of this program could hardly be overemphasized. The reviewer added that this was a very important part of the overall development, production, use, and recycle strategies that needs to be developed for efficient, cost-effective development and use of vehicular batteries.

Reviewer 2:

The reviewer acknowledged that an opportunity exists to develop a recycling approach analogous to lead-acid. Also, the reviewer stated that this addressed at least the single most costly material in a Li-ion cell.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

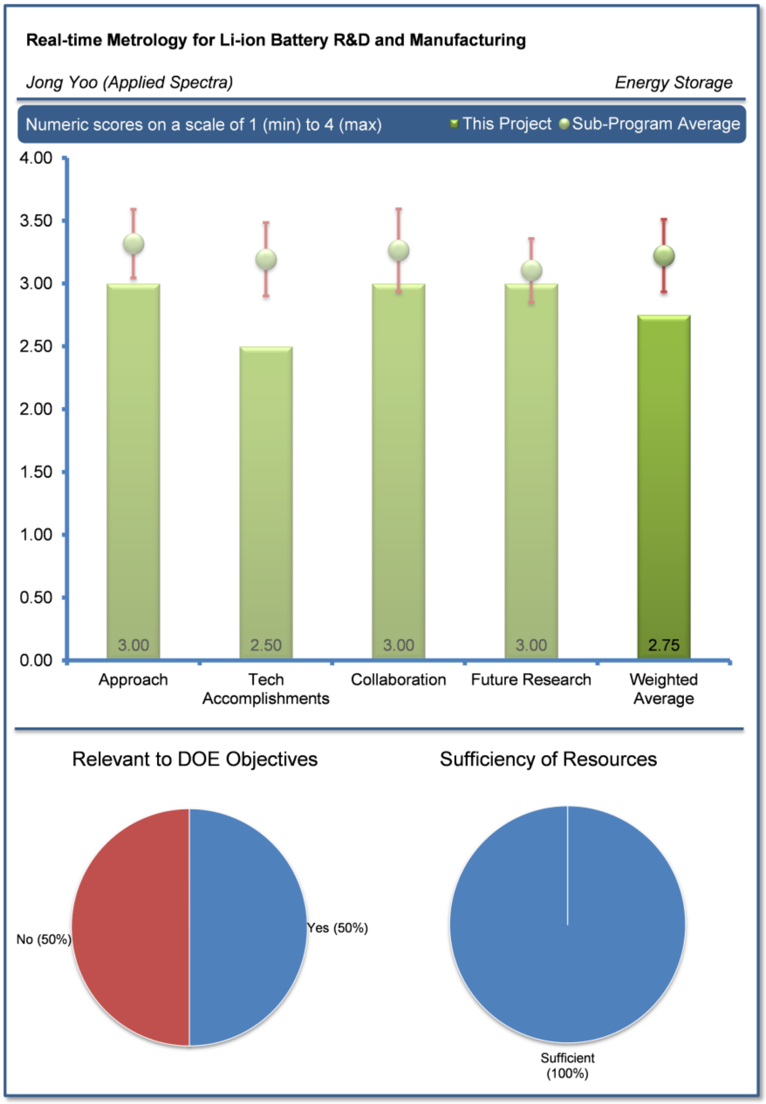
Reviewer 1:

The reviewer recommended a higher level of funding for this important project.

Reviewer 2:

The reviewer pointed out that there were no issues and that this was a well-balanced project.

Real-time Metrology for Li-ion Battery R&D and Manufacturing: Jong Yoo (Applied Spectra) - es206



Reviewer Sample Size

A total of two reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The viewer indicated that the approach appeared interesting provided it could meet manufacturing and cost targets: acquisition and response time, data reliability, accuracy etc. The reviewer said that knowledge about the spatial distribution of various cell and electrode components is very useful for designing efficient electrodes.

Reviewer 2:

The reviewer reported that the investigator has applied an effective approach to the implementation of Laser-induced breakdown spectroscopy (LIBS) to li-ion and related battery technology. The reviewer added that the investigator is also well on the way to achieving the goal of a user friendly device.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that the data for carbon or Polyvinylidene difluoride (PVDF) in the electrodes provides a good opportunity to analyze the quality of electrodes. The reviewer stated that it would have been better if the authors would have provided any correlation between the various spectra and the composition of the electrodes to see if one could use this technique to monitor the quality of the electrodes. As the reviewer mentioned earlier, it is not clear that this technique can be deployed as an in-line QC tool, because it needs to provide rapid analysis so that there could be some feedback to tweak the composition if needed. The reviewer added that it could still be a powerful off-line technique provided its response time, accuracy, and cost are superior to competing techniques.

Reviewer 2:

The reviewer explained that this is an analytical tool and it operates through a destructive analysis process. The reviewer added that the tool has the ability to provide insight into compositional and structural variation. The reviewer indicated that it is not clear from the investigation how this tool and the analytical data it generates complement other test methods. Also, the reviewer suggested that the investigator should focus on demonstrating a case study where the LIBS technique is used to support investigations with other analytical methods.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that LBNL can provide excellent feedback on various technical issues.

Reviewer 2:
The reviewer reported that the breakdown of work responsibilities was not clear.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that a 3D analysis of begin-of-life and end-of-life electrodes should be a part of the project.

Reviewer 2:
The reviewer encourages the investigator to also demonstrate the LIBS technique complementary with other analytical techniques.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

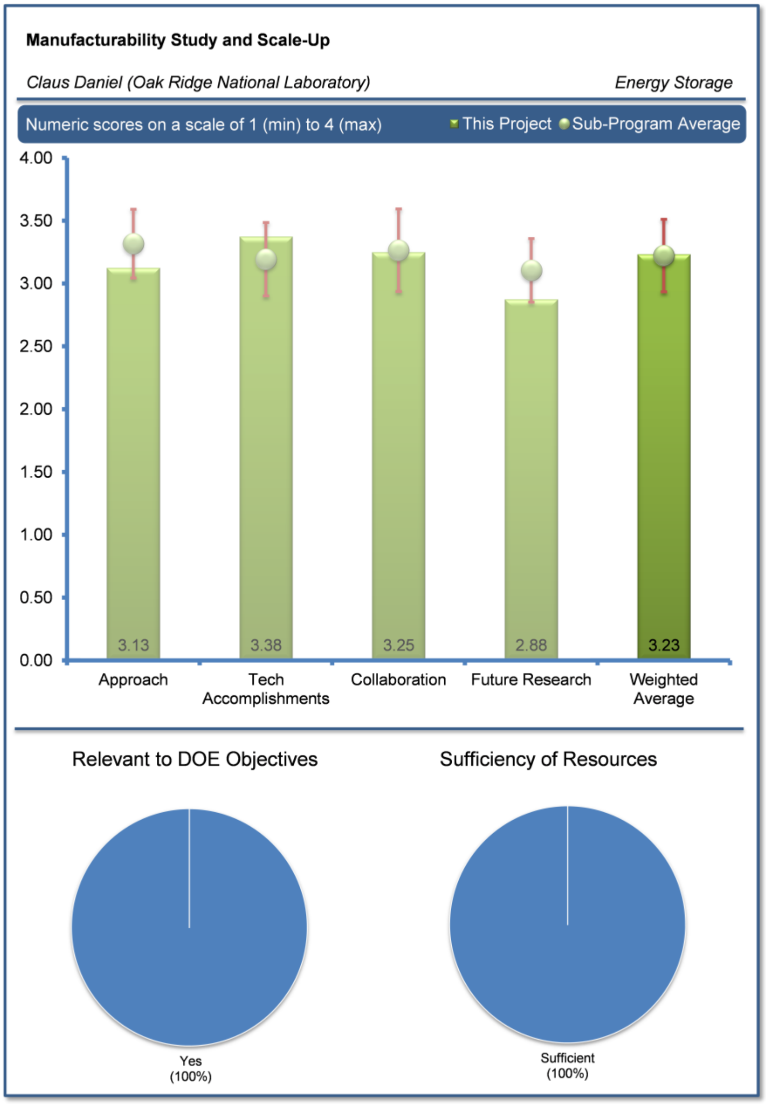
Reviewer 1:
The reviewer said that the project team had a good understanding of the electrode composition and structure as a requirement for building efficient batteries.

Reviewer 2:
The reviewer remarked that it is not clear how significant an improvement to a manufacturing process would result from the inclusion of this analysis tool.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the project is nearing completion, and that no issues were seen.

Manufacturability Study and Scale-Up: Claus Daniel (Oak Ridge National Laboratory) - es207



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the project was keenly focused on benchmarking against commercial materials and processes and developing a domestic supply chain network. Also, the reviewer pointed out that great effort was put into bringing in external staff to address the team's internal limitations.

Reviewer 2:

The reviewer observed that the technical approach appears sound in terms of validating advanced manufacturing processes used in Li-ion technology. The reviewer added that this group is also a receiving entity for new materials developed in other domains of the DOE materials which allows the overall evaluation of materials in a complete system. While this is clearly an important aspect of moving the overall technology forward, and a well done aspect of this goal, a separate stated goal of the program is that of ultimate cost reduction. The reviewer is less convinced that this program will address that particular goal, but the reviewer saw the value of the program despite this concern.

Reviewer 3:

The reviewer indicated that the right equipment is in place and the general areas are good. It is a good thing for ABR partners with no cell capability if any. The reviewer would prefer to see them work on more advanced materials, but the reviewer stated that the project team is still using well known materials to be sure they are getting good product manufactured.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the group is providing the component quantities that were set at the milestone level.

Reviewer 2:

The reviewer claimed that the project team has clearly learned a lot about making cells. A lot of equipment was installed, they made a number of cells and thousands of feet of electrodes. The reviewer pointed out that large cells are still lacking somewhat in durability. The reviewer said that work on improving yield could bear fruit.

Reviewer 3:

The reviewer indicated that the project team has met all project milestones to date, and are working on their fourth quarter FY 2014 milestone. The reviewer commented that the project team should develop a more quantitative metric of technology development. The reviewer added that qualitatively it looked like the technology commercialization strategy was progressing.

Reviewer 4:

The reviewer said that the project team setup manufacturing facilities for electrodes (both anodes and cathodes) and produce large areas of coated electrodes and test them in pouch cells.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project team had aligned scaled up work which was being done at ANL. The reviewer added that the project team has targeted other facilities for their analytical capabilities and that the project team is using commercial equipment to get results that can be translated out to commercial partners.

Reviewer 2:

The reviewer commented that the collaboration is occurring with domestic cell producers, materials suppliers, and etc. The reviewer said that a comment from the partners on the value of the work might be appropriate at future meetings.

Reviewer 3:

The reviewer stated that the facility itself involved a number of industrial partners.

Reviewer 4:

The reviewer indicated that the partners seemed to be consultants, customers or suppliers. The reviewer noted that the project team needed to engage partners as partners who work together with ORNL, and maybe each other, to really make gains that matter to the economy and the people. The reviewer added that in questions, the presenter said that the project team had people in to work, but it still sounded like that was the exception. According to the reviewer, to succeed in getting a supply chain built, this work needed to be significantly more interactive and have partners working on site and learning all the time.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that, given the project successes to date, it appeared that continuing along and doing more of the same with this kind of user facility would lead to project success. The reviewer said that while the project was scheduled to go until FY 2016 it was unclear what the milestones would be. The reviewer added that future work could be better defined and planned, currently quite nebulous.

Reviewer 2:

This reviewer indicated that the project team had logical and reasonable future goals.

Reviewer 3:

The reviewer observed that the plans were not very detailed. The focuses noted were good ideas but there was not an integrated plan. The reviewer said that this was a great facility, the project team should set a virtuous goal and work to accomplish it, and in doing so, include a set of meaningful U.S. partners as active participants in the work.

Reviewer 4:

The reviewer recommended that the facility work with several academic institutions for new materials and processes. The reviewer also said that the pilot scale facilities established here seemed to follow the well-established processes and materials. So, it was important to introduce new processes developed at some of the academic institutions for introducing new materials in to Li-ion battery production.

Otherwise, the value of these facilities may be limited in the long run when industrial partners build their own facilities in the United States.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that with the correct objectives, this was a valuable capability in the overall goal of moving the Li-ion technology forward.

Reviewer 2:
The reviewer said that manufacturing research was very relevant to cutting down the battery costs.

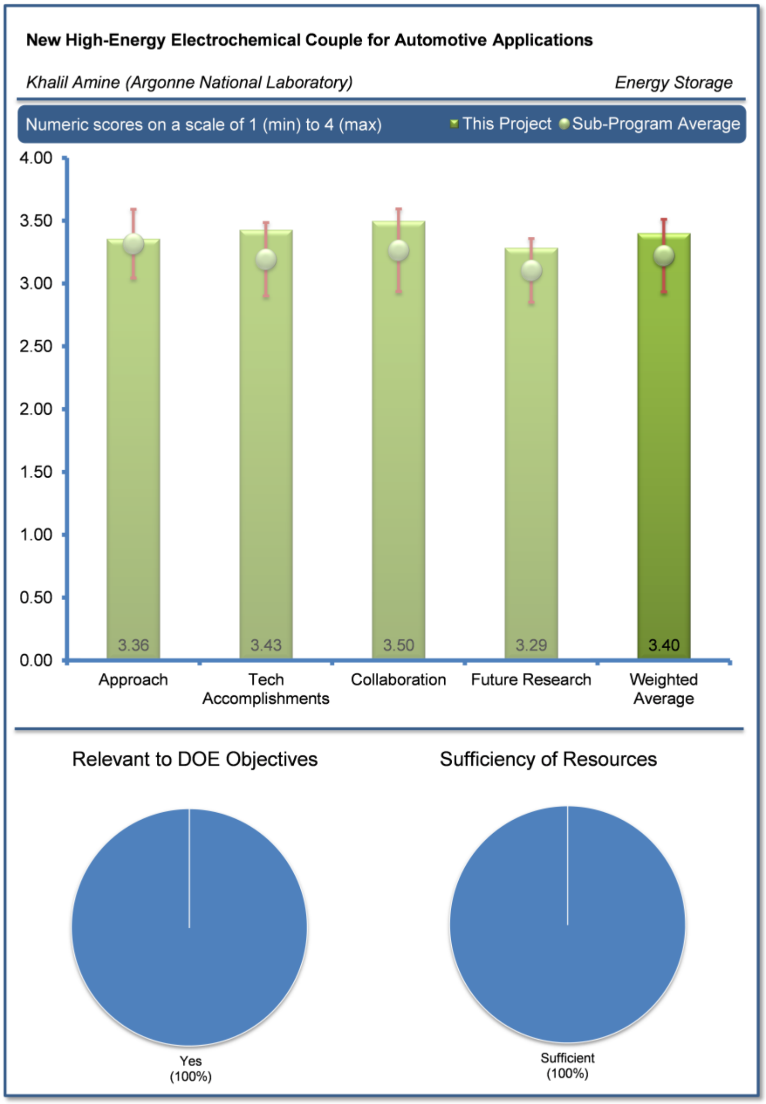
Reviewer 3:
The reviewer pointed out that advanced batteries consisted of a large number of materials. Being able to source these materials domestically will be the key to growing America's manufacturing capabilities. The reviewer added that addressing these scale-up issues will ultimately allow batteries to displace petroleum.

Reviewer 4:
The reviewer remarked that the project helped the DOE and researchers under contract to make better estimates of the true cost. The reviewer added that if it was clear this was moving advanced materials to commerce it would be incredibly relevant, but it was not clear how much of this would be used by the battery making partners.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer encouraged the continued funding of this program, especially if it continued to bring in matching external funds.

New High-Energy Electrochemical Couple for Automotive Applications: Khalil Amine (Argonne National Laboratory) - es208



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the project was being carried out by a strong technical team led by a well-established scientist, Dr. Khalil Amine with expertise in all aspects of battery research such as electrode materials, binders, and electrolytes, as well as strong characterization capabilities at ANL and BNL. The reviewer added that the project goals were clearly defined and milestones were on schedule.

Reviewer 2:

The reviewer pointed out that the project team had a clear strategy and approach to address the problems. The reviewer added that existing knowledge was good basis to solve challenges.

Reviewer 3:

The reviewer said that in this project, the PIs were developing full concentration gradient (FCG) NMC cathode and Sn-Si composite anode for high energy density battery greater than 250 W/Kg.

Reviewer 4:

The reviewer noted that the preliminary work by the PI and Professor Sun has shown good properties of the FCG NMC material and it is appropriate to evaluate it in full cells to test actual performance in various possible applications. The reviewer added that the choice of anode has led to a large irreversible capacity so it may be useful to extend the work to graphite cells and pure silicon, or modified silicon, in addition to the SiO combination with the Sony tin alloy. This may allow separation of anode and cathode effects since it is well known that these system types can have strong interactions between anode and cathode.

Reviewer 5:

The reviewer reported that the gradient concentration materials were unique and a counterpart to the approach of Mn-rich shells. The reviewer added that the preparation of the materials was based on a batch process obviously, although a continuous product was possible in theory; however, a scale up appeared to be correspondingly challenging.

Reviewer 6:

The reviewer commented that the specific challenges associated with each of the new components and system as a whole could be defined a little better. The reviewer added that as always, cost projections would be useful to help guide the practicality of the system.

Reviewer 7:

The reviewer commented that it was not completely clear how this FCG material is synthesized. The commenter noted that the authors mentioned that the powders can be synthesized by using carbonates or NaOH in a continuously stirred tank reactor (CSTR) process; however, if the process starts with water only (at the beginning of the process), some of the initial material will not be produced at steady state and will have to be discarded. Furthermore, the reviewer described that the process will have to run for a short period of time (or until the metal solution reach the maximum Mn concentration, a point where the process will have to be stopped). The reviewer asked how much material is out of spec and being lost. The commenter suggested that the synthesis can also proceed through a CSTR-batch process, where nothing is discarded and the process is stopped after the metal feeding solutions reach the maximum in Mn concentration; in this case none of the material is lost. The reviewer requested that the authors should explain further how practical is their synthetic method.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the results had been presented in a consistent, meaningful and complete way. The reviewer added that taking into account the elapsed time, the amount of results was astonishing.

Reviewer 2:

The reviewer claimed that it was early in the program; however, good progress was observed in terms of establishing baseline performance and the early stage synthesis of key components.

Reviewer 3:

The reviewer stated that the project had just started and showed good preliminary results.

Reviewer 4:

The reviewer said that the team had carried out a large amount of work in making and evaluating anode and cathode materials as planned. The team has identified “Remaining Challenges and Barriers.” The reviewer added that after the first year of the project, the team may reevaluate its future plans to focus on overcoming challenges and barriers. Specifically, it is unclear why conducting polymer binder should be a focus because the SnyCo1-xFexC alloy should be electronically conducting. Also, the reviewer stated that the team should also put more effort on characterizing the composition and structure of the ball-milled SiO-SnyCo1-xFexC. The claim of “possible alloying between Si and Sn” is intriguing because equilibrium phases do not exist in the Si-Sn binary system. The reviewer asked if the ball-milled material is a single phase alloy or a multiple phase composite and if it is amorphous. The reviewer wanted to know where the oxygen is after ball milling. Also, the reviewer asked if the oxygen in the “alloy” was the cause of the irreversible loss. If so, the team needed to consider alternative anodes.

Reviewer 5:

The reviewer observed that the work to date has set the stage for the construction of full cells. The reviewer would like to see the full cell evaluations carried out in sealed pouch cells or cylindrical cells rather than the coin cells utilized in the early work, particularly for cycle life tests. The reviewer added that the use of SiO guarantees the high irreversible capacity of the anode unless only very small proportion is used in comparison to the Sony material. The reviewer hopes that a more satisfactory anode component can be devised to minimize the irreversible anode capacity. This may involve a more conventional binder such as carboxymethyl cellulose (CMC) at least as a baseline material.

Reviewer 6:

The reviewer observed good accomplishments with plenty of data and positive results for a proof of concept; however, rate capability was still in question although it was still in an early stage.

Reviewer 7:
The reviewer indicated that the accomplishments with cathode materials seemed reasonable. The reviewer said that it was not clear about the anode and the processing method used. Also, the reviewer stated that both the performance of FCG NMC cathode materials and the processing technique needed to be established.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that there was a good collaboration network with a wide range of expertise.

Reviewer 2:
The reviewer indicated that the collaboration was well balanced and effective, not too many partners. The reviewer added that there was a consortium with the necessary skills on board. A partner for industrialization or end-user would have been great. The reviewer noted that the approach for anode and electrolyte were quite similar to the 3M and Envia project. The reviewer said that a comparison of results across the board of those projects would be interesting.

Reviewer 3:
The reviewer said that the team was quite competent and had access to all of the resources necessary to run a complex materials and cell development program.

Reviewer 4:
The reviewer agreed that the collaboration seems to be good.

Reviewer 5:
The reviewer stated that collaboration was very appropriate to the work. Dr. Yang and Professor Sun were key figures in achieving the cathode materials and Dr. Liu and others would contribute to the anode work.

Reviewer 6:
The reviewer stated that collaboration with others was not well defined other than those involved in the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer observed that the proposed next steps were focused on main challenges and suitable to overcome the key barriers. The reviewer added that the efforts in investigation of thermal stability and safety are of major importance. Also, the reviewer remarked that cost prognosis relative to state-of-the-art would be beneficial.

Reviewer 2:
The reviewer indicated that it was a good idea to try the 622 as a baseline cathode powder. The reviewer added that the authors would have the opportunity to better understand this important high capacity powder, in addition to the gradient materials.

Reviewer 3:
The reviewer stated that the use of a pouch cell approach would be valuable to truly assess the system. The reviewer added that the suggestions above concerning the anode were the key to obtaining high energy density. The reviewer said that the work proposed by the PI was important to continue as well.

Reviewer 4:
The reviewer agreed that it was a good idea to try the 622 as a baseline cathode powder. The commenter explained that the authors will have the opportunity to better understand this important high capacity powder, in addition to gradient materials. The reviewer suggested

that it could be of interest to show data on the rate of discharge, in particular of the cathode powders. The reviewer concluded by asserting that third-party verification of future results should be in place.

Reviewer 5:

The reviewer stated that the project team may consider the questions the reviewer raised in Part 2.

Reviewer 6:

The reviewer would have liked to see some data beyond the proof of concept and characterization data. For example, cycle life data and rate capability data can provide more convincing path for further optimization and development. The reviewer then asked if there was any cost analysis and projection plan.

Reviewer 7:

The reviewer said that the scale-up of proposed anode materials was not clear. In fact, it was not clear on why the PIs chose this type of anode material. Both the composition and the processing method seemed complicated. The reviewer indicated that the performance of FCG NMC materials tested here did not seem to meet the target values. It was not clear what kind of concepts in terms of both compositional variations and process that will be tried this year.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer remarked that the potential high energy density of the system was very relevant to the DOE.

Reviewer 2:

The reviewer stated that higher capacity materials and cell designs were critical to the further adoption of electrified vehicles.

Reviewer 3:

The reviewer claimed that the work was directed towards achieving battery energy density targets for xEV.

Reviewer 4:

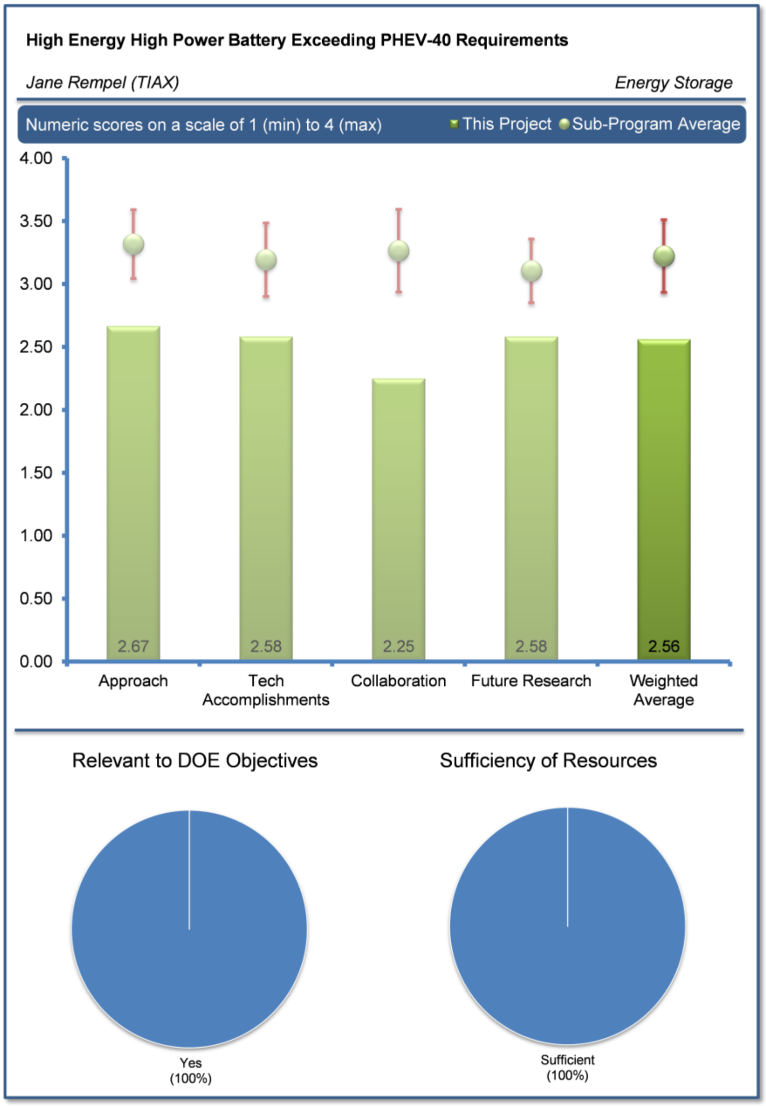
The reviewer said that high energy density materials and processes were important for meeting DOE's target goals for Li-ion battery technology.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that there were sufficient resources.

High Energy High Power Battery Exceeding PHEV-40 Requirements: Jane Rempel (TIAX) - es209



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach of combining high energy cathodes and anodes together with electrolyte studies was very comprehensive. However, the authors were relying on experimental materials produced by others. The reviewer hoped that the quality and the reproducibility of those materials were good. The reviewer added that it was important for the authors to show data in larger cells, and that was clearly stated in the program and the results that were shown with the 18650 Li-ion cells.

Reviewer 2:

The reviewer stated that it was very difficult to evaluate the validity and uniqueness of this project because there were not many technical details presented in either the slides or during the presentation beyond some general statements, such as using nano Si as anodes and separators with high porosity and thin thickness. The reviewer added that the slides and presentation raised many issues which may make the success of the project doubtful. Specifically, this reviewer is confused about the status of the "CAM-7TM High Energy High Power Cathode." It appeared to the reviewer, to be a unique and mature technology that satisfied the DOE requirements on Slides 5 and 6, but it became apparent on Slide 16 that the project would need to "explore cathode surface coatings" and "develop accelerated testing protocols" (see Slide 16), as well as to "continue cathode materials development to improve high temperature cycle life" and "down-select cathode formulation" (Slide 21). The reviewer wanted to know what was unique about CAM-7TM. The reviewer commented that it was unclear why "accelerated testing protocols" were needed because these have been developed by DOE labs as standard test procedures. Furthermore, the success of the project seemed to depend heavily on material suppliers (e.g., sourcing "several state-of-the-art silicon anode materials" (Slide 17) and accessing to "high purity electrolytes" and accessing to "production and research grade high performance separators ideal for energy and power applications" (Slide 19). However, the best industrial sources do not seem to have shelf-ready solutions as evident from the on-going DOE projects at various national laboratories on developing solutions to the same set of issues. This project can therefore have benefited from collaborations with national laboratories early on.

Reviewer 3:

The reviewer said that CAM-7/Graphite high energy 18650 cells showed stable cycleabilty up to 275 cycles, for commercial purpose 1000 cycle was necessary. The reviewer added that mass loading of anode electrode has a very big impact for high energy density and high power density for Lithium-ion battery. The reviewer said that this needed to be addressed.

Reviewer 4:
The reviewer indicated that the project made good attempts to use state-of-the art materials; however, it was difficult to identify the specialty or merits of this approach over others.

Reviewer 5:
The reviewer said that the approach was very difficult to assess from the presentation. The reviewer added that the focus on negative electrode properties and performance was not clearly stated. The importance of irreversible capacity was not discussed nor was the anode efficiency. The reviewer warned that without a careful assessment of these properties, a half cell assessment of the various supplier materials would not be predictable. Also, the method of mixing of hard carbon with silicon is not discussed, nor are the variations to be studied discussed. The reviewer commented that separator types were not discussed in the approach. Also, the reviewer said that electrolyte additive types were not discussed. Even though the cathode material had been available since at least 2010, few properties were disclosed in the presentation.

Reviewer 6:
The reviewer said that the development approach was not clear, where was it just a combination of the CAM7 material and other existing materials from material supplier. The reviewer stated that the interaction with partners for continuous improvement was not clear. The reviewer warned that relevant competencies to reach the target might be missing.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that there was decent progress in the initial stages of this project.

Reviewer 2:
The reviewer observed that the project had just started and that the authors had shown good progress. This project was important, in particular if the capacity fade, observed on the layered-layered materials, cannot be resolved or bypassed.

Reviewer 3:
The reviewer said that the cathode results still showed severe impedance growth in most coating formulations at 45 degrees. This result did not lead to any conclusions on the part of the presenter. The reviewer then remarked that indeed, it was not clear what the goal for the project was with regard to 45 degree cycling, so any result would be within the goals. High energy cells are only shown at room temperature, while high power cells are cycled at only current rate without any high rate pulse tests and only at 45 degrees. The reviewer added that anode testing had apparently just begun and properties such as irreversible capacity and anode efficiency are not presented. The reviewer said no information regarding the particular anodes tested was given. The reviewer stated that the baseline cell had only 1.9 Ah compared to the 2.7 Ah discussed in the introduction. The reviewer mentioned that no reason was given for the relatively poor performance of the baseline cell. The reviewer also commented that the separator work seemed to be rather limited. The reviewer added that no discussion of the use of coated separators for safety implementation was given.

Reviewer 4:
The reviewer remarked that the project was fairly new. The milestones have only been "scheduled" (see page 4). The reviewer pointed out that there was little information on the metrics used for "down select" Si and cathode formulation. The reviewer added that there was little information on how to "optimize electrode design in coin cells and select separator, electrolyte, cathode and anode formulations."

Reviewer 5:
The reviewer commented that the interpretation of results was difficult due different testing protocols for different cell designs (e.g., 1,8 Ah cycling with 1C vs. 0,5C for 2,7 Ah). The reviewer added that the overall message regarding status of the work was not clear.

Reviewer 6:

The reviewer stated that using the state-of-the art materials, the performance at a cell level appeared to be mundane and even inferior to the existing commercial products. The reviewer said that the capacity 1.9-2.7 Ah at C/20 for the 18650 form factor appeared to be surprisingly low compared to those of commercial products. The reviewer pointed out that this effort was supposed to be implementing the materials and developing state-of-the art cells.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that collaboration was only with suppliers of the materials. The reviewer added that the program would benefit from some collaboration with independent researchers. For example, many experts in cathode materials could provide valuable advice on the Cam 7 material and its use. Also, the reviewer claimed that many University and national laboratory people would be available to consult on anode effects and formulations.

Reviewer 2:

The reviewer reported that it should be beneficial to collaborate with DOE lab, especially on accelerated testing protocols. The reviewer also indicated that the project team had a heavy reliance on suppliers of Si, electrolytes, and separators, the project may not solve the challenges facing high capacity, high power, and long lasting lithium ion batteries.

Reviewer 3:

The reviewer did not see collaborators listed, and inquired if it was a trade secret or if there was no clue about what to do.

Reviewer 4:

The reviewer said that there was no obvious collaboration with partners, just material supply.

Reviewer 5:

The reviewer said that it was not very clear the collaboration the authors may have had with other institutions.

Reviewer 6:

The reviewer indicated that it was not clear about the collaborations and partners; no information was provided.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the third party verification of the main results, obtained by the authors, was highly recommended.

Reviewer 2:

The reviewer remarked that the direction of further development and improvement was not clear. The reviewer said that thermal stability and safety aspects should be included. The reviewer added that cost prognosis relative to state-of-the-art would be beneficial.

Reviewer 3:

The reviewer mentioned that no specific concepts were mentioned. It was difficult to evaluate the progress and future work.

Reviewer 4:

The reviewer observed that there was little information on how to quantify the success of proposed future work (page 21 and page 24).

Reviewer 5:

Nothing caught the reviewer’s eyes.

Reviewer 6:

The reviewer reported that so few details were given regarding future work, that it was impossible to assess the program's future, the work will continue according to the presentation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

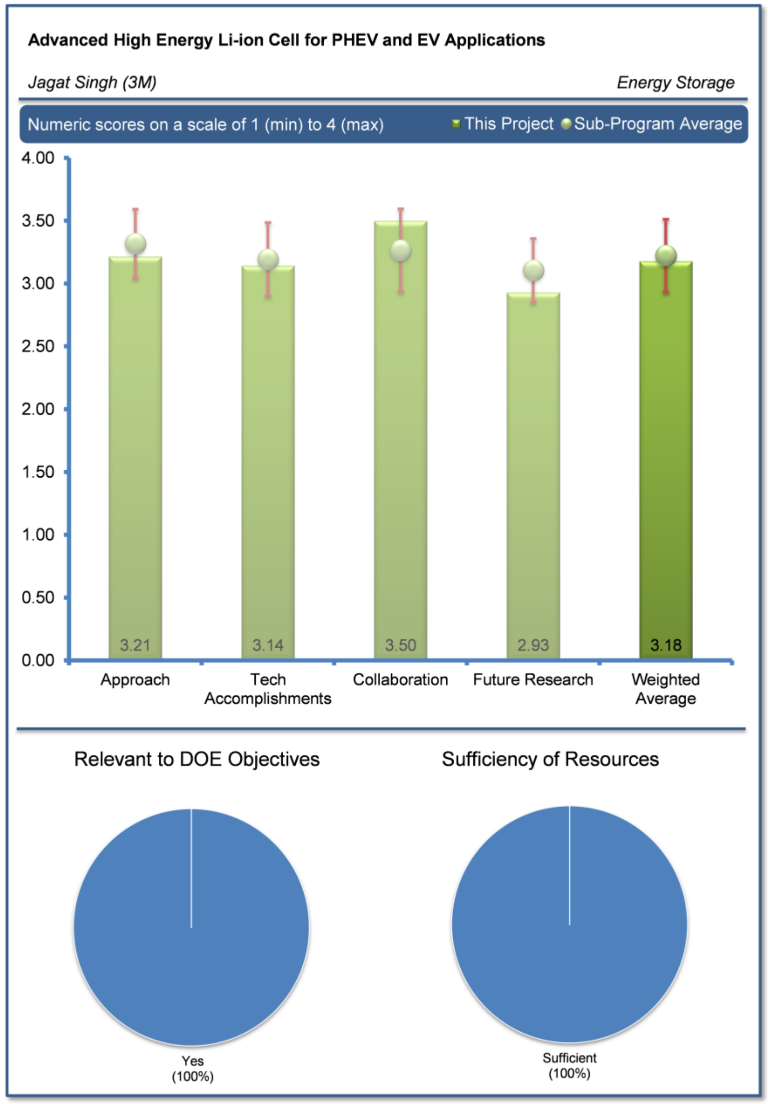
The reviewer indicated that the work was directed towards achieving battery energy density targets for xEV.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer was not sure but the project was big as far as the funding goes.

Advanced High Energy Li-ion Cell for PHEV and EV Applications: Jagat Singh (3M) - es210



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the project was being carried out by an outstanding team from industry and government labs to overcome the main technical challenges facing high energy density and long cycle life lithium ion batteries.

Reviewer 2:

Just as the reviewer mentioned to other authors from a related project, the approach of combining high energy cathodes, anodes, together with electrolyte studies is very comprehensive. The reviewer said that it would be important to procure reproducible powder and electrolyte samples. The reviewer added that this project was very important, in particular if the capacity-fade observed on the layered-layered materials cannot be resolved or bypassed.

Reviewer 3:

The reviewer stated that the approach to high energy battery is based on improving the capability of the silicon anode for energy and stability as well as the capability of the high energy cathode, also with respect to energy and stability. This will require improvement in the anode binder, the cathode material, the electrolyte as well as processing improvements. The reviewer added that the approach to the anode binder is to take advantage of advances made by LBNL via the use of special electronically conductive binders, The approach to improving the electrolyte is to take advantage of improvements in voltage stability from ARL and 3M. The approach to improvements in processing is related to work carried out at Leyden Energy and scale up work at Umicore. The approach to improving the high energy cathode material is to utilize the 3M work on cathode composition variations to find optimum behavior. The reviewer commented that all of these steps are state-of-the-art and likely to yield progress in cell performance.

Reviewer 4:

The reviewer indicated that the PI was using the best materials for both electrodes, fluoro-additives, and binder; these are great approaches. The reviewer asked what the project team got as a capacity or energy in the 18650 cells, rather than mAh/g, and suggested to provide form factor-based numbers. The reviewer observed that 3M has been working on both materials that were supposedly the state-of-the-art for quite a while. The reviewer wanted to know what has improved or achieved since 2-3 years ago.

Reviewer 5:

The reviewer explained that the general approach of developing a high energy anode, cathode and electrolyte system that work together was similar to the program being run by ANL. The reviewer said that specific technical barriers to success would need to be identified more clearly and ways to address more clearly defined. The reviewer added that it was early in the program so the next review should focus on the clarity with these challenges that were identified and addressed.

Reviewer 6:

The reviewer said that discharge capacity versus cycle of Si alloy/NMC at the voltage range of 4.2-2.8 V at the C-rate of C/5 showed the capacity retention of 75%, improvement of capacity retention is necessary for commercial purpose. The reviewer added that mass loading of anode/cathode electrode full cell test also had a big impact on increasing the capacity and cycle life. The reviewer said that the author needed to focus on mass balance as well as electrolyte too. The reviewer indicated that volume expansion of silicon during the charge-discharge state is very severe up to 400% and capacity fades is also a big challenge. The reviewer observed that the author needs to focus on binder and Si alloy chemistry, too.

Reviewer 7:

The reviewer commented that the quantitative targets were not stated.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the project just started and showed very good preliminary results.

Reviewer 2:

The reviewer noted that there were good accomplishments to date.

Reviewer 3:

The reviewer said that it was early in the program, and the establishment of the baseline performance seemed adequate.

Reviewer 4:

The reviewer indicated that the technical accomplishments were on material level progress in line with elapsed time since project start. The reviewer added that there were also technical accomplishments on cell level achievements in energy density, rate capability and cycle life quite far from target.

Reviewer 5:

The reviewer stated that the Leyden cell looked good. The reviewer also said that the NMC Scale up at Umicore appeared to be successful. The reviewer asked what the prospect was of achieving the 1000 cycle target. The reviewer also wanted to know why everybody was using Gao Liu’s (LBNL) slide. Liu was everybody’s partner and was used so many times to account budget although Liu has a DOE funded project. The reviewer asked if Liu’s project was one effort for multiple credits.

Reviewer 6:

The reviewer stated that the target for developing Si alloy electrodes (e.g., 20% increase in mAh/g and 10% increase in mAh/cc) seemed achievable. The reviewer also said that the target for “high efficiency” and “surface stability” should be quantified. The reviewer added that modeling should include the coupled mechanical-chemical degradation mechanisms, especially since one of the members of the team, GM R&D Center, had published a number of papers in this field.

Reviewer 7:

The reviewer commented that the progress in the various steps was not exceptional in any property discussed above. The reviewer added that the high energy cathode variation had shown a slight improvement in capacity and first cycle efficiency at the C/20 rate for a new composition; however, the higher rate capacity was inferior to the older composition. This was not very useful, since the low rate was not usable in an electric vehicle. The reviewer also stated that the binder result was poor for silicon. The best reported LBNL binder was not tested and no explanation was given for this. The reviewer also said that the electrolyte result was also unimpressive with less than 200 cycles for the best result. Again, no explanation was given. The reviewer claimed that the cathode results were also unimpressive with increasing hysteresis over only 30 cycles, no explanation was given for this either. The reviewer mentioned that the electrolyte additive result was rather poor. The reviewer was concerned about the lack of attention to these details and wonders how the team assesses results.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer explained that there was good collaboration with high competence. The reviewer added that fast progress should be expected if it is effectively coordinated.

Reviewer 2:
The reviewer reported that the project team was a strong multidisciplinary team with good credentials. The reviewer added that it was to the program's credit that a commercial manufacturer was developing the cathode material.

Reviewer 3:
The reviewer stated that there was good collaboration with other groups.

Reviewer 4:
The reviewer said that the collaboration was very extensive with a good prospect.

Reviewer 5:
The reviewer remarked that the project team had good collaboration with Industries, national laboratories and interaction with academia.

Reviewer 6:
The reviewer commented that the PI had assembled a very good team. The reviewer was concerned that the poor results of the first several quarters were an indication that the team was not functioning in a critical manner toward these results.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer mentioned that the approach of combining high energy cathodes, anodes, together with electrolyte studies was very comprehensive. The reviewer stated that it would be important to procure reproducible powder and electrolyte samples.

Reviewer 2:
The reviewer said that detailed identification of specific technical hurdles should occur as soon as possible with focus on these going forward.

Reviewer 3:
The reviewer reported that the strategy to improve cell performance was not fully clear. The reviewer suggested that the thermal stability and safety aspects should be included. The reviewer added that the cost prognosis relative to the state-of-the-art would be beneficial.

Reviewer 4:
The reviewer stated that the details were not sufficiently provided to analyze future work.

Reviewer 5:
The reviewer asked that the presentation team show the 18650 data. The reviewer suggested that the project team tell the prospect of achieving 1000 cycles next time.

Reviewer 6:
The reviewer cannot evaluate because of lack of detail. The reviewer added that there seemed to be a poor sense of detailed direction.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that high energy electrode materials and cell designs are critical to electrification of vehicles at any level.

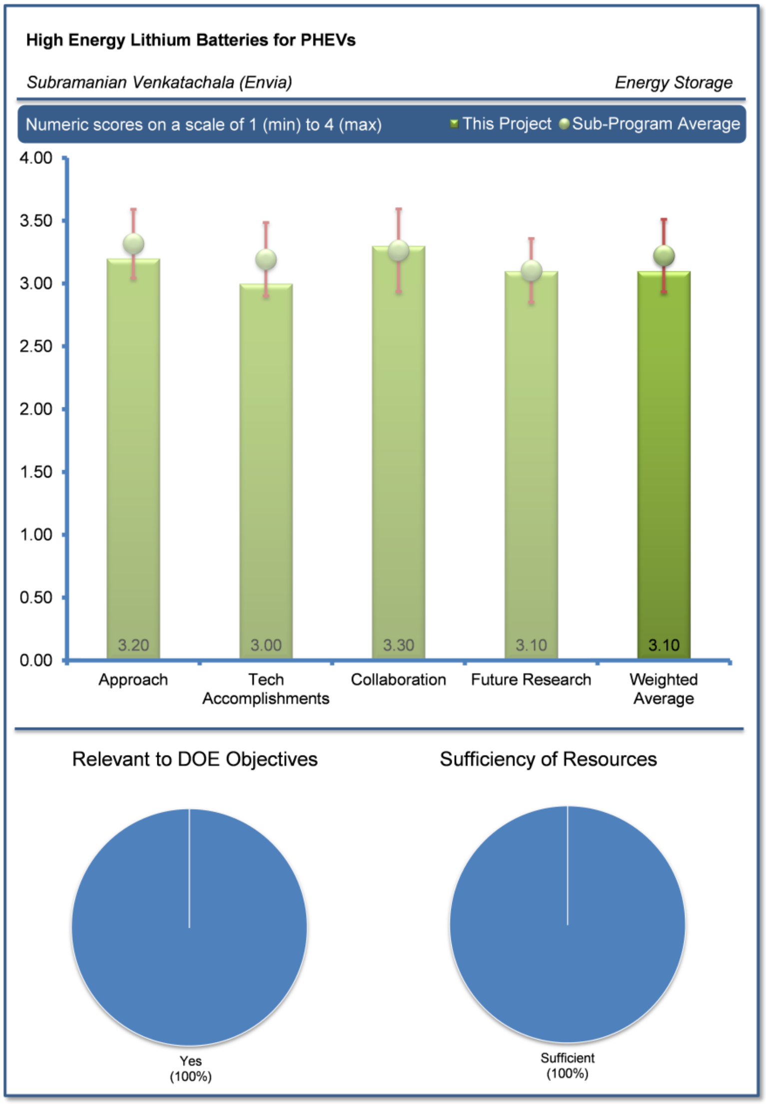
Reviewer 2:
The reviewer said that this project was relevant to advance commercial implementation of high energy density Li-ion battery technology.

Reviewer 3:
The reviewer mentioned that the work was directed towards achieving battery energy density targets for xEV.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that all relevant resources appeared to be available to the team.

High Energy Lithium Batteries for PHEVs: Subramanian Venkatachala (Envia) - es211



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer asserted that this project is important and very challenging. As mentioned by the authors, the main problem with the cathode powder is the capacity fade observed with the layered-layered materials. The commenter highlighted that the mitigation strategies are showing some promising results such us the coating developments.

Reviewer 2:

The reviewer stated that the targets were clearly defined in detail and that the approach to meet the targets was well structured.

Reviewer 3:

The reviewer pointed out that the author mentioned that high capacity Mn rich xLi_2MnO_3 (1-x)$LiMO_2$ cathode electrode showing the capacity of 240 mAh g-1 at C/10 at the voltage range of 4.6-2.0V, which is good for high energy density. The reviewer added that the project team did not show more cycles of charge-discharge curve of Mn rich xLi_2MnO_3.(1-x)$LiMO_2$ cathode electrode because there is a high chance of layered Mn rich xLi_2MnO_3.(1-x)$LiMO_2$ cathode electrode to change into spinel phase at high voltage test. The reviewer also said that a PHEV cell with high capacity manganese rich (HCMR) XP cathode shows 75% capacity retention up to 5000 cycles, which is good for commercial application. The reviewer also said that the author mentioned that nano coating can improve the capacity increase up to 15 mAh g-1 but, ALD coating of Al_2O_3 and AlF_3 shows the similar performance like the pristine electrode. The reviewer asked how the ALD coating can help with high voltage cell tests.

Reviewer 4:

The reviewer asked why there were such large form factor cells. The reviewer explained that larger cells were believed to have more issues than advantages (e.g., defect probability, maintenance cost, thermal managing, etc.). The reviewer stated that lithium phosphorous oxynitride (LiPON) coating sounded very expensive. The reviewer wanted to know if it could be cost effective, which was one of the critical barriers.

Reviewer 5:

The reviewer said that the approach is to improve the baseline cathode material from Envia, which is different from ANL material (Envia has licensed the ANL patents) in unspecified ways. The reaction mechanism under charge at high voltage is alleged to be Li_2MnO_3 going to MnO_2, lithium ions and oxygen. The reviewer added that this proposal is obviously a great simplification. If true, the MnO_2 that is cycling would be transformed completely to spinel material with gradual loss of capacity and substantial loss of voltage. Further improvement is sought be coating the active material with various coatings and various methods. Also, the reviewer stated that there is a lot of information regarding coatings already in the literature, but no effort is made to distinguish their approach from work already done. The reviewer indicated that various partners and Envia will carry out the coatings consisting of LiPON, polymers, conductive and nonconductive, ceramics, and carbon. The reviewer also reported that silicon anodes will be made with Envia prepared silicon and LBNL electronically conductive binders. The reviewer commented that the approach to ranking the various coating types and experimental protocols to evaluate the many coatings is not specified. The reviewer finds this troubling and will detract from the program if the work is not done according to some systematic planning. The reviewer noted that the PI suggested that the project team may investigate doping of the cathode material in order to minimize voltage fade. The PI also states that one of the forms of Envia HCMR material has no voltage fade. The reviewer is suspicious of such contradictory claims. The reviewer asked if there was no voltage fade, why the project team needed to study doping.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that there was significant progress to date.

Reviewer 2:

The reviewer remarked that status was shown on relevant cell size and that reasonable test conditions results were very valuable.

Reviewer 3:

The reviewer said that the project has just started. The reviewer added that, in the future, it is going to be important to clearly propose mitigation strategies in case the capacity fade of the HCMR cathode layered-layered materials cannot be resolved. Also, the reviewer stated that the atomistic model, suggesting Mn migration to the Li layer is important. Additionally, the reviewer suggested that it could be of great interest to study that mechanism further so that solutions or partial mitigation strategies can be proposed.

Reviewer 4:

The reviewer commented that Envia is supposed to integrate cells rather than to carry out material studies. The reviewer noted that there was too much characterization data. The reviewer would like to see more cell trial data.

Reviewer 5:

The reviewer stated that it was somewhat difficult to understand what had been accomplished with this program and what refers to prior work. The reviewer added that three different morphologies of cathode active material had been discussed, but it was possible that all these materials were already available. The reviewer said that this extended to the carbon coating work as well. The ORNL coating of LiPON did appear to have been carried out in this program. The reviewer noted that the results of LIPON coating were not as good as the carbon coating where the voltage fade was worse and the capacity was lower. No explanation was given for this result. It is important to assess the work as it continues, particularly when so many coatings are planned and poor results should not be pursued. The ALD coatings showed comparable results on voltage fade compared to carbon coatings, but poorer results on capacity. Again, no conclusions were drawn. The reviewer pointed out that only one slide was devoted to anode development and that said that LBNL binders would be employed. Apparently, no work was done on this aspect.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer reported that the project team had good collaboration with national laboratories and industry.

Reviewer 2:

The reviewer commented that the project was well structured and that work packages were clearly addressed to partners.

Reviewer 3:

The reviewer stated that the collaboration looked good.

Reviewer 4:
The reviewer stated that the collaboration and coordination seems to be very good.

Reviewer 5:
The reviewer said that it was not clear that good communication among the many partners had been established. The reviewer added that on paper it looked good, but if there was not an effort to communicate results and do team evaluations of results, the program was unlikely to succeed.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The project has just started. As mentioned earlier, in the future is going to be important to clearly proposed mitigation strategies in case the capacity fade of the HCMR cathode layered-layered materials cannot be resolved. The reviewer suggested that it could be of great interest to know how reproducible are the HCMR powders used by the authors in this study. The commenter also pointed out that the Si-C based anode is also becoming increasingly more complex. The reviewer recommended that the authors should focus also on the reproducibility of their results.

Reviewer 2:
The reviewer stated that the approach on modeling combined with experiments for their proposed concepts of using nano-coatings seemed reasonable.

Reviewer 3:
The reviewer remarked that the modeling should be extended to the effect of doping und compared to experimental results. Also, the reviewer said that thermal stability and safety aspects should be included. The reviewer added that the cost prognosis relative to state-of-the-art would be beneficial.

Reviewer 4:
The reviewer asked if the project team would like to test smaller cells as well, or if developing large cells itself was the goal of the project.

Reviewer 5:
The reviewer stated that the future work plans were extremely broad and do not form the basis for the evaluation. The reviewer reported that the project team basically said that the work would continue. In fact the plans to do extensive studies of LiPON coatings did not make a lot of sense to this reviewer as they are clearly inferior in properties studied to date to the carbon coating and no known method existed to make an economically viable coating of this material.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer claimed that the relevance would be sacrificed if good planning was not applied to this program.

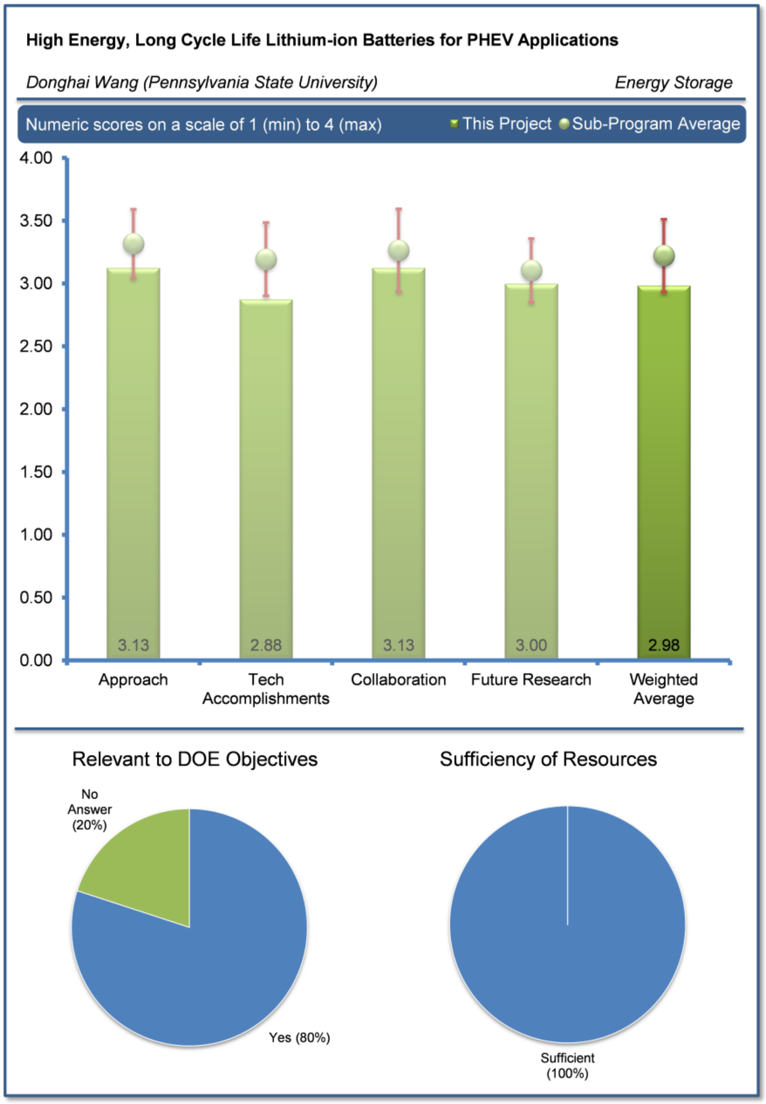
Reviewer 2:
The reviewer stated that the work is directed towards achieve battery energy density targets for xEV.

Reviewer 3:
The reviewer commented that just like many other projects, high energy density and durable electrode materials were necessary for meeting DOE's targets for Li-Ion battery technology toward electric vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

High Energy, Long Cycle Life Lithium-ion Batteries for PHEV Applications: Donghai Wang (Pennsylvania State University) - es212



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that this project was very important, in particular if the capacity fade observed on the layered-layered materials cannot be resolved or bypassed. The reviewer added that it was not very clear if the authors were using a two layer powder, as a cathode powder, with two clear compositions, or a gradient powder. The first will have a Ni-rich core surrounded by a Mn rich outer layer. A gradient powder will have a Mn outer layer that gradually changes in composition with higher Mn content looking towards the surface of the particle.

Reviewer 2:

The reviewer commented that the approach was much more academic than alternate programs, with more focus on individual components rather than a coordinated activity. The reviewer added that individual component advances could occur; however, integrated performance demonstration was less likely.

Reviewer 3:

The reviewer stated that the author showed micro size Si-porous C anode electrode showing high capacity of 2400 mAh g-1 up to 50 cycles. The reviewer explained that it was not clear on what strategies were implemented for minimizing the first irreversible capacity loss. Also, the reviewer said that it was mentioned that the fluorinated electrolyte additive enable higher capacity at 4.8V to achieve high energy density but, the capacity fade was also a big problem. It was not clear on the proposed solution. Additionally, the authors mentioned developing cathode materials but no new ideas or concepts were proposed.

Reviewer 4:

The reviewer stated that the cathode material of Ni-rich core and Mn-rich shell looked good. The reviewer asked how this compared with the ANL material. The reviewer also wanted to know if this Si-C composite was superior to those from 3M or Amprius. The reviewer suggested that the project team show some comparison to these other materials, and was always good to show advantages and superiority over the existing competitor or the state-of-the art. The reviewer added that the functional binder sounded good; however, it was led by those at LBNL who have their own project. That effort should not get multiple credits or other party additions to own project to get a credit. The reviewer queried what was special about the project team’s fluorinate electrolyte, and whether this was fashion.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer asked what accomplishments belonged to the project team and what accomplishments belonged to collaborators who have their own projects. The reviewer said to see the comments above.

Reviewer 2:
The reviewer indicated that the project had just started and that the authors had shown good progress.

Reviewer 3:
The reviewer stated that the materials capability had been base-lined, but it was not clear that an integrated baseline cell structure had been developed and characterized.

Reviewer 4:
The reviewer remarked that the technical accomplishments with the anode seemed good, but that the progress with cathode did not seem to be as good.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the project team had good collaboration with industry and national laboratories.

Reviewer 2:
The reviewer said that the collaboration and coordination looked good.

Reviewer 3:
The reviewer stated that the collaboration seems to be good; however, the reviewer suggested that it may be too early to tell.

Reviewer 4:
The reviewer commented that collaboration groups appeared to be competent. The reviewer pointed out that the presenter was far less informed on the work occurring at the collaborators than other program presentations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that this project was very important, in particular if the capacity-fade observed on the layered-layered cathode materials cannot be resolved or bypassed. The reviewer suggested that the scale up of the anode and cathode materials should be better clarified.

Reviewer 2:
The reviewer thought that the project team should consider benchmarking with other materials.

Reviewer 3:
The reviewer commented that the proposed studies on first cycle efficiency for silicon anode were important. The reviewer added that it seemed that the proposed studies were scattered and were not focused enough to warrant significant progress within the project duration.

Reviewer 4:

The reviewer said that the program seemed perhaps less integrated into the much more integrated set of programs otherwise presented in this section. This was just an observation, without any further insight.

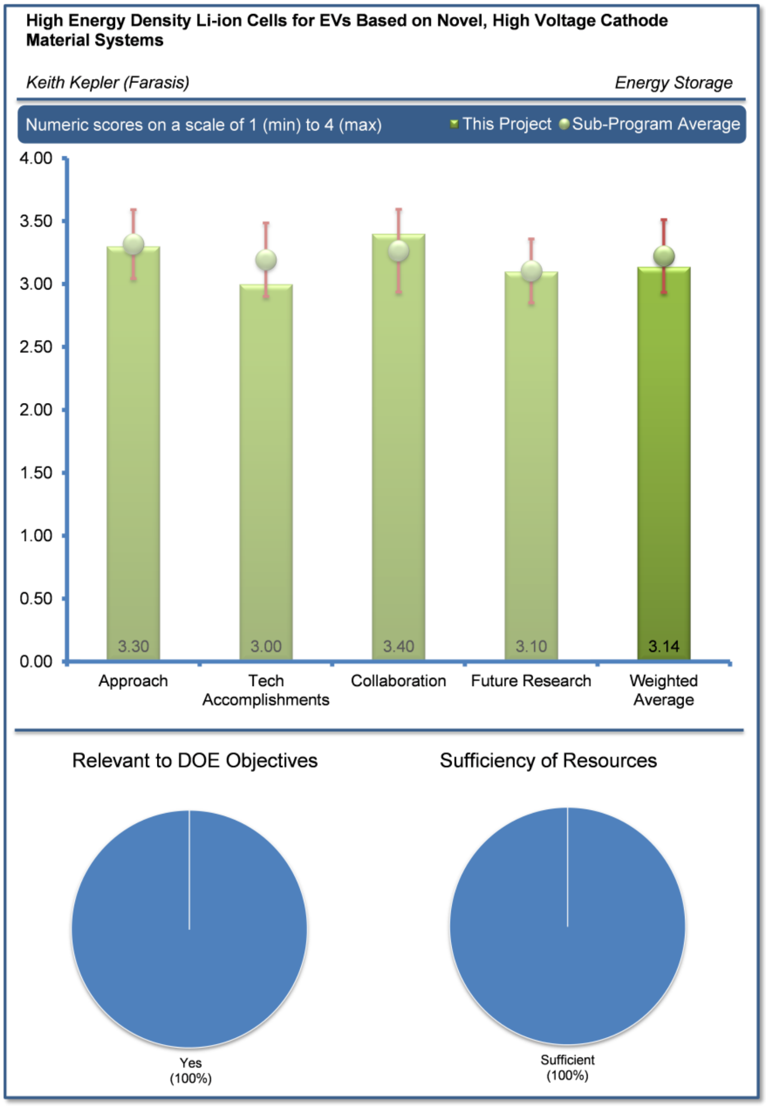
Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

No comments were received in response to this question.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

High Energy Density Li-ion Cells for EVs Based on Novel, High Voltage Cathode Material Systems: Keith Kepler (Farasis) - es213



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed that the targets were clearly defined in detail and that the approach to meet the targets was well structured.

Reviewer 2:

The reviewer reported that the approach of combining high energy cathodes, anodes together with electrolyte studies was very comprehensive. It will be important to procure reproducible powder samples. The reviewer added that it was important to produce generation one cells with a more traditional anode, so that it can be used as a baseline.

Reviewer 3:

The reviewer commented that the approach was to develop cells with lithium and manganese rich cathode materials containing cobalt, derived from ion exchange process (sodium to lithium).This was known to produce stacking faults and some spinel content in addition to the layered-layered structure. The reviewer added that this type of material was known to have better stability in cycling and is capable of higher power than the standard layered-layered structure material. The reviewer stated that this work was done in collaboration with ANL. A second cathode approach was to investigate stoichiometric NCM materials doped with other transition metal ions, which have a coating to stabilize the material to high voltage. The reviewer also said that the coating technology is supplied by LBNL. The reviewer added that the second strategy was to use a silicon anode material derived from silicon whisker growth directly on carbon developed by Nano-system and currently supplied by OneD Material LLC. This material has displayed good power capability and high efficiency. The reviewer also remarked that the third aspect of the approach was to utilize stabilized electrolytes and separators developed at DuPont, which continues to work on developing new materials and supplies the PI. These aspects were all addressing the barriers that have been encountered in earlier work regarding high capacity, high voltage materials.

Reviewer 4:

The reviewer stated that if the assumption is followed, ion exchange (IE)-NCM is supposed to be more stable at higher voltages. The reviewer wondered if the experiments supported this. The reviewer stated that the capacity fading was significant at 4.6V. The reviewer wanted to know if the project team was planning to compare “usual” NCM and IE-NCM after doping. The reviewer then inquired about the target performance, volumetric energy, as well as power and number of cycles for the pouch and 18650 cells.

Reviewer 5:

The reviewer stated that the author shows the cycle performance of NCM(532) cathode electrode at high voltage of 4.6 V to achieve high capacity more than 200 mAh g-1, but the capacity fading after 50 cycles was nearly 60%. The reviewer added that the selection of a moderate voltage was necessary. Also, the reviewer said that the ion exchange layered lithium (LL)-NCM showed stable capacity of over 200 mAh g-1 at the high voltage range of 4.7-4.9-2.0V up to 20 cycles.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that there were substantial and meaningful results. The reviewer added that the capacity and energy density of baseline cell was quite low taking into account the use of LL-NCM.

Reviewer 2:

The reviewer remarked that the project had just started and that the authors had shown good progress.

Reviewer 3:

The reviewer stated that the baseline cells involving LL-NMC/graphite cells had been supplied to INL and that test protocols had been developed. The reviewer added that the 18650 cylindrical and pouch cells had been designed for electrolyte developing using experimental electrolytes as well as separators in a first round study at 4.4 and 4.6 V. The cells use conventional NCM and graphite. This appeared to be a good couple to study electrolyte problems. The reviewer stated that silicon anodes would also be incorporated into this work. Unfortunately, no details regarding the electrolytes under study have been supplied. The reviewer would like to see such information to assess the likelihood of success of this work. Also, the reviewer said that the stabilized NCM had been received and preliminary evaluation was carried out. Early cycling data at 4.6 V appeared promising. Silicon anode material had also been received and preliminary evaluation carried out. The reviewer said that only about 600 mAh/g was achieved and the cells faded in capacity over 150 cycles. This relatively poor result was a concern for anode progress. Finally, the reviewer noted that the ion exchange derived LL-NMC was tested and early cycling appeared promising although some power fade was already apparent.

Reviewer 4:

The reviewer commented that the project team should show actual numbers in the capacity instead of normalized values. The reviewer noted that it looked like cells were being built. The reviewer asked if the project team would share the actual performance data.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the project team has good collaboration with industries and national laboratories.

Reviewer 2:

The reviewer said that the collaboration and coordination looked good.

Reviewer 3:

The reviewer stated that the project was well structured and work packages clearly addressed to partners.

Reviewer 4:

The reviewer indicated that the collaboration seems to be good; however, the reviewer suggested that it may be too early to tell.

Reviewer 5:

The reviewer indicated that collaboration with ANL, LBNL and DuPont all appeared to operate at good levels. The reviewer said that the collaboration with OneD appeared to exist, but the poor results with initial materials may be cause for concern.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the future work plans were solid. The reviewer added that the continued work on silicon anode should have a high priority, as preliminary work was not good enough for long term cycling.

Reviewer 2:
The reviewer explained that the use of pouch cells and 18650 was important. The reviewer added that the authors should make efforts to fully characterize the cathode and anode powders to make sure that the results are reproducible. The reviewer stated that these experimental materials were not easy to synthesize in large amounts.

Reviewer 3:
The reviewer indicated that a decision matrix and key performance indicator to decide between the two cathode material options should be clearly defined. The reviewer said that thermal stability and safety aspects should be included. The reviewer added that a cost prognosis relative to state-of-the-art would be beneficial.

Reviewer 4:
The reviewer reported that the proposed research involved stabilization of high voltage cathode materials using dopant additions. The reviewer added that it was not clear on how they would be chosen and added to the materials structures.

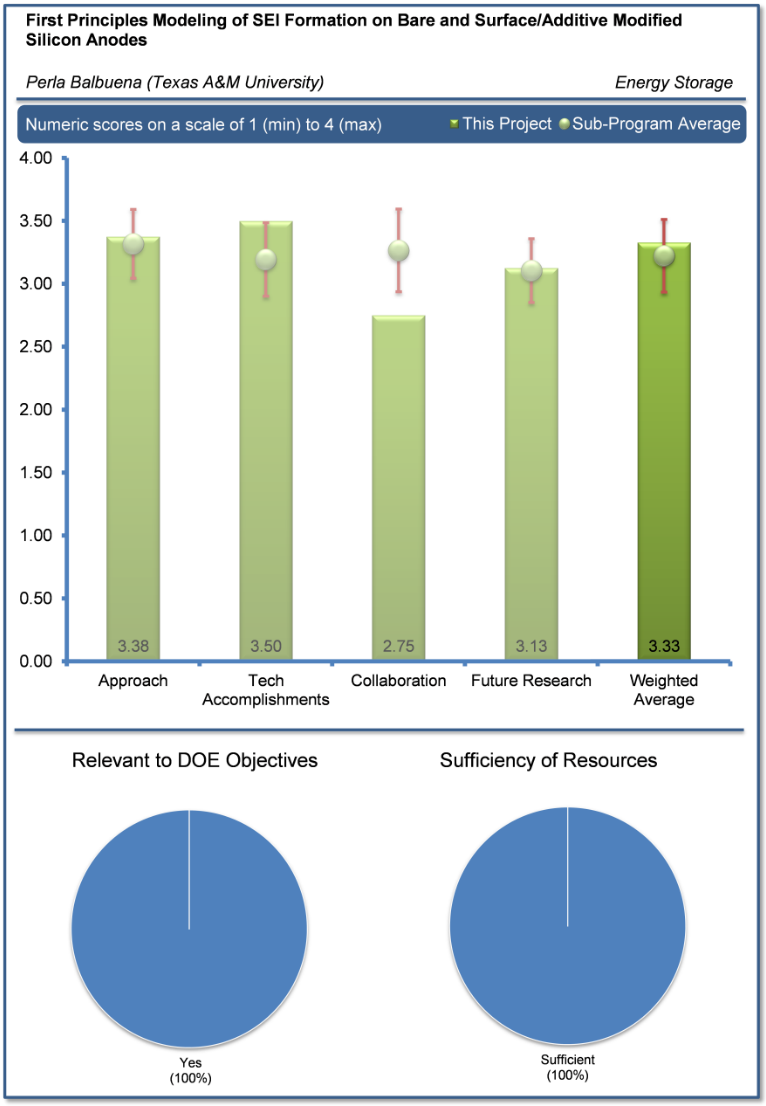
Reviewer 5:
The reviewer suggested that the project team show benchmarking data with respect to non-IE materials not normalized data but row data. Then the reviewer said that the project team should set cell performance targets and show the progress by the data.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the work was directed towards achieving battery energy density targets for xEV.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
No comments were received in response to this question.

First Principles Modeling of SEI Formation on Bare and Surface/Additive Modified Silicon Anodes: Perla Balbuena (Texas A&M University) - es214



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer was very glad to see a theoretician study the SEI layer working with experimentalists who are specialized in electrolytes and SEI layers. The reviewer added that it was not clear how the surface of Si was treated as the initial state and structure. The Si surface often terminated by oxides before lithiation, thus, it would be covered by Li_2O when lithiated. The reviewer asked how that would affect the simulation.

Reviewer 2:

The reviewer stated that the project had a good, from the beginning, modeling approach in that the project team was factoring in the actual electrode surface in the reaction that includes stearic effects as well as energetics. The reviewer reported that it seemed rigorous, but the reviewer really did not have the expertise to determine that. The reviewer indicated that this project seemed to be an improvement on the work done a few years ago at the University of Utah. The reviewer suggested that the project team asked University of Utah to critique this work offline (e.g., Oleg Borodin now at the U.S. Army Research).

Reviewer 3:

The reviewer's limited experience with first-principles calculations of interfaces is that they are quite challenging. The reviewer added that taking on the SEI formation of a phase-change negative electrode is carving out a very difficult problem. The reviewer stated that the PI's approach, to developing the active material models then exposing the active material to various solvent molecules, seems good. Also, the reviewer said that the issue when building the SEI is how idealized it has to be and whether it is realistic or not.

Reviewer 4:

The reviewer commented that this modelling program investigates the surface structure of silicon lithium alloys, the interaction of electrolyte solvent, salt with the surface and the reactions of electrolyte with the surface to form a solid electrolyte interface with the reaction products, all at various stages of lithiation of the surface, from four different lithium silicon alloys. The reviewer added that the properties of the SEI will be studied to help interpret the effect of capacity loss and SEI growth as the electrode is cycled.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that four important milestones have been achieved since the start of the program. The first is that the most favorable surfaces of the alloys have been determined and their reactivity characterized. The second is that a preliminary model of the SEI and its thickness has been established. The third is that surface effects for solvent component reactivity have been studied including solvent decomposition. The fourth is that reaction pathways and activation energies for ethylene carbonate (EC) and fluorinated ethylene carbonate (FEC) have been identified. The reviewer explained that this has been a substantial accomplishment and sets the stage for developing the model for SEI growth as well as capacity fading with cycling. The reviewer hopes that the study will point the direction toward improved electrolytes.

Reviewer 2:

The reviewer said that overall, the results seemed consistent with the experiments. The reviewer added that the solvent and additive molecule reactions seemed to have a lot of two electron reductions, which seems unusual. The reviewer especially liked the PI's observations about FEC.

Reviewer 3:

The reviewer indicated that the reaction of lithiated Si surfaces with the solvent looked good. The reviewer asked if the project team had experimental confirmation for the given reaction mechanism or reaction products.

Reviewer 4:

The reviewer observed that the project shows the degradation reaction mechanism of EC and FEC. The reviewer commented that there was nice work showing that both FEC and VC, which both increase cell cycle life and stability, react to give the same surface species. The reviewer was very supportive of this from the beginning work as it provides insight that is hard or impossible to get experimentally. In addition, the reviewer said that the project team can go back into their models and explain why certain reactions are preferred, not just identify the reaction products. Doing this experimentally, if it were possible, can provide a more accurate estimate of what is actually formed, but leads one to infer the mechanism. Understanding the mechanism, which modeling can help provide, could be critical in trying to design an interface and SEI layer and provide direction to new solvents and salts.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer reported that the Collaboration for the most part was excellent; however, the contract has not been completed for the collaboration with SNL as yet. The reviewer added that this was an important part of the program as substantial parts of the computations were planned to be carried out at SNL and it is necessary to complete these negotiations in order to reach the goals of the project. If the agreement is not reached, a modification of the contract with DOE may have to be agreed upon.

Reviewer 2:

The reviewer stated that there was a great combination with experimentalists who have focus on electrolytes and SEI layers.

Reviewer 3:

The reviewer stated that the PI has established a few collaborations. The reviewer thought that the PI was smart to team with experimental efforts to support the work.

Reviewer 4:

The reviewer commented that the work desperately needed validation by experimentalists. The reviewer suggested that the project team link up Sommarjai/es215 work where the project team was using FTIR to study surfaces and get at organic structures formed on the electrode surfaces on site.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that it would be nice to see the ion conduction mechanism in the SEI layer, identifying any limiting factors in the diffusivity, which would guide the electrolyte optimization.

Reviewer 2:
The reviewer observed that the proposed development of the SEI model would allow modelling of the nucleation and growth of the SEI, the electronic and ionic conductivity of the SEI and the effect of voltage on these properties. The reviewer said that these would then lead to a mesoscopic model of the SEI which can be compared with experiment. The reviewer added that the aspect of prediction of solvent types for superior SEI properties should be an important goal of this part of the project.

Reviewer 3:
The reviewer remarked that the PI's focus for the future is to build up her SEI model. Again, this was quite challenging and interesting. The reviewer added that there did not seem to be any effort to improve the interface, such as predicting better additives.

Reviewer 4:
The reviewer indicated that the project needs better collaboration to get validation of their modeling results. The reviewer said that plans to look at follow on reactions to form complete SEI should provide good fundamental knowledge. The reviewer suggested looking at the fluorinated ethers being developed to improve cycle life. Also, the project team should, if possible, model a mixed solvent electrolyte system and salt. The reviewer pointed out that modeling new solvents to guide the partner’s ability to design new solvents for Li-Ion cells is a laudable goal. The reviewer was not sure if this work could really do that, but maybe a better understanding of the existing SEI formation process could provide direction.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that the project was addressing SEI formation and could lead to new electrolytes that give more stable SEIs and improve cycle life of new high energy density cells using silicon anodes.

Reviewer 2:
The reviewer reported that the PI did not make the best case for relevance, but developing an alloy based negative electrode would greatly improve lithium-ion battery technology.

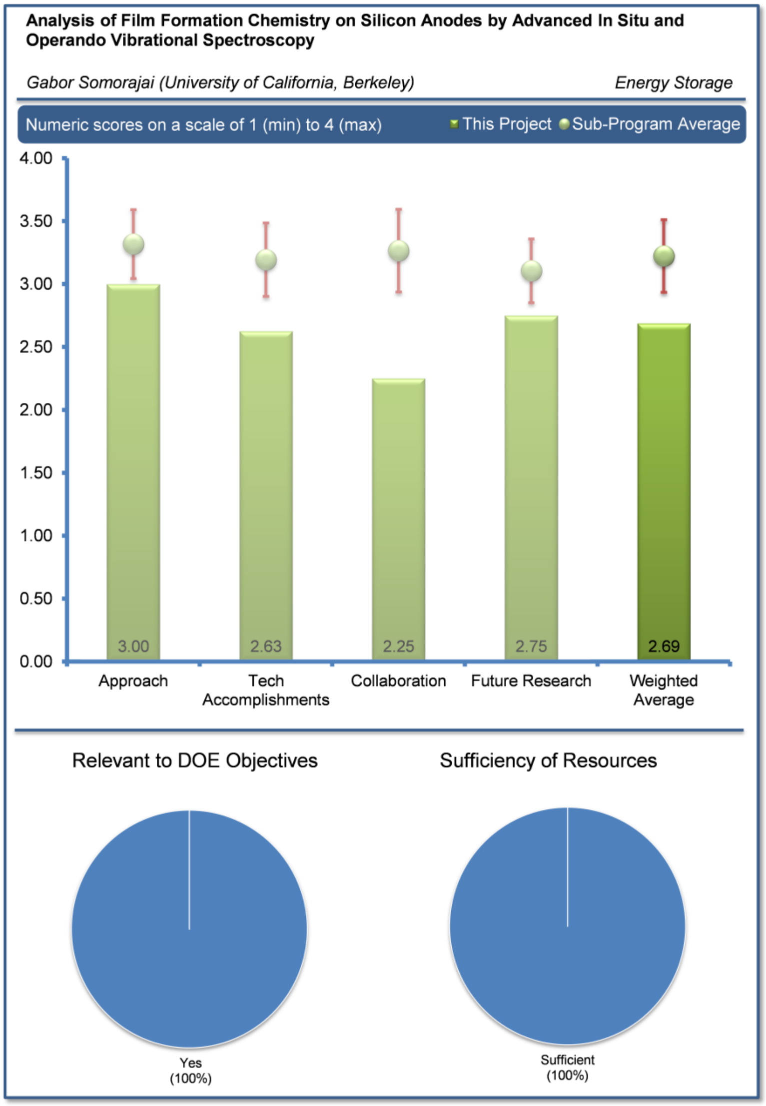
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said this may depend on the agreement with SNL.

Reviewer 2:
The reviewer stated that there are sufficient funds to conduct the studies based on the PI's productivity.

Reviewer 3:
The reviewer said that the project team needed a partner or more help from others in the program.

Analysis of Film Formation Chemistry on Silicon Anodes by Advanced In Situ and Operando Vibrational Spectroscopy: Gabor Somorajai (University of California, Berkeley) - es215



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that surface vibration spectroscopic probes are powerful to collect molecular specific information for SEI films. However, it would be nice to show the electrochemical cell setup. The reviewer added that to enhance the sensitivity, excitation of surface plasmon using a Kretschmann configuration was a very good approach.The reviewer asked why the gold “electrode” was necessary. To excite plasmon, the gold gold film on the internal reflection element need not be electrically connected. To observe the SEI film formation on silicon (Si) in the vicinity can cause gold-lithium (Au-Li) alloy formation, which causes the optical property changes including the plasmon excitation angle, likely leading to modulation of spectral features. The reviewer acknowledged that the University of California-Berkeley is the birth place of vibrational sum frequency generation (SFG) (R. Shen’s in late 1980’s). The reviewer asked how to do SFG on Si nano-particles. SFG requires mirror like surfaces to detect coherent signals. The reviewer then asked if there were any preliminary results.

Reviewer 2:

The reviewer noted that attenuated total reflection (ATR) in combination with stem to develop high spatial resolution of the SEI on various materials shows promise to achieve additional information regarding the SEI. This can be useful in solving problems related to high energy anodes as well as reaction products formed on high potential cathode materials.

Reviewer 3:

The reviewer said that the PI used a non-standard format for his poster presentation. As a poster this was fairly well laid out, but for the purposes of this review, the PI should have submitted the work in the standard format.

Reviewer 4:

The reviewer said that FTIR or surfaces in the electrolyte by passing a beam from underneath the electrode. The reviewer noted good use of angle to vary sample depth and differentiate between bulk and surface films. The reviewer commented that the presentation was very sparse (one slide) and that more detail would have been better to review this project.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer said that the PI had some interesting results, but the project appeared to be in its early stages.

Reviewer 2:
The reviewer noted that the material indicates that the new in situ ATR -FTIR cell was developed, but it is not clear if this was done as part of the contract or existed previously. The detection of soluble dioxohexane dicarboxylate (DEDOHC) on Si and tin surfaces could be a useful result.

Reviewer 3:
The reviewer observed signs of DEDOHC on the surface. However, the reviewer felt that the known reactions of EC and DEC during formation to form DEDOHC in the liquid electrolyte were not appreciated. This reaction, along with transesterification when more than one dialkylcarbonate is present, is pretty well-known. The reviewer indicated that Kerr, et. al., published papers on this, and provided the following references: J. Power Sources (2003) 119-121, 330; and Electrochem. Solid State Lett.,(2001) 4, A42. The reviewer then noted that the project pointed out only seeing this at the surface, but the interactions between the two solvents was important. The reviewer recommended checking the liquid phases by GC to really differentiate between reactions at the surface and reactions that can occur in the bulk initiated by alkoxide ions generated at the surface from EC degradation.

Reviewer 4:
The reviewer inquired about spectral analyses.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that the collaborations seemed rather limited, but that it was difficult to determine from the presentation.

Reviewer 2:
The reviewer commented that the collaborations were not discussed, but should be encouraged to ensure that important problem areas are pursued.

Reviewer 3:
The reviewer noticed that the presenter seemed to be completely disconnected from the rest of the DOE program.

The reviewer noted that this work needed to be closely linked with the modeling work (e.g., es214). Also, the reviewer asked if there had been talks with John Kerr at Berkeley about this work.

Reviewer 4:
The reviewer asked that the presentation please list collaborators. Both PIs are not known for surface vibrational SFG.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer looked forward to some more results.

Reviewer 2:
The reviewer commented that the proposed future research was only sketched out. Indications were given that FEC would be studied and surface modifications of Si, would be tested, although the type of modification was not mentioned.

Reviewer 3:

The reviewer noted that there were only a couple of statements on the future work and that it was difficult for the reviewer to determine the overall plan for the project.

Reviewer 4:

The reviewer said that the plan was to look at FEC next, which seemed reasonable. The reviewer added that it might be good to look at other salts maybe and/or VC. The reviewer's main problem with the future plans was the disconnect between this and modeling work – both present and past work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer commented that this work is very relevant for the advancement of lithium-ion battery technology.

Reviewer 2:

The reviewer stated that the SEI layer is still very poorly understood and that this method could provide valuable insight.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer stated that UC Berkeley is self-sufficient for this project assuming the Department of Physics folks who are specialized in SFG are available. The reviewer thought both PIs were retired and was glad that both were active.

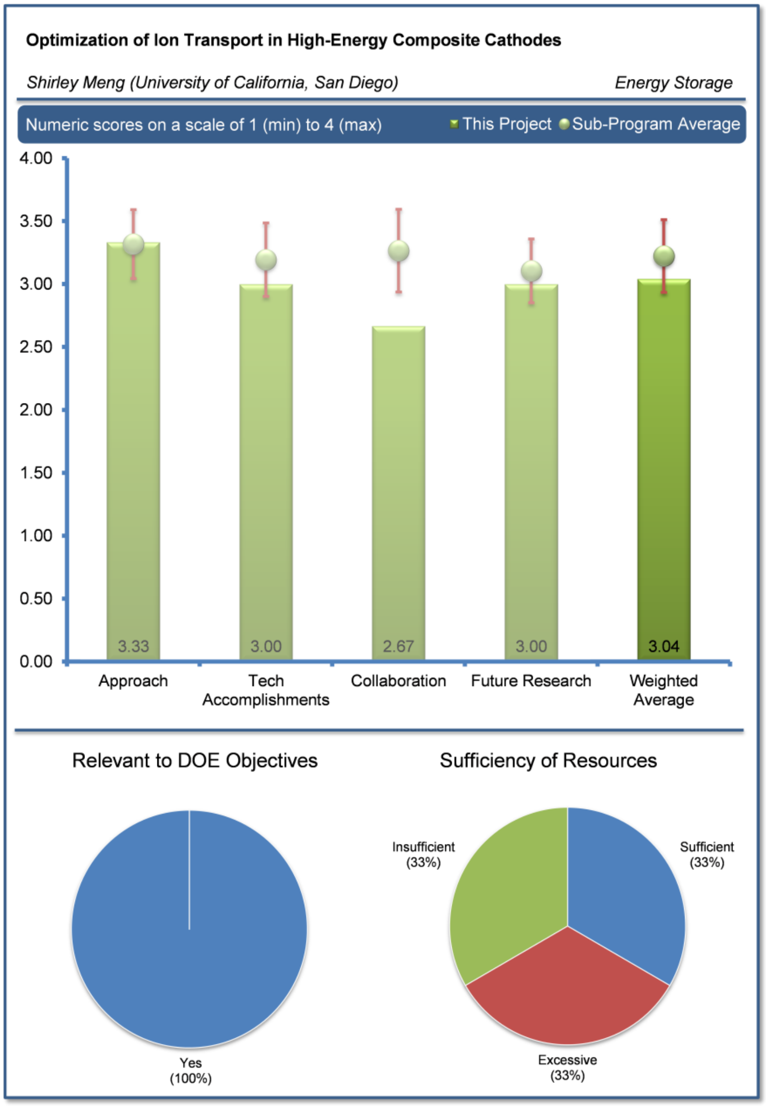
Reviewer 2:

The reviewer said that it was difficult to determine this accurately, but had the impression that the funds were adequate.

Reviewer 3:

The reviewer thinks that this PI and postdoc needed a lot of help. The reviewer added that the PI and postdoc seemed to be working in isolation from others.

Optimization of Ion Transport in High-Energy Composite Cathodes: Shirley Meng (University of California, San Diego) - es216



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the high energy cathode material that the PI refers to actually has a very wide compositional range and very complicated property/composition/structure relationships, making any study of this material challenging. The PI's approach of doing a wide range of diagnostic studies, combined with synthesis and first-principal calculations, to examine these cathode materials is good. However, the reviewer added that it does run the risk of being too wide and shallow, creating an increased possibility of making preliminary conclusions that are not fully substantiated.

Reviewer 2:

The reviewer noticed that the approach to this work builds on the expertise of the PI in the fields of electron and X-ray absorption and scattering experimentation at the scale of atomic resolution to characterize the surface as well as the bulk structure effects for materials of greatest interest for the vehicle technology program. The reviewer stated that the combination of scanning transmission electron microscopy/electron energy loss spectroscopy (STEM/EELS), X-ray photoelectron spectroscopy (XPS), X-ray absorption spectroscopy (XAS) and first principle computations is a powerful approach to understanding the structure of important materials as well as understanding the effect of structure on properties such as voltage fade and material instability. The reviewer observed that the main work to date has been on cobalt containing lithium manganese rich materials. Future work will involve similar studies to understand the structure of silicon lithium alloys.

Reviewer 3:

The reviewer commented that if a material is an insulator such as $LiFePO_4$, then the conduction band information is irrelevant. The reviewer further added that the drawing was not making sense. The reviewer inquired about simply stating, “empty DOS near the Fermi level.”

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the PI did a lot of work and presented many results. However, the reviewer said that it was difficult from the presentation to adequately review the PI's results and conclusions. As indicated, many of these results will be published, and the reviewer looked forward to reading about them.

Reviewer 2:
This reviewer indicated that the migration of manganese and nickel ions to the lithium layer was discovered in the presence of oxygen vacancies. This can result in the formation of spinel material and voltage fade. The reviewer went on to say that the substitution of cobalt had beneficial effects on voltage fade. The reviewer added that morphology control also had beneficial effects on voltage fade.

Reviewer 3:
This person stated that tossing in nice-looking drawings and images do not mean much. The reviewer asked what material had been studied in the achievement, and asked about high voltage spinel. The reviewer commented that there was not much explanation or captions on figures. The reviewer asked if the PI was expecting the reader to read all of the cited literature.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed that the PI had several collaborations and found it a little surprising that the PI did not have more collaborations, considering the breadth of what the PI had studied.

Reviewer 2:
The reviewer asked what data was contributed and by who, and what the partners' was. The reviewer wanted to know what the difference was between "collaborators" and "partners" after having noted a difference in the listing.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the future work indicates that the PI is finishing up the cathode studies and moving on to Si. The reviewer said that it would be interesting to see what recommendations the PI suggests for an improved high energy cathode material.

Reviewer 2:
The reviewer said that the effect of coatings will be important because of sensitivity of methods to surface will make it more easily studied.

Reviewer 3:
The reviewer commented that unlike the title, no ion transport data was present although the project had been going on more than a year. The reviewer then wanted to know when the data/calculations concerning ion transport in the materials are gathered.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

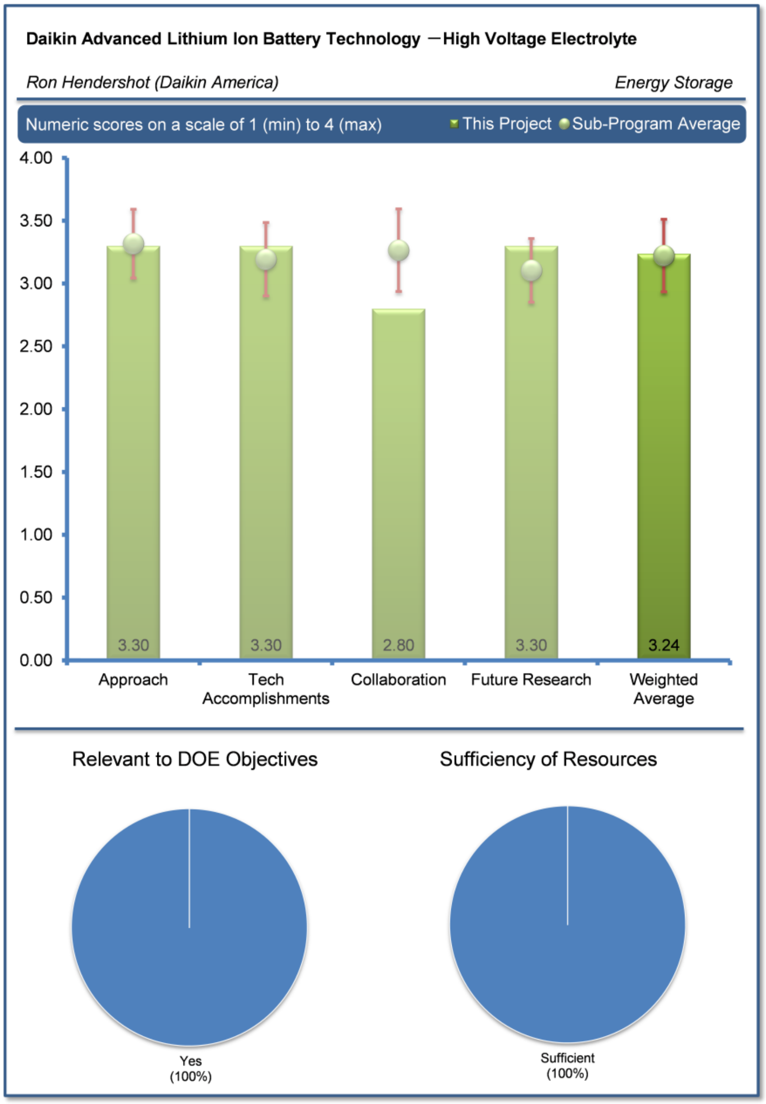
Reviewer 1:
The reviewer said that the PI does not make a great case for relevance, but that the materials studied were very important to advanced lithium-ion battery technologies.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer was not sure about the resources, but noted that there were many names listed.

Reviewer 2:
This reviewer was not sure how the PI had the resources to conduct these studies in sufficient depth.

Daikin Advanced Lithium Ion Battery Technology - High Voltage Electrolyte: Ron Hendershot (Daikin America) - es217



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project was well-designed and feasible to tackle the technical barriers. The literature review and baseline development are comprehensive. The reviewer then recommended that for electrochemical window evaluation, together with platinum, carbon (e.g., glass carbon) should be considered as well.

Reviewer 2:

This reviewer said that the approach seemed to be good. However, the reviewer suggested that the authors have to make sure that the supply of raw material is reliable and consistent, since this could be particularly critical when dealing with battery materials.

Reviewer 3:

The reviewer said that the study started in October 2013, and had made reasonable progress in developing a R&D program. The reviewer continued to note that a listing of high voltage electrolyte materials, conductivity, viscosity stable voltage range, etc. had been compiled. A list of electrolyte additives/solvents, their properties and their supplier had been developed. Further, the reviewer commented that the identification of promising high voltage electrolytes had started. The study is at a very early stage and experimental work is a learning experience.

Reviewer 4:

The reviewer reiterated that the objective of the project is to develop an electrolyte that can cycle up to 5 volts and is safe (self-extinguishing). To meet this goal, the program focuses on identifying electrolytes containing fluorocarbons for improved SEI layers. The reviewer added that the project addresses some of the key technical barriers confronting lithium battery technology.

Reviewer 5:

The reviewers pointed out that the researchers used the design of experiments approach which is in the very early stage; and needs to see what parameters and at how many levels are being assessed to better understand the scope. The reviewer added that it was important to provide cost estimates for the baseline versus newly developed formulations to have at least an understanding of the value proposition and, thus, probability of the commercial success.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
This reviewer commented that the project had just started and that the authors have shown good progress.

Reviewer 2:
This reviewer stated that the project was on the right track. The technical achievement contributed to the understanding the performance of various electrolytes for high voltage application.

Reviewer 3:
This reviewer recounted that the project was initiated in October 2013. During this 6-month time frame (i.e., October - April), satisfactory progress was achieved. A comprehensive review of electrolytes was conducted that included a review of Daikin's internal data and external literature. As a result of these studies, two electrolytes were selected as baseline formulations. The electrolytes were analyzed in terms of conductivity, voltage window stability and temperature stability. Electrolytes were also evaluated in cells. The reviewer concluded that the results are promising. Preliminary data show an increase in capacity retention when cells are charged to 4.6V.

Reviewer 4:
This reviewer said that it was too early to assess the progress and accomplishments of the project; however the initial results looked promising.

Reviewer 5:
This reviewer stated that the characteristic basic elements for developing new cell high performance components that have been identified had been obtained. The reviewer added that voltage stability range and conductivities had been obtained.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that there would be collaborations with Coulometrics, LLC who would be helping with cell fabrication and testing. The reviewer added that it would be beneficial for the program and for the PI to be in communication with other VTO laboratories. This would be helpful in terms of electrode fabrication and to ensure cell testing methods are valid.

Reviewer 2:
This reviewer noted that the program was in its early stages, and further reported that Voltammetry has developed the stable range of common solvents and other properties of conductivity. A simple differential scanning calorimetry (DSC) testing was confirmed to supply safety data of electrolyte behavior in a cell. The reviewer observed that baseline properties had been collected.

Reviewer 3:
This reviewer commented that the project had just started and commented that additional collaborations should be encouraged.

Reviewer 4:
This reviewer said that the PI should make an effort to collaborate outside the organization, especially academic institutions, to further understand the mechanism for the performance of the electrolytes observed.

Reviewer 5:
This reviewer stated that the characterization of the SEI layer might require establishing collaborations with the universities/national laboratories, unless the company has internal capabilities.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer noted that the plan for future works covered the ground of the interested area, but that the PI should extend the scope to investigate new potential active material in the electrolytes.

Reviewer 2:
This reviewer commented that the program plan had been developed and work had begun. To date, the reviewer observed that the progress was typical.

Reviewer 3:
This reviewer commented that the future efforts were appropriate. Efforts will begin on characterizing the SEI layer formed by the additives. Cells (NMC/graphie and LMN/graphie) containing the various electrolyte formulations will be built and tested. The reviewer added that cells would be evaluated when charged at high voltages.

Reviewer 4:
This reviewer stated that it was not clear in which type of cell the authors would be testing the two baseline electrolytes. Also, that the physical surface analysis for the SEI formation was not clearly specified.

Reviewer 5:
The reviewer said that the future work was well aligned with the project objectives. The reviewer noted that there was not enough data yet to provide recommendations. This reviewer continued to say that it might be beneficial to use commercially available electrode materials for the baseline comparison.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that the project does support the overall DOE goals. Electrolyte investigation is critical for the development of high energy Li or Li-ion batteries for transportation technologies.

Reviewer 2:
This reviewer said noted that the effort is relevant and supports DOE's objective of petroleum displacement. The project is attempting to identify high voltage electrolytes that could result in higher energy density batteries.

Reviewer 3:
This reviewer indicated that the data collected and interpreted would be valuable.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer assumed that the company has a good instrumentation base for characterization of the SEI additives (surface analysis).

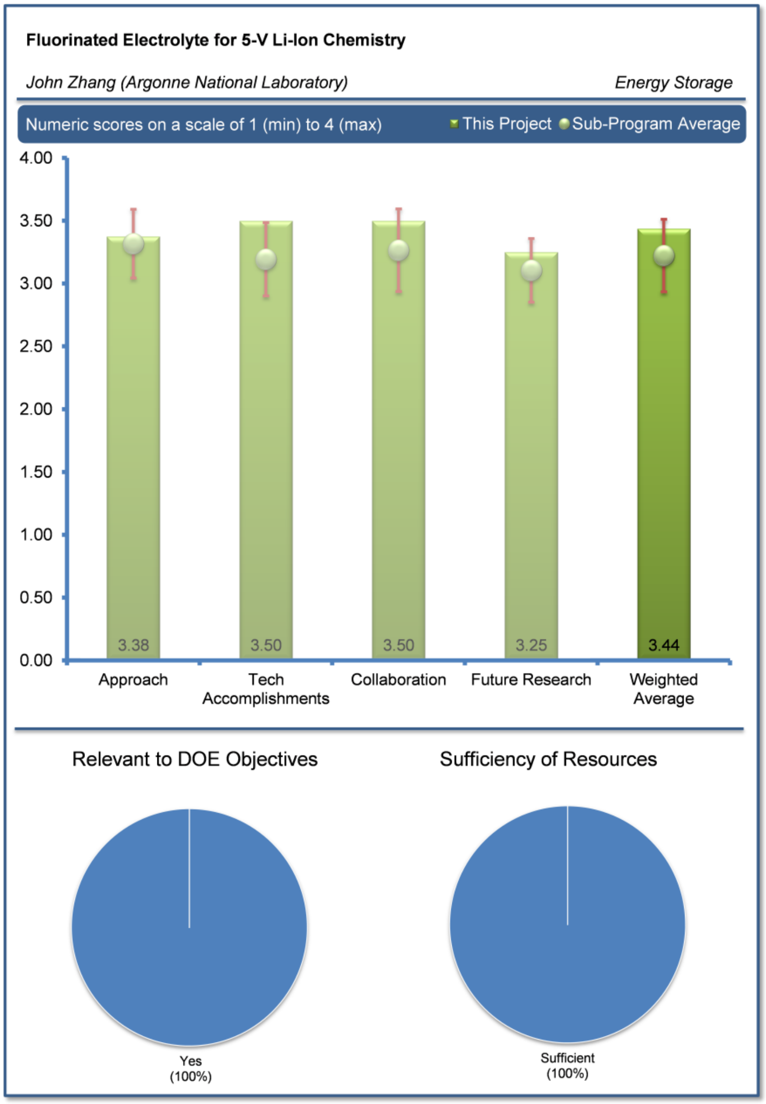
Reviewer 2:
This reviewer commented that sufficient resources were available to carry out the project.

Reviewer 3:
At this time in the project, the reviewer said that the level of resources appeared to be sufficient.

Reviewer 4:

The reviewer said that the PI seems to have adequate resources for the work. However, the reviewer encouraged the PIs to extend their collaboration outside the organization.

Fluorinated Electrolyte for 5-V Li-Ion Chemistry: John Zhang (Argonne National Laboratory) - es218



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the goal of this project is to develop advanced electrolyte materials that can significantly improve electrochemical performance without sacrificing the safety of the lithium-ion battery. The reviewer recounted that the project would pay attention to affordability. To do this, the project will develop electrolyte materials that can tolerate voltages greater than 5V. High voltage electrolyte candidates will be screened with the aid of quantum chemistry modeling and electrochemical methods. The electrolytes will include fluorinated carbonates and they will be evaluated using $LiNi_{0.5}Mn_{1.5}O_4$ (LNMO)/LTO and LNMO/graphite chemistries. According to this reviewer, this approach is excellent.

Reviewer 2:

The reviewer commented that the project had a well-designed approach that tackled the barriers.

Reviewer 3:

The reviewer said that with the aid of quantum calculations, promising compounds for 5V electrolytes were designed/identified, synthesized, characterized and evaluated. These are necessary to use the high voltage cathode materials under development. The goal is to use molecular engineering to identify promising compounds and verify their stability by experimentation.

Reviewer 4:

It seemed to this reviewer that the PI's approach's for the project was to use modeling to provide guidance for the synthesis, than to test the new electrolyte in cell. It appears that the fluorinated compounds demonstrated the performance improvement, but the theoretical base for the molecule design was not quite clear. The electrochemical testing was not complete, e.g. cyclic voltammetry ought to be used to identify the electrochemical window (should be used to verify the calculated HOMO/LUMO), AC impedance and fitting should be used as well; besides SEM, more structural analysis should be done on the SEI layers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that excellent progress had been made since this project was initiated in October 2013.

Reviewer 2:

The reviewer said that the performance of the synthesis electrolyte demonstrated superior performance than control electrolyte. The PI should expand the scope of testing to variable cathode/anode materials.

Reviewer 3:

The reviewer noted that the authors already reported significant results for a fairly new project.

Reviewer 4:

The reviewer commented that the initial experimentation has begun. The reviewer observed that some electrolytes are not stable at higher voltages. There is a relationship between the electronic structure of the electrolyte molecules and their stability.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the use of molecular engineering principles (DFT, etc.) is a giant step in the right direction. Today molecular calculations are proving useful in a number of areas. It is fitting to adopt this into identifying high voltage battery materials as well as stability.

Reviewer 2:

The reviewer indicated that the potential for good collaboration with other institutions appeared to be in place. The institutions include: the U.S. Army Research Laboratory (collaborator), Brookhaven National Laboratory (BNL) (collaborator), University of Rhode Island (interaction), Jet Propulsion Laboratory (interaction), and Dr. Larry Curtiss – Theoretical modeling.

Reviewer 3:

The reviewer said that the PI's collaboration with other national laboratories is important and fruitful.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This reviewer thought that the proposed future research was reasonable and well thought-out. During the remainder of FY 2014 the project would continue to explore the additive effect on the newly developed high-voltage fluorinated electrolyte (HVE) 1 on the graphite electrode. Efforts will continue to design and synthesize new fluorinated carbonate solvents based on the recent research results. In addition, tailored cathode electrolyte interphase (CEI) additives will be employed to further improve the stability of the LNMO/electrolyte interphase.

Reviewer 2:

The reviewer commented that using the rest of 2014 to explore and identify new compounds is very much in order. Once a base is established the project should be able to make significant contributions and speed the development of high voltage systems needed for the future demands.

Reviewer 3:

The reviewer stated that it is always difficult to know if the authors are going to succeed; but that the theoretical approach coupled with organic synthesis and in-situ measurements is highly encouraging.

Reviewer 4:

The reviewer suggested that the PI should allocate more resources to the advance analysis especially in-situ diagnostics for the SEI formation and to focus more attentions on the development of additives and conduct adequate electrochemical analysis beyond simple coin cell charge and discharge.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer said that the project was highly relevant and supports the overall DOE objective of petroleum displacement. To replace petroleum, a high energy density battery must be developed, and a high voltage electrolyte would be one approach to achieve this.

Reviewer 2:

The reviewer noted that the development of high voltage electrolyte contributes to the overall goal of DOE.

Reviewer 3:

This reviewer said that calculations can take the place of trial and error. Designer electrolytes, cathodes and anodes are very much in order for the future.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer said that the present resources were adequate. Once a pattern of success is realized, then additional funding will be in order.

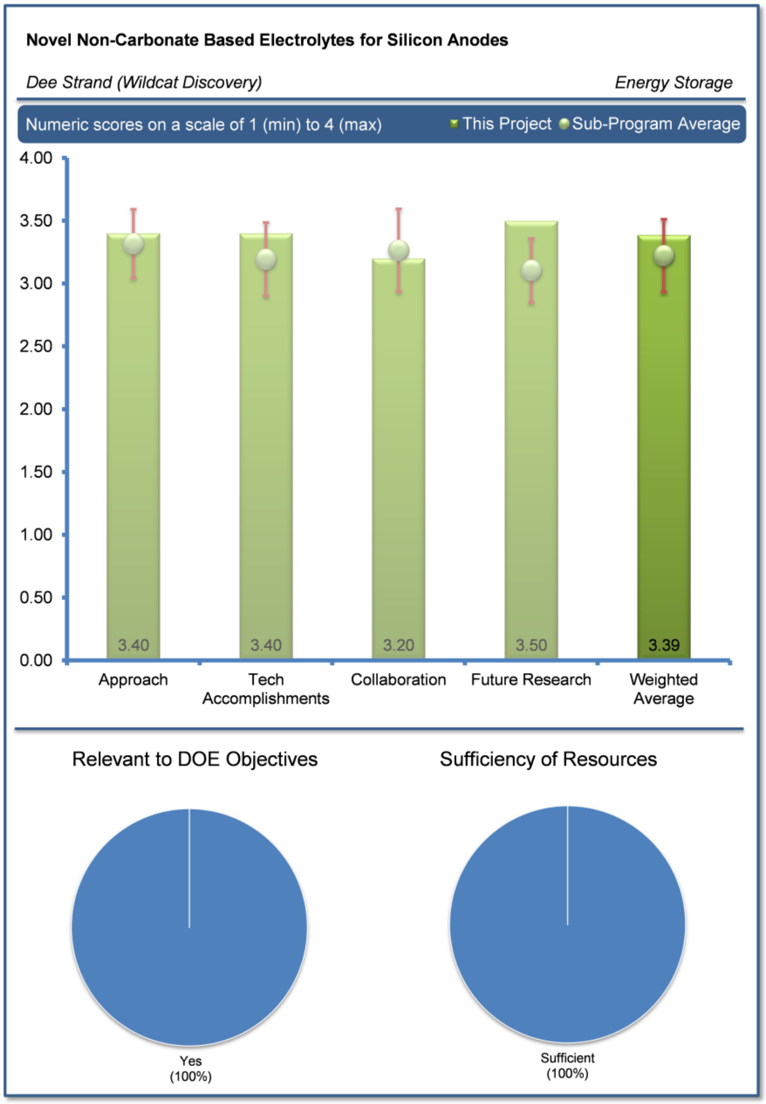
Reviewer 2:

The reviewer indicated that the resources were sufficient to complete this effort.

Reviewer 3:

This reviewer stated that the PI had adequate resources for the investigation, but that the lead PI should allocate the resources more smartly.

Novel Non-Carbonate Based Electrolytes for Silicon Anodes: Dee Strand (Wildcat Discovery) - es219



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer said that the high throughput approach was excellent for the initial screening. Based on the discussion during the poster session, experiments were conducted in duplicates. The reviewer commented that there was no data suggesting how reproducible the results are. The focus on the 3M specific cell chemistry narrows the scope to one design. It might be important to do some benchmarking testing of the selected formulations

Reviewer 2:

The reviewer commented that the approach was clear, well-reasoned, systematic, and addressed one of the key technical barriers of lithium ion batteries. Non-carbonate electrolytes will be developed such that they can form stable SEIs on a 3M silicon alloy anode, have comparable ionic conductivity to carbonate formulations, are oxidatively stable to 4.6V, and will not increase cell cost. Silicon anodes will be investigated because it holds the promise of significantly improving energy density.

Reviewer 3:

This reviewer stated that the final use of 18650 cells is important. The reviewer suggested that the authors should be careful and make sure the materials received for testing are of similar quality since this is very important, particularly when talking about battery materials.

Reviewer 4:

The reviewer said that the PI screened a large amount of alternatives against the benchmark electrolyte. The approach for the screening, recounted the reviewer, is to use first capacity, first cycle efficiency and either the 50th or 75th capacity retention. Although those are valid quick engineering evaluations, the reviewer recommended that the PI conduct some electrochemical or physical testing for the electrodes, so that the evaluation could be more focused.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that good progress had been made in a relatively short period of time. Eighty two electrolytes were tested, some of which look very promising.

Reviewer 2:
This reviewer said that an impressive amount of work was conducted in a short period of time. The reviewer added that it would be helpful to have inserts/separate graphs for the promising/selected formulations vs. control; the reviewer clarified that the data was somewhat cluttered.

Reviewer 3:
The reviewer said that the project was on-track to achieve the milestones. With about 85 different electrolyte combination screens, the potential winner indeed surfaced. However, due to lack of in-depth electrochemical and physical analysis, the reviewer noted that little guidance was provided from the existing work regarding future development.

Reviewer 4:
The reviewer stated that the project is relatively new. Surface analysis of the SEI should be pursued at some point. This is an interesting approach where the silicon anodes should be able to play a critical role.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
This reviewer observed that there will be some collaborations/interactions with 3M but that it was not clear to what extent.

Reviewer 2:
This reviewer stated that it appeared that the only partner was the only beneficiary of this project. Thus, the reviewer suggested establishing collaboration with other companies within the BATT program to understand the applicability of the findings and to study SEI formation.

Reviewer 3:
This reviewer stated that further collaboration with other groups was strongly encouraged.

Reviewer 4:
This reviewer noted that the objective was to develop an electrolyte for the 3M silicon anode and that the collaboration with 3Mwas critical. The reviewer then recommended that the PI take more advantage of UCSD’s analysis capability of materials.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer said that the plan for the future work was well design. More electrochemical analysis (e.g., AC impedance) should be beneficial for the understanding.

Reviewer 2:
This reviewer stated that this was a very well-planned program.

Reviewer 3:
This reviewer noted that testing and collaboration with 3M was important and added that it was also important to have some intimate knowledge about how the 18650 cells are fabricated and to be able to follow and analyze the data as it is produced.

Reviewer 4:
The reviewer commented that the proposed future plans were appropriate and well-reasoned. Efforts will continue to identify non-carbonate solvents as well as a polymer additive for improved SEI layer formation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer stated that this project was highly relevant and supports DOE's objectives to displace petroleum with electric drive systems. For example, the EV Everywhere battery goals for 2022 are a cost of $125/kWh and energy densities of 400 Wh/L and 250 Wh/kg. This will require higher energy density systems and new electrolytes and additives that help the battery cycle will be of immense benefit.

Reviewer 2:

The reviewer said that the development of adequate electrolyte for the Si anode will contribute to the performance improvement of the Li batteries, which is suitable for the department goal.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

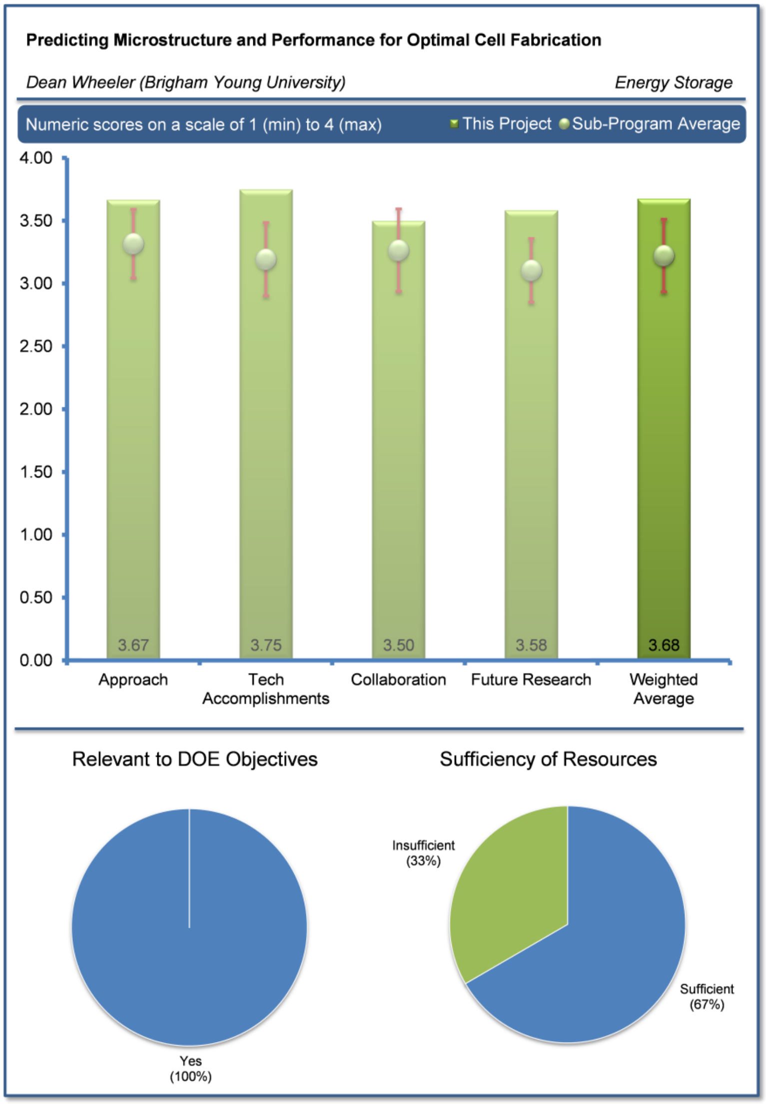
Reviewer 1:

The reviewer stated that sufficient resources appeared to be in place at this time.

Reviewer 2:

The reviewer commented that the PI had adequate resources for the project, which should be better utilized.

Predicting Microstructure and Performance for Optimal Cell Fabrication: Dean Wheeler (Brigham Young University) - es220



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer thought that this approach was absolutely outstanding. The reviewer continued to say that it was elegant, well characterized, and that the PIs had done an excellent job of validating their approach.

Reviewer 2:

This reviewer said that this was very innovative work very and that it was much needed for the quality control and electrode design improvements.

Reviewer 3:

The reviewer commented that the development of this new technique of measuring the electronic (and hopefully soon, the ionic) conductivity of composite electrodes is quite significant and could add substantially to the tools available to the battery designer. The reviewer would like to see the method extended to measurements as a function of formulation as well as processing parameters such as calendaring pressure, coating speed and temperature, etc. This would help in developing and optimizing electrode manufacture to the extent that it is within the scope of the contract. Finally, the reviewer would have liked to see cell tests done on cells with electrodes of the same material and electrolyte, but different electronic/ionic conductivity due to processing conditions or formulation.

Reviewer 4:

The reviewer stated that the project was well designed and that it was already showing interesting results.

Reviewer 5:

The reviewer commented that the PIs focus on electronic conductivity effects in electrodes. This tends to be more important for cathodes where the active materials are generally poor conductors. The reviewer remarked the PIs overall plan was good. However, the more challenging aspects of the project are left for the later years.

Reviewer 6:

The reviewer stated that the PIs completed the development of the first generation of multi-probe devices for conductivity measurements and that the probes were validated. Clearly, the milestones were met and the approach is valid. The reviewer then suggested that the PI address the electrode active materials particle size issues that would occur in the same order of the distances between the probes. Thus, continued this reviewer, there would be evaluation of how the boundary effect was being considered.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the proven success was that the industry partner was acquiring the technology. The reviewer thought there was a very honest assessment of the results and implications and commended the project on an excellent execution.

Reviewer 2:

This reviewer commented on how it has always been hard to measure the conductivity of a thin film of semiconductor material on a conductive carrier – the problem is how much of the current between the probes goes through the electrode material and how much through the carrier. The reviewer then commended that this group had successfully produced a tool that could measure both conductivity within a thin film and also the contact resistance of that film to the carrier in a relatively simple manner. As far as the reviewer knew, there was no way to measure either of these with any accuracy. Moreover, the reviewer said the project demonstrated both excellent accuracy (using standards) and really quite surprising repeatability. According to the reviewer, the project had a wide range of conductivity on a typical electrode material, which was surprising. Work like this could really help improve electrode uniformity and ensure even current distribution of cells under high rates of charge and discharge. The reviewer continued to say that this was the best method poster/talk the reviewer had seen at the AMR or any other recent meeting and represented a clear advance in the state of the art of battery technology for Li-ion and other battery systems.

Reviewer 3:

This reviewer said that even though this project was relatively new, the authors have shown great progress.

Reviewer 4:

This reviewer noted that the progress in developing the technique was substantial. However, the presentation did not delineate the sources of error in the measurement, and this would have been useful in evaluating the method.

Reviewer 5:

The reviewer said that the progress of the project was satisfactory. The research would make an impact on electrode manufacture, especially quality control.

Reviewer 6:

The reviewer stated that the PI developed a technique to easily measure conductivity and current collector contact resistance in a finished laminate, which had not been done previously. It extends the classical four probe measuring technique to a dimension smaller than the thickness of the electrode for the measurement to be made. This technique should be able to be effectively transferred to industry.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed that the communication with A123 and national laboratory personnel was good. It would be even more useful to be able to specify variations in formulation and processing conditions as discussed above, so that automated electrode manufacture could be applied to reveal these effects more precisely.

Reviewer 2:

The reviewer thought that the project was getting lots of interest from the industry.

Reviewer 3:

The reviewer acknowledged that the PI had established many collaborations in academia, industry, and with the national laboratories.

Reviewer 4:

The reviewer noted that the PIs closely collaborated with battery manufacturers (e.g., A123 Systems), which gave the PI a real-world production perspective.

Reviewer 5:

The reviewer strongly encouraged collaboration with additional institutions.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the future work plan was well designed and added that the PI should add electrode particle size and porosity into consideration and compare them against the conductivity data.

Reviewer 2:

This reviewer said that this was a very practical and important quality manufacturing technique. This technique may end up reducing the amount of off spec material in a production facility.

Reviewer 3:

The reviewer stated that the PI had a good plan going forward. His work on modeling the coating process should prove interesting.

Reviewer 4:

The reviewer stated that the microstructure model may be more difficult to achieve the desired accuracy than the PI hoped for. It is certainly worth the effort to develop such a model, however, as it could add an additional dimension to the largely empirical process of electrode manufacture design as used presently.

Reviewer 5:

The reviewer was looking at spatial variation of conductivity. The reviewer observed that the project also plans to add an electrolyte and to try to measure the ionic conductivity of an electrode film as well, which would again be extremely valuable. The reviewer thinks that knowledge like this would be invaluable inputs to cell designers and especially to modelers. The reviewer suggested that it might be good to compare their spatial mapping of electrode conductivity with thermal images of the electrodes hit by a heat pulse to see if they match (thinking heat conduction and electronic conduction often go hand in hand).

Reviewer 6:

The reviewer said that it was very important to validate the technique using same active materials fabricated into the electrodes by different suppliers. The reviewer asked if this technique could be used for quality control, in particular to spot metallic particles in the electrode. This would be very important to ensure safety of the Li-ion batteries. If possible, the reviewer commented that this work should be given a highest priority.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that the PI made a solid case for relevance.

Reviewer 2:

The reviewer said that this method actually addresses two key issues associated with thin electrodes used for many battery systems, Li-Ion, primary lithium, air cells, etc. The fact that the project could for the first time get “real” conductivity in such films is enormously important to the battery industry.

Reviewer 3:

The reviewer said that the project research on the 3D profile of the conductivity of porous electrode would provide a valuable tool for the electrode production, improve quality control and cutting the production cost, which contribute the overall goal of DOE.

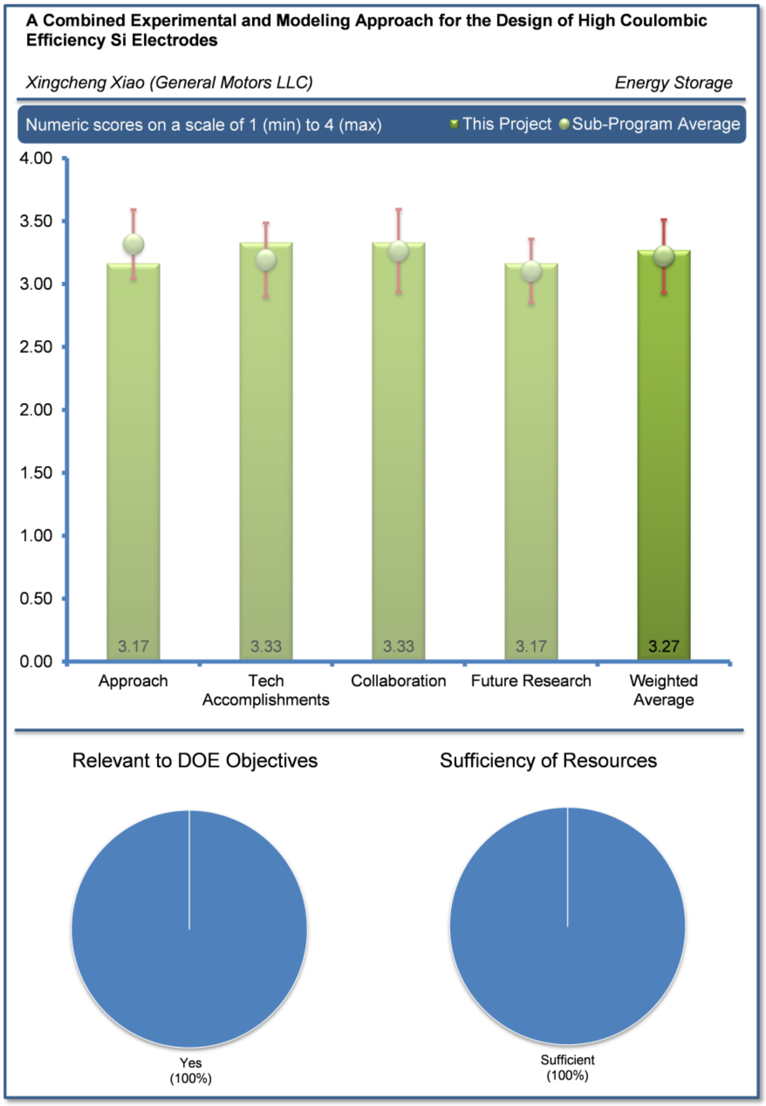
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
Based on the PI's productivity, there seemed to be sufficient funds to conduct the studies.

Reviewer 2:
The reviewer said that the PI had adequate resources for the investigation.

Reviewer 3:
This reviewer would like this work expanded to provide a clear way for others, in and outside the DOE's programs, to build and use devices based on their work. The reviewer said that the project had created an industry-wide asset that needs to be widely disseminated and leveraged.

A Combined Experimental and Modeling Approach for the Design of High Coulombic Efficiency Si Electrodes: Xingcheng Xiao (General Motors LLC) - es221



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the combination of modeling and experiment approaches were very effective to verify each other and that the group successfully achieved that.

Reviewer 2:

The reviewer said that the PI had put together an impressive group to examine and attack the mechanical issues on silicon alloy electrodes. The effort included extensive experimental and theoretical studies.

Reviewer 3:

The reviewer stated that the approach was not clearly delineated. However, to the extent that the reviewer understood the effort, it appeared to be proceeding as designed. The reviewer stated that the comparison of uncoated silicon and core shell silicon to yolk-shell silicon seemed contrived. It would be better in the reviewer's opinion to show comparisons to the best available samples from the literature.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the PI had a broad spectrum of results that clearly demonstrated that the project had been very productive and is off to a great start.

Reviewer 2:

The reviewer said that the project has acquired high quality data for better understanding. In particular, relating the cell height changes to the in situ microscopic data on shelled Si particles is outstanding for obtaining insight into the material dynamics subjected to electrochemical processes. On the other hand, the interpretation of Al_2O_3 ALD data (accomplishment 2) is questionable because the shell can be partial when it is less than 10 atomic layers.

Reviewer 3:

The reviewer said that the milestones already completed indicated that some real progress had been made in trying to understand the effects of coatings. However, it would be useful to show the uniformity and repeatability of the ALD coatings in order to better assess the measurements. Also, some attempt to determine the accuracy of the measurements would be useful.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that this group had a great research network.

Reviewer 2:

The reviewer said that the PI had a number of collaborations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that it would be interesting to follow this project as it moves forward.

Reviewer 2:

The reviewer described the proposed future research as too physical, and added that some characterizations of the chemical nature of materials are recommended through collaborations.

Reviewer 3:

The reviewer said that the relevance would be improved with better attention to accuracy and uniformity of materials and coatings.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

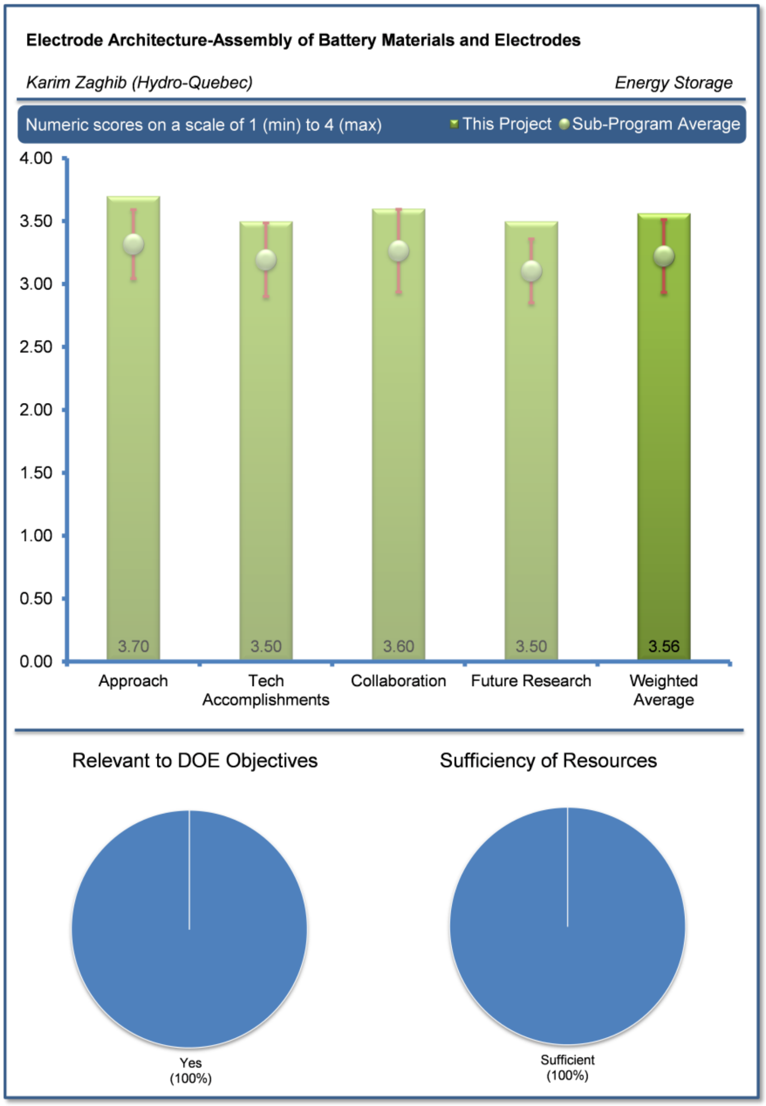
The reviewer said that the PI made a good case for relevance.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that it was hard to see how the funds supported the level of effort.

Electrode Architecture-Assembly of Battery Materials and Electrodes: Karim Zaghib (Hydro Quebec) - es222



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer pointed out that the overall approach was excellent in meeting the project objectives. To be more effective, it might be beneficial for Headquarters to utilize knowledge and findings within the BATT program instead of developing new Si anodes and electrode formulations. This way more time could be allocated to developing low cost electrode architectures with good electrochemical performance. This will allow to best utilize the HQ' strengths and to avoid overlapping with the work done by others within the BATT program.

Reviewer 2:

The reviewer stated that the electrode architecture by controlling tortuosity and porosity and maintaining high ionic conductivity is a good approach.

Reviewer 3:

This reviewer stated that this was a very important contribution to high capacity cells using a new generation of anodes. The reviewer added that there were very interesting in-situ results provided by SEM.

Reviewer 4:

The reviewer said that the project approach was effective to identify the major issues associated with the Si anode, and analyze the cause for those problems.

Reviewer 5:

This reviewer said that this project addressed technical barriers by designing Si electrode architecture for improved lithium ion battery energy density. In-situ and ex-situ characterization techniques are used to investigate SEI.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed that the work done to date was solid and confirmed industry knowledge. The reviewer added that it was important for HQ to take leadership in providing direction towards commercial approaches.

Reviewer 2:
The reviewer said that important results were already provided in a fairly new project.

Reviewer 3:
This reviewer observed that Si anode was one of the DOE focus areas. The results from the project shine light to the root cause of the problem with Si anode, and the possible ways to alleviate those problems by engineering electrode structure design.

Reviewer 4:
This reviewer observed that this project had identified Si-based anode with a capacity of 1200mAh/g and provided Si power to other BATT PIs. However, the charge/discharge efficiency at deep discharge status is still a challenge which may affect battery cycle life.

Reviewer 5:
This reviewer commented that the loading of silicon should be given.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that this project brought together some excellent research from various different institutions to attack the technical barriers together.

Reviewer 2:
The reviewer stated that there was good collaboration.

Reviewer 3:
The reviewer indicated that the PI collaborated with both an academic institution and a national laboratory effectively.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that future activities were in-line with achieving project goals.

Reviewer 2:
The reviewer noted that the future activities were well aligned with the deliverables, but that it was not clear what the critical assumptions and issues were.

Reviewer 3:
The reviewer recounted that interesting results were already reported. The high carbon content for these Si anodes seemed to be a good compromise that may overcome the electrode degradation.

Reviewer 4:
The reviewer said that future activities were in-line with achieving project goals.

Reviewer 5:
The reviewer noted that the future activities were well aligned with the deliverables, but that it was not clear what the critical assumptions and issues were.

Reviewer 6:
The reviewer said that the proposed future research was reasonable as planned.

Reviewer 7:
This reviewer commented that the loading of the silicon for the current experiment as well as for the proposed future experiment should be given.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that the goals of this project were highly relevant to DOE targets to increase battery energy density and cycle life.

Reviewer 2:
The reviewer commented that the engineering development for the Si anode process was in-line with overall goal of DOE.

Reviewer 3:
This reviewer noted that the project reduces the petroleum use.

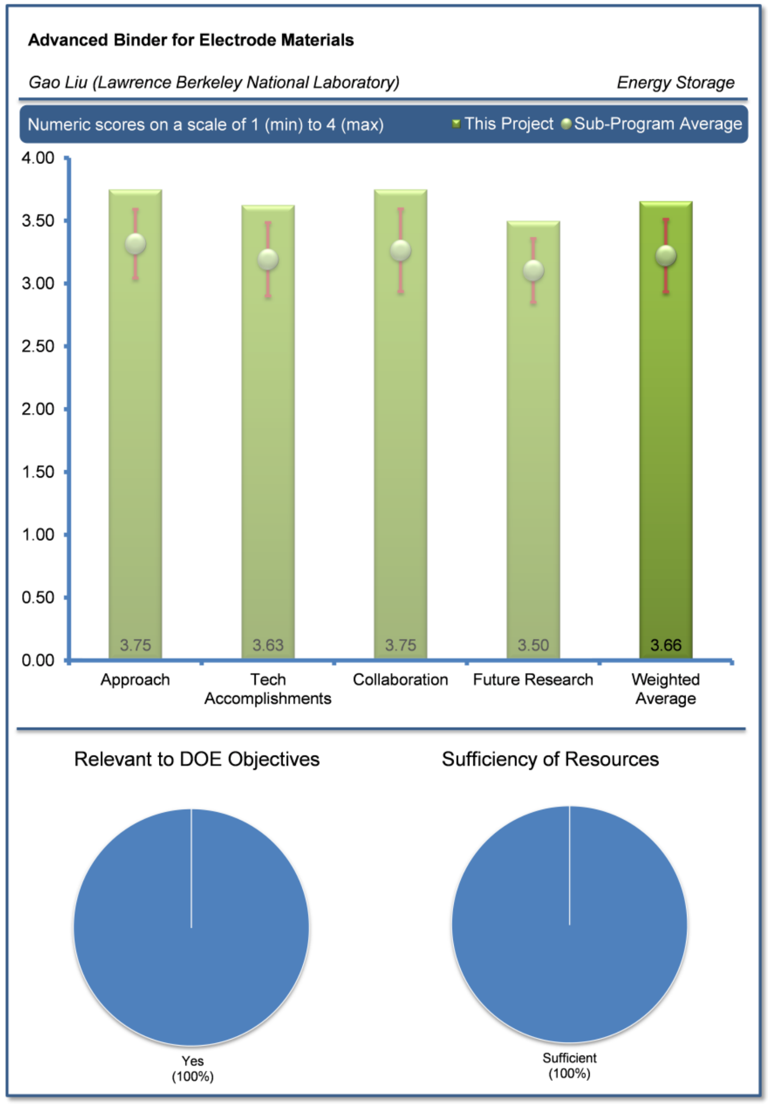
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
To this reviewer, it appeared that the Pi had sufficient resources to conduct the proposed work.

Reviewer 2:
This reviewer commented that there were sufficient resources.

Reviewer 3:
The reviewer noted that the PI had adequate resources for the investigation.

Advanced Binder for Electrode Materials: Gao Liu (Lawrence Berkeley National Laboratory) - es223



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the functional conductive polymer binder approach was very good.

Reviewer 2:

The reviewer stated that the PI developed a unique conductive and elastic binder which is used in a rechargeable Si anode for Li-ion batteries. The conductive binder can compensate the volume change during the Si anode cycling, and therefore maintain the integrity of the Si anode. The reviewer continued to say that the approach to solve the cyclability problem for Si anode was sound.

Reviewer 3:

This reviewer said that the project had a very interesting approach to the Si anode. The use of conductive polymers, together with spherical Si, may be the right approach to improve the stability of these new type of electrodes.

Reviewer 4:

This reviewer said that the project targets the improvement of Si-based anode insufficient energy density and poor cycle life for lithium ion battery applications.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the performance was very good with conducing binder approach. The reviewer wanted to know what the current loading was.

Reviewer 2:

The reviewer noted that there was great progress for a fairly new project.

Reviewer 3:

The reviewer said that improved performance had been demonstrated. The project is on track and all the milestones were met.

Reviewer 4:

This reviewer said that the project had achieved many progress in terms of conducting binders and Si-based anode material. However, recycling efficiency and life seemed to still be challenges ahead.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the PI had excellent collaboration with researchers from different institutions to attack the technical barriers together.

Reviewer 2:

The reviewer commented that there was excellent collaboration.

Reviewer 3:

The reviewer said that the PI formed a strong collaboration with various national laboratories and industries.

Reviewer 4:

The reviewer noticed that several teams were collaborating.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer sated that the 3 mAh/cm2 loading was a good target. The reviewer added that a postmortem analysis was important.

Reviewer 2:

The reviewer said that the proposed future research was well planned and feasible. The PI should focus its attentions on the elastic SEI formation.

Reviewer 3:

The reviewer noted that the project was on schedule and that the proposed future work was reasonable. The reviewer was not sure if this project had a go/no-go plan. If not, a go/no-go plan may be needed or illustrated in the review slides for project planning purpose.

Reviewer 4:

The reviewer said that it was not clear which type of cells the authors would be using to validate their best anode design. is the reviewer strongly recommended to use cylindrical or pouch cells.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project supported the DOE objectives and that it targeted attacking Si-based anode technical barriers for improved battery life and energy density.

Reviewer 2:

The reviewer stated that the project aimed to alleviate the problem associated with the rechargeable Si anode, which is in line with the DOE goal.

Reviewer 3:

The reviewer said that the project reduces petroleum use.

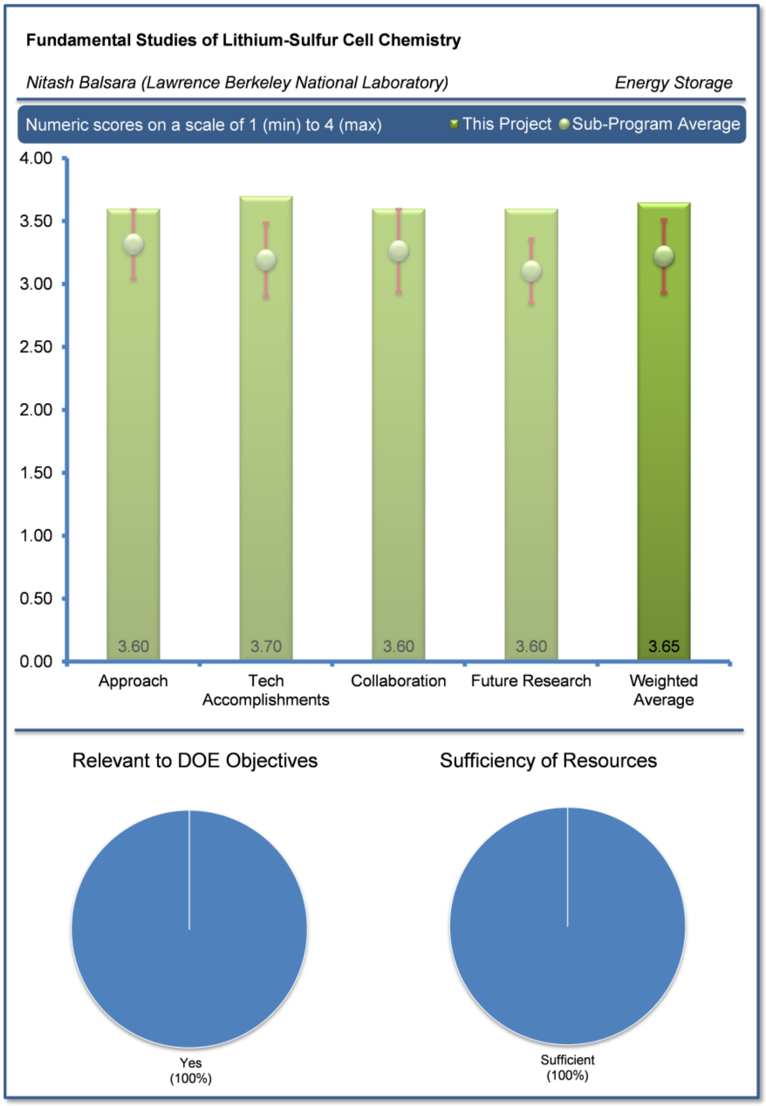
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer said that there were sufficient resources.

Reviewer 2:
This reviewer said that it appeared that there were sufficient resources for this project to achieve the goals described.

Reviewer 3:
The reviewer said that the PI had adequate resources to accomplish the tasks.

Fundamental Studies of Lithium-Sulfur Cell Chemistry: Nitash Balsara (Lawrence Berkeley National Laboratory) - es224



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the project aims to identify the polysulfide species using X-ray absorption techniques and calculation. The approach to tackle the problem is sound.

Reviewer 2:

The reviewer commented that the project had an interesting theoretical approach linked to experimental results. The study of the sulfur (S) chemistry should be one of the critical areas that can move forward the lithium-sulfur (Li-S) cells.

Reviewer 3:

This reviewer said that the work was focused on the fundamental understanding of the sulfur cathodes products and includes the experimental validation steps. The reviewer added that it might be beneficial to benchmark even initial findings vs. results reported in the literature.

Reviewer 4:

The reviewer said that if the high energy density benefit of the Li-S battery is to be realized, then there must be a fundamental understanding of the polysulfides that limits its performance. This effort will provide a fundamental science-based understanding of the redox reaction products (polysulfides). It will enable rational cell design strategies. First-principles molecular dynamics simulations will be used to determine charge distribution and X-ray absorption spectra of polysulfide solutions will be used to help in the identification of the various species. Finally the reviewer concluded that this method would allow a simple hypothesis for sulfur oxidation in ether-based solvents to be obtained.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the PI had found a unique way to transform the liquid polysulfide ions into a solid polymer, therefore the X-ray analysis could be conducted. The reviewer observed that the ternary diagrams were established and thought the project was progressing well.

Reviewer 2:

The reviewer commented that the project had demonstrated significant progress. The project has shown that only Li_2S_4 and Li_2S_8 species were likely to exist in the sulfur cathode during cycling.

Reviewer 3:

The reviewer said that for a fairly new project, the results shown by the authors were encouraging.

Reviewer 4:

The reviewer noted that the use of principal component analysis (PCA) seemed to provide unbiased conclusions on the components in the S cathode. The reviewer was looking forward to seeing experimental data.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed that an appropriate level of collaboration existed. These include National Energy Research Scientific Computing Center (NERSC), ALS, LBNL, University of Illinois, ONRL and BNL. The reviewer added that many of the investigators were within the Vehicle Technology Office and that this was very good.

Reviewer 2:

The reviewer said that the PI collaborated with researchers in another national laboratory and academic institution. The reviewer continued to say that such collaboration was suitable for the project.

Reviewer 3:

This reviewer stated that correlating results of statistical modeling vs. data reported in the literature is important for the validation of the use of the PCA. The reviewer added that the project needs to establish more collaboration with leading research groups.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed future efforts were appropriate and were clearly defined. It is an excellent idea to perform in situ experiments to create polysulfides by electrochemical reactions and then to use fingerprinting strategy to determine reaction products.

Reviewer 2:

The reviewer noted that there were very well articulated future plans.

Reviewer 3:

The reviewer indicated that the future work for the continuous X-ray experiments was sound. The reviewer added that other analytical technics should be used to validate the results alongside with X-ray absorption.

Reviewer 4:

The reviewer sated that in-situ measurements to study reaction products, and design simulation to better understand the sulfur cathode may end up moving this field forward.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer observed that the project aimed to understand polysulfide ions, which was critical for the development of Li-S batteries.

Reviewer 2:

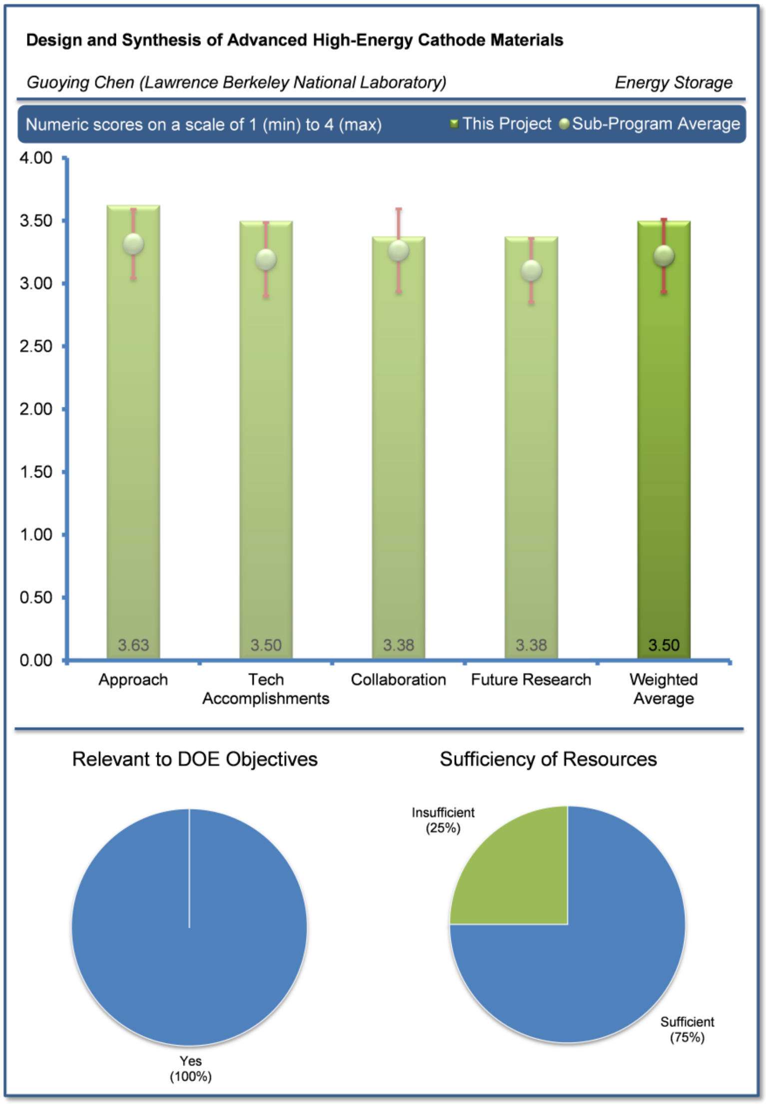
To this reviewer, obtaining a fundamental knowledge of the polysulfide reaction products in a lithium sulfur battery is highly relevant. This supports DOE objective of petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that the PI had adequate resources to accomplish the tasks.

Reviewer 2:
The reviewer commented that the resources were sufficient for this project.

Design and Synthesis of Advanced High-Energy Cathode Materials: Guoying Chen (Lawrence Berkeley National Laboratory) - es225



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This approach, the reviewer fully approved of. The program could use this powerful experimental tool to overcome the barriers between the experimentalist and the mathematician. The reviewer proceeded to say that both need each other but often feel challenged by their presence.

Reviewer 2:

The reviewer stated that the project has addressed one of important problem for all high voltage cathode materials which is stability.

Reviewer 3:

The reviewer summarized that the project objective is to obtain a fundamental understanding on the phase transition mechanisms, kinetic barriers, and cyclic instabilities (as a function of crystallographic planes) in high-energy cathode materials. The commenter explained that the approach adopted is to use single-crystal model systems and to perform advanced ex-situ and in-situ studies to characterize the crystal-plan specific transport properties and interfacial chemistry. Based on these studies, the reviewer noted that direct correlations between crystal structure, composition, morphology, performance, and stability will be established, which will help in the design of optimized high-performance electrode materials. The project evaluator agreed that this approach is consistent with the objectives of this project as well as the goals of the DOE ABR program, is well-integrated with the other materials-based efforts, and appears to be feasible.

Reviewer 4:

The reviewer commented that the approach taken combining single crystals, as well as diagnostic and modeling studies in the project, are yielding results helpful for improved synthesis of high capacity cathode materials and better understanding of their fade mechanisms.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that there was a rich collection of quite interesting data that was still not enough to pinpoint the key criteria for improved synthesis of the cathode materials but the reviewer was hopeful that the remaining tasks would go a long way toward achieving that goal.

Reviewer 2:

The reviewer applauded that impressive studies were made that led to a good understanding on the effects of crystallographic planes on the interfacial stability. The commenter also explained that single crystals of high-voltage LMNO and layered oxide cathodes were synthesized with a variety of sizes and morphologies and studied for self-discharge, interfacial stability and cycle life. It was shown clearly that the side reactions and self-discharge are reduced on the 111 plane compared to 112 plane of the LMNO cathode and that the electrode performance could be manipulated by particle morphology engineering. The reviewer noted that similar single crystal studies have been carried out to understand the effect of morphology and particle size on the activation kinetics and interfacial stability of layered oxides. The commenter stated that these results are quite interesting, but cautioned that then one would ask the relevance of this understanding form a single-crystal behavior in a polycrystalline electrode, i.e., if we one control the crystalline facets of the cathode. The project evaluator asked whether it would it be possible to synthesize bulk materials with the desired crystalline facets. The commenter also noted that good characterization tests are underway on these single crystal cathodes, including Li_xMNO solid solutions. Overall, the reviewer acknowledged that good progress has been demonstrated towards the DOE goals.

Reviewer 3:

The reviewer stated that hopefully, the experimentalists can realize the need for cooperation is making a success for the program for electrification of the transportation in the United States. The reviewer continued to say that each could make rapid progress if there was cooperation. This reviewer further explained that it really is a combination of experimentalist and quantum calculation to more accurately identify promising, new high energy materials. The reviewer pointed out that there is a need to keep both sides happy.

Reviewer 4:

The reviewer observed that the research has been focused on the comparison of two different kinds of single crystals: plane versus octahedron single crystals. The chemical and electrochemical stabilities have been investigated. The crystallinity and surface states during aging had also been investigated.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed that there were a great team of collaborators.

Reviewer 2:

The reviewer stated that there are excellent on-going collaborations with researchers from LBNL and from universities.

Reviewer 3:

This reviewer said that the collaboration appeared to be appreciated.

Reviewer 4:

The reviewer commented that there were limited outside collaborative activities, except with ANL for the particle mapping.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer observed that the proposed future research focused on understanding phase transition mechanisms, kinetic barriers, and instabilities of high voltage cathode.

Reviewer 2:

The reviewer summarized that the proposed future research is to continue further evaluation of the impact of surface properties, including surface modifications, on side reaction kinetics and products as well as capacity fade in high-voltage cathode materials and to explore other aspects of particle engineering to improve cathode performance and stability. The single-particle diagnostic studies will be extended to the layered-layered oxides to understand their structural changes and voltage fade and impedance growth upon cycling. The commenter also described that the studies will focus on constructing the LxMNO phase diagram to establish solid solution versus two-phase behavior, and thus understand the stability and performance of these materials as functions of Li content and temperature. The commenter agreed that the proposed studies are logical, while addressing the technology barriers, so are consistent with the DOE goals.

Reviewer 3:

This reviewer commented to learn as you go, and that it will take time for both sides to accept the other and create a really powerful team. The reviewer continued that the human mind is a marvelous organ, and to have an assist to carry out the new concepts would be outstanding.

Reviewer 4:

The reviewer said that of course, issues such as capacity and voltage fades were key targets of studies. Additional studies at the particle level should include severe gassing at the outset. The reviewer then asked about TM dissolution studies.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that this approach was the wave of the future. The reviewer encouraged to keep it going.

Reviewer 2:

This reviewer said that extremely focused studies to improve synthesis of high energy cathode materials is key to developing a long-life, low-cost battery for vehicle propulsion.

Reviewer 3:

This reviewer stated to develop high-capacity high voltage cathode for Li-ion batteries.

Reviewer 4:

The reviewer highlighted that the limited driving range and higher cost of the Li-ion batteries are serious impediments for their use in electric vehicles. The commenter explained that high energy density electrode materials will result in improved specific energy for Li-ion cells, increased driving range for the vehicle, as well as reduced overall cost for the battery. The state-of-the-art cathode materials provide capacities of only ~160 mAh/g, which are about half of the capacities possible from the carbon anodes. The reviewer confirmed that the battery research community needs to develop new cathode materials, based on basic understanding of these materials, as is being addressed by this project.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer proposed increasing the funds for such a high-powered group.

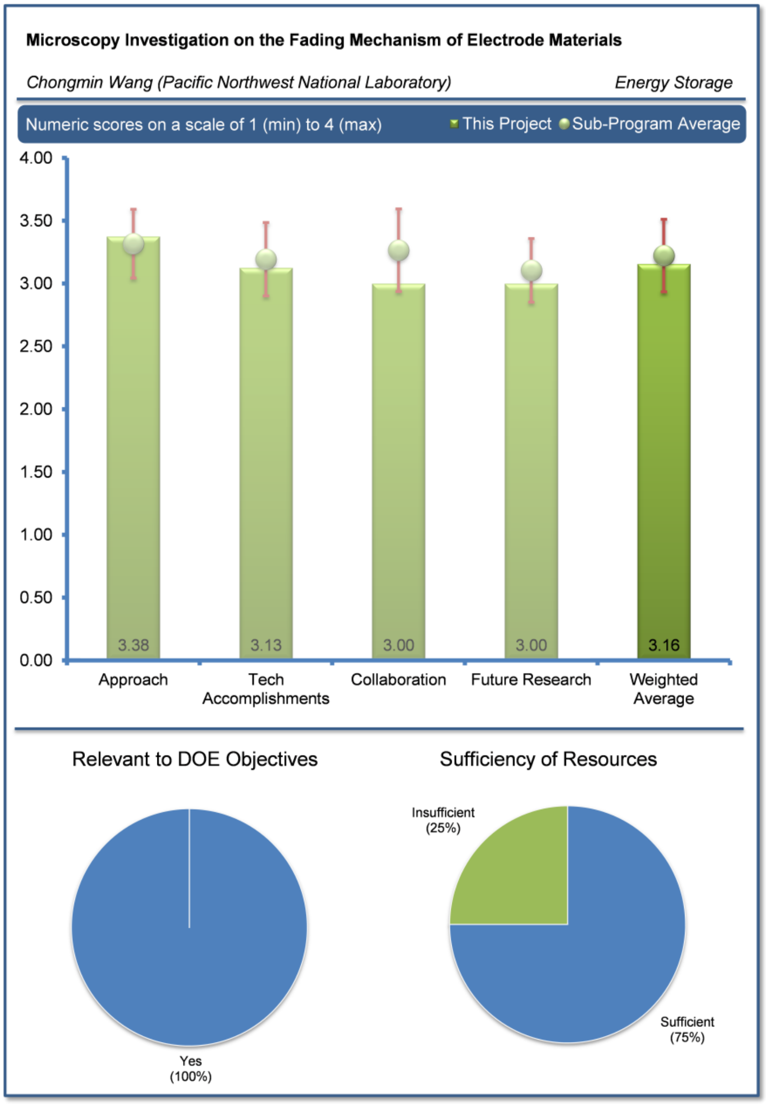
Reviewer 2:

The reviewer said that the resources are adequate for the scope of the project.

Reviewer 3:

The reviewer said that for now, resources were adequate.

Microscopy Investigation on the Fading Mechanism of Electrode Materials: Chongmin Wang (Pacific Northwest National Laboratory) - es226



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that it was good to see the atomic level dynamics. However, the information obtained may be too local to make strong connection with the ensemble behavior of particles in the electrochemical condition that contains highly convolved surfaces, interfaces, crystalline faces, etc.

Reviewer 2:

The reviewer said that the PI proposes to use TEM, EELS, and EDS to study advanced electrode materials. The reviewer added that the use of in situ cells made this work more interesting.

Reviewer 3:

This reviewer observed that the project had an interesting and innovative approach to try and get some in situ measurements of battery electrodes and their interfaces.

Reviewer 4:

The reviewer commented that the development of in-situ method of studying active materials during electrochemical changes could yield important information about the mechanisms for degradation reactions as well as structural changes occurring during the cycling of the material.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

According to this reviewer, the project’s accomplishments and progress seemed to be going well. The reviewer thought that there was nice in situ TEM work. Then the reviewer added that it would be good if the method could be used to study the SEI formation in terms of organic species from the electrolyte; the reviewer was not sure if this was really possible with the window used.

Reviewer 2:

The reviewer commented that the development of the operando TEM liquid electrolyte cell is a real step forward. The studies of lithiated silicon coated with conductive polymer and the lithium manganese rich cathode material are good demonstrations of the technique. The reviewer would have liked to see better definition of the materials studied in future presentations, however. The specific conductive polymer is quite important to the operation of the electrode, but no definition of the polymer used is given. Also, the reviewer added that the physical parameters of the cathode material are quite important to function.

Reviewer 3:
The reviewer said that the PI had conducted many microscopy studies on both advanced anode and cathode materials and electrodes. The reviewer especially liked the in-situ cell development.

Reviewer 4:
This reviewer noted that the Si is wrapped with conductive polymer, and wanted to know what the volumetric capacity was. The reviewer then commented that the TEM images showed that a very small fraction was Si (Slide 7). The reviewer continued to say that the correlation between Ni segregation with capacity fading in the Li excess materials was good. The EDS image on crack formation did not support that atom segregation is responsible and asked if the two were related.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
This reviewer observed that the collaborations were well established.

Reviewer 2:
This reviewer said that the collaboration and coordination with other institutions looked good.

Reviewer 3:
The reviewer said that the PI had established many collaborations.

Reviewer 4:
This reviewer stated that this was more of a stand-alone method development project, but it would seem to overlap a bit with some of the X-Ray techniques being used by BNL to study surface and bulk electrode compositions. The reviewer then suggested maybe talking to BNL, if it has not already been done.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer observed that the plans for things to study looked fine.

Reviewer 2:
The reviewer observed that the PI proposed more diagnostic studies and added that it would be interesting to see what guidance the PI gave on improving the electrode materials.

Reviewer 3:
This reviewer suggested considering benchmarking with other materials.

Reviewer 4:
This reviewer would have liked to see an emphasis on solving real problems with the technique such as voltage fade in lithium manganese rich materials and inefficiency if cycling lithiated silicon.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
According to this reviewer, this project could become a very useful tool in addressing fundamental studies of electrode interfaces and electrode/electrolyte reactions.

Reviewer 2:
The reviewer discussed that the PI's choice of electrode materials studied made this project relevant.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer was not sure how the project was being conducted on the stated funds.

Acronyms and Abbreviations

Acronym	Definition
3D	Three Dimensional
ABR	Advanced Battery Research
AC	Alternating current
Ah	Ampere-hour
ALD	Atomic Layer Deposition
AMR	Annual Merit Review
ANL	Argonne National Laboratory
ARK	Abuse Reaction Kinetics
ARL	Army Research Lab
ATR	Attenuated Total Reflectance
BATT	Batteries for Advanced Transportation Technologies
BMS	Battery Management System
BNL	Brookhaven National Laboratory
C	Carbon
CAD	Computer-aided design
CAE	Computer-aided engineering
CAEBAT	Computer-aided engineering of batteries
CAMP	Cell Analysis, Modeling, and Prototyping
CATARC	China Automotive Technology and Research Center
CEI	Cathode electrolyte interphase
CMC	Carboxymethyl Cellulose
CNT	Carbon Nanotubes
Co	Cobalt
Cr	Chromium
CSTR	Continually stirred tank reactor
Cu	Copper
DEDOHC	Dioxohexane dicarboxylate
DFT	Density Functional Theory
DOE	Department of Energy
DSC	Differential Scanning Calorimetry
EC	Ethylene Carbonate
ECT	Electrochemical-Thermal Coupling
EDS	Energy Dispersive X-ray Spectroscopy
EELS	Electron Energy Loss Spectroscopy
EIS	Electrochemical Impedance Spectroscopy
EPR	Electron Paramagnetic Resonance
EV	Electric Vehicle
EXAFS	Extended X-ray Absorption Fine Structure
F	Fluorine
FCG	Full concentration gradient
Fe	Iron

Acronym	Definition
FEC	Fluorinated ethylene carbonate
FTIR	Fourier Transform Infrared Spectroscopy
FY	Fiscal Year
GM	General Motors
HCMR	High capacity manganese rich
HEV	Hybrid Electric Vehicle
HR	High-resolution
HRSXRD	High-resolution Synchrotron X-ray Diffraction
HRTEM	high-resolution transmission electron microscopy
HVE	High-voltage fluorinated electrolyte
HVM	High-volume Manufacturing
IE	Ion exchange
INL	Idaho National Laboratory
IR	Infrared
JCI	Johnson Controls, Inc.
LBNL	Lawrence Berkeley National Laboratory
LCO	Lithium Cobalt Oxide
LEESS	Lower-Energy Energy Storage System
LFO	Lithium Iron Oxide
LFP	Lithium Iron Phosphate
Li	Lithium
Li_2MnO_3	Lithiated transition metal oxides
LIB	Lithium Ion Battery
LiBF4	Lithium tetrafluoroborate
LiBOB	Lithium bis(oxalato)borate
LIBS	Laser-induced breakdown spectroscopy
Li-ion	Lithium Ion
LiPF6	Effective electrolyte salt for lithium-ion battery
LiPON	Lithium Phosphorous Oxynitride
LiTFSI	Lithium Bis(Trifluoromethanesulfonyl)Imide
LL	Layered lithium
LLC	Layered-layered spinel composite
LMNO	Ni-substituted manganese spinel oxides
LMO	Lithium Manganese Oxide
LMR	Lithium Manganese Rich
LT	Low Temperature
Mg	Magnesium
MIT	Massachusetts institute of Technology
Mn	Manganese
NaOH	Sodium hydroxide
NCA	Battery cathode material (nickel cobalt aluminum oxide)
NCM	Nickel Cobalt Manganese
NERSC	National Energy Research Scientific Computing Center

Acronym	Definition
NDE	Non-Destructuve Evaluation
Ni	Nickel
NMC	Nickel Manganese Cobalt oxide
NMP	N-Methylpyrrolidone
NMR	Nuclear Magnetic Resonance
NP	Nail penetration
NREL	National Renewable Energy Laboratory
O_2	Oxygen
OAS	Open architecture standard
ORNL	Oak Ridge National Laboratory
P	Phosphorous
PAN	Polyacrylonitrile
PCA	Principal component analysis
PEV	Plug-in Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
PI	Principal Investigator
PRC	People's Republic of China
PVDF	Polyvinylidene difluoride
QC	Quality Control
R&D	Research and Development
ROM	Reduced-Order Models
Ru	Ruthenium
S	Sulfur
Sb	Antimony
SEI	Solid Electrolyte Interface
SEM	Scanning Electron Microscope
SFG	Sum frequency generation
Si	Silicon
Sn	Tin
SNL	Sandia National Laboratory
SOC	State of Charge
STEM	Scanning transmission electron microscopy
TEM	Transmission Electron Microscope
Ti	Titanium
TM	Transition Metal
TMA	Tri Methyl Aluminum
TXM	Transmission x-ray microscope
USABC	US Advanced Battery Consortium
USCAR	U.S. Council for Automotive Research
V	Volts
VC	Vinylene Carbonate
VTO	Vehicle Technology Office
XANES	X-ray Absorption Near Edge Spectroscopy

Acronym	Definition
XAS	X-ray Absorption Spectroscopy
XPS	X-ray Photoelectron Spectroscopy
XRD	X-ray Diffraction (Crystallography)
XRF	X-ray Fluorescence

3. Advanced Power Electronics and Electrical Machines Technologies

Advanced power electronics and electric motors (APEEM) that make up vehicles' electric drive system are essential to hybrid and plug-in electric vehicles. As such, improvements in these technologies can substantially reduce petroleum consumption in transportation, and help meet national economic, environmental, and energy security goals. Hybrid electric vehicles (HEVs) can reduce petroleum use compared to average conventional vehicles by as much as 50%, while plug-in electric vehicles (PEVs) extend these savings even further. The Vehicle Technologies Office (VTO) supports research and development to reduce the cost and improve the performance of innovative electric drive devices, components, and systems.

VTO's long-term R&D strategy recognizes that reducing the cost of electric drive is essential for consumer adoption. Because technology breakthroughs are necessary to achieve R&D goals, VTO funds research on APEEM to:

- Reduce cost, weight, and volume
- Improves performance, efficiency and reliability
- Develop innovative modular and scalable designs
- Improve manufacturability and accelerate commercialization

These improvements will help DOE meet the EV Everywhere Grand Challenge goal of making the U.S. the first nation in the world to produce plug-in electric vehicles by 2022 that are as affordable for the average American family as today's gasoline-powered vehicles.

VTO funds research to advance electric drive technologies in two key areas:

- power electronics
- electric motors

Within these areas, research efforts focus on:

- Wide bandgap (WBG) devices for power electronics
- Advanced motor designs to reduce or eliminate rare earth materials
- Novel packaging for power electronics and electric motors
- Improvements in thermal management and reliability
- Integration of power electronics functions

In addition, VTO is also supporting research on propulsion materials to lower barriers to advanced power electronics and electric motors that face specific material limitations.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Susan Rogers (U.S. Department of Energy) – ape000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer commented yes.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer remarked yes, the program area and strategy were adequately covered. However, it would be helpful to include a couple of overview charts including all of the relevant U.S. Department of Energy (DOE) cost, power density and performance metrics for the motor and power electric systems under development.

Reviewer 4:
The reviewer said yes, there are specific targets for inverter and motor in terms of cost. However, the reviewer would like to know where the cost targets for the converter and charger are.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer responded yes, and observed a good balance between national laboratories, academics, industry and federal agencies.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer said yes, and recommended that DOE Vehicle Technologies Office (VTO) funding to DOE labs should have end applications and should be driven with this as one of objectives. The reviewer commented that even if it takes one or two more years for the project to complete, however, having the deployment of the developed technologies to end applications followed by commercialization could bring better results in long-term.

Reviewer 4:
The reviewer commented yes, the program appears to have an appropriate balance between near-, mid-, and long-term research and development (R&D) objectives. To accentuate this, the reviewer suggested an additional chart that bins the ongoing projects into these categories would be helpful during the presentation or as supplemental information to the reviewers.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer commented yes.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer summarized that the important issues and challenges included the adoption of Wide Bandgap (WBG) solutions, reduction of rare earth metals, improved performance metrics, and reduced cost of electric drive systems. The challenges also included packaging, thermal management, and reliability improvements.

Reviewer 4:
The reviewer noted that the presentation identified as areas of increased emphasis of WBG devices and reduction or elimination of rare earth magnetic materials. Cost is the biggest challenge, with technologies identified to reduce cost. For this reviewer, the incumbent, off-roadmap, technologies would be of interest to learn more about (e.g., determine their importance).

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer commented yes.

Reviewer 2:
The reviewer stated yes.

Reviewer 3:
The reviewer said yes.

Reviewer 4:
The reviewer commented that although the overview presentation did not address solutions to each of the challenges, the projects included in the program address many of these challenges. Projects in other areas, however, are also complementary to these issues. The reviewer suggested that a chart describing the challenges, showing which specific projects address each challenges would be beneficial to the audience. The reviewer believed that it would be good if the chart included the complementary projects managed by the other areas.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes, and commented that today's specific costs and targets were presented with the targets for 2020 and 2022 used for comparison.

Reviewer 3:
The reviewer observed that fiscal year (FY) 2013 progress was highlighted, but not in detail. From the two progress charts, it was difficult for this reviewer to extract significant improvements from the prior year. The slides did not emphasize all of the progress during the year.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:
The reviewer said that technologies have been identified to lower the cost size and weight of transportation power electronics. Lower cost, smaller size and weight power electronics is an enabler for electric drive vehicles (EDVs), which will reduce our dependence on foreign oil.

Reviewer 2:
The reviewer commented yes, in the focus areas of electrical machines and power converters, these projects certainly address VTO's broad problems and barriers.

Reviewer 3:
The reviewer said yes.

Reviewer 4:
The reviewer said yes.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer said yes, and elaborated that Susan Rogers and Steven Boyd are well focused and are doing a great job managing the program and addressing VTO's objectives.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer commented yes.

Reviewer 4:
The reviewer stated yes.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
The reviewer identified as standouts those approaches that accelerate the manufacturing capability and mass production adoption of energy-efficient and cost-effective advanced power electronics and electric machine (APEEM) capacitor technologies into electric drive vehicles, such as electric vehicles (EVs), hybrid electric vehicle (HEVs), and plug-in hybrid electric vehicles (PHEVs). The reviewer identified as a standout the General Motors' (GM) program, and elaborated that GM is looking at applying technologies for future vehicles, which is an application of DOE developments. The reviewer also identified non-rare earth magnetic motors and the work at Ames National Laboratory, and elaborated that this future application will enable lower cost motors. Finally, the reviewer identified capacitors, and commented lower cost, smaller size and weight to enable lower cost, smaller size and weight power electronics.

Reviewer 2:
The reviewer commented yes, and elaborated that R&D work on high-temperature low-cost capacitors is suitable for silicon carbide (SiC)/gallium nitride (GaN)-based power electronics. The reviewer added that thermal management of inverter interconnects is very key to meet life, reliability and durability goals of power electronics parts and systems needed for vehicle applications, particularly for SiC/GaN inverter systems.

Reviewer 3:
The reviewer commented that the U.S. manufacturing of electric machines for the Chevrolet Spark EV that Susan highlighted is certainly a key success story for the program. The reviewer remarked that because many key HEV technologies are imported, it is great that a U.S. manufacturer has brought this technology in-house. The original equipment manufacturer (OEM) now has full ownership of the design and technology, and a complete understanding of the cost of this technology. Additionally, for this reviewer, it is a positive sign that production and sales of vehicles with this technology will increase in the near-term.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer said yes, and elaborated that the projects certainly explore novel methods to achieve their specific objectives.

Reviewer 2:
The reviewer commented yes.

Reviewer 3:
The reviewer stated yes.

Reviewer 4:
The reviewer said yes.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer said yes, and commented that the program area includes numerous key players from industry and national laboratories and appropriate partners from academia and federal agencies.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer commented yes.

Reviewer 4:
The reviewer said yes.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer said yes.

Reviewer 4:
The reviewer said yes, effectively. However, according to this reviewer, more could be done to bring the program area partners together to extend collaboration opportunities.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer did not observe any gaps.

Reviewer 2:
The reviewer commented that the EV roadmap developed by the Electrical and Electronics Tech team, which are mostly vehicle OEMs, provides the direction for what industry is looking for. The APE VTO group works to enable technologies that fill the gaps in the roadmap.

Reviewer 3:
The reviewer said this was not applicable.

Reviewer 4:
The reviewer remarked that thermal management of inverter interconnects is lacking. Thermal management of inverter interconnects is a must to meet life and reliability goals, particularly for WBG inverters. The reviewer expressed concern that the lack of this information

may pose barriers to industries to adopt WBG inverter technologies developed by DOE laboratories, such as Oak Ridge National Laboratory (ORNL) and the National Renewable Energy Laboratory (NREL). The reviewer concluded that inverter and power device packaging concepts need to be proven out in vehicle applications and must meet vibration, thermal/power cycling needs, and reliability goals.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer commented not observable.

Reviewer 2:
The reviewer noted that one of the key objectives in the overview included an integrated inverter into the motor housing. According to the reviewer, none of the projects seem to address this goal yet. It would be exciting to put together a partnering effort to fully explore this topic.

Reviewer 3:
According to this reviewer, maybe a slide on how the targets are set and who sets them, and the role of the EE Tech Team.

Reviewer 4:
The reviewer referenced comments in question number 12 addressing thermal management of inverter interconnects.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:
The reviewer did not observe other areas to consider funding.

Reviewer 2:
The reviewer did not observe other areas to consider funding.

Reviewer 3:
The reviewer suggested encapsulation and sealant material research to IEC, Underwriters Laboratory (UL) standards, and meeting high voltage product safety requirements for medium- and high-voltage electric drives.

Reviewer 4:
The reviewer suggested high frequency, high current magnetics.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:
The reviewer suggested an X-Prize approach for anyone who can demonstrate a process for growing a defect-free WBG wafer.

Reviewer 2:
The reviewer suggested that DOE-funded projects to DOE laboratories should be tied to end applications and that industry inputs should be collected at the start of the project rather than at a very late stage in the project. The reviewer believed that this would ensure that R&D activities undertaken by DOE laboratories are focused on applications and meet industry needs.

Reviewer 3:
The reviewer responded that this was not applicable.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer suggested that project duration should be made to five years, and that an entity who receives DOE funding should be mandated to commercialize developed technology if cost and performance targets are met. The reviewer added that cost and performance targets should be tracked closely from the very beginning of the project and may be audited by a third party that has no conflict of interest with the principle investigator (PI) and his/her organization and partners in the project.

Reviewer 2:

The reviewer suggested that the program could consider partnering with other program areas to further explore the electric drive system integration with its mechanical transmission. This integration is the key to successful commercialization of these technologies.

Project Feedback

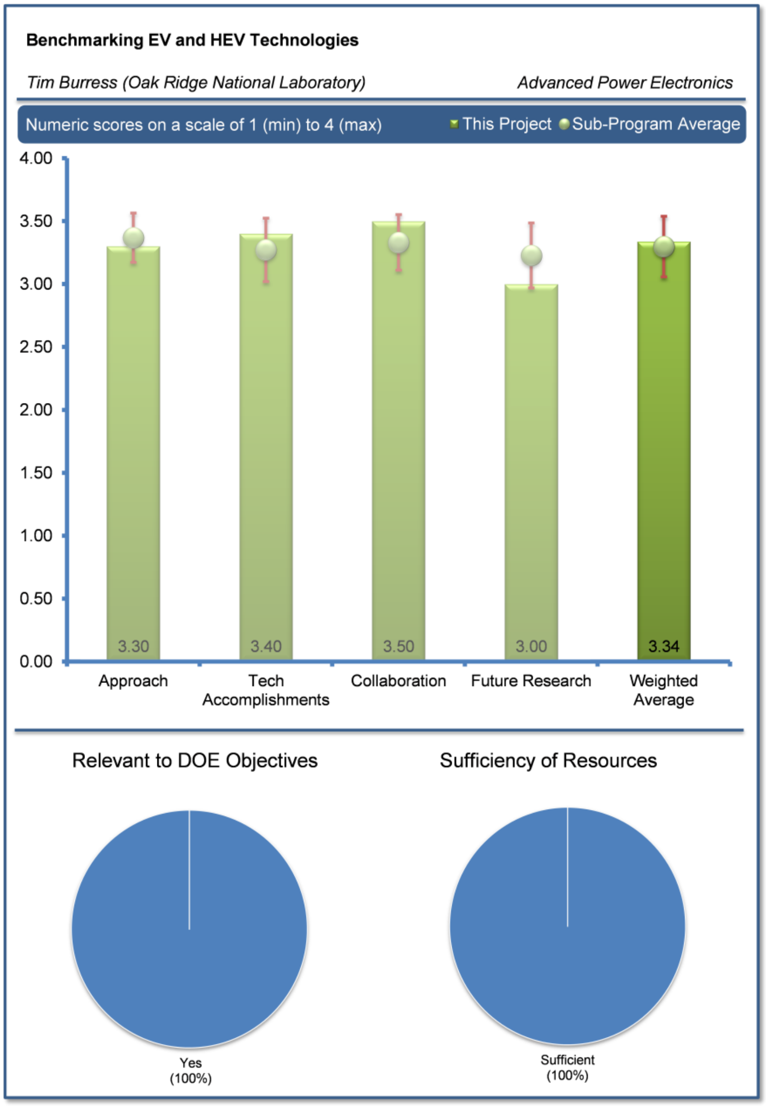
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† Benchmarking EV and HEV Technologies	Tim Burress (Oak Ridge National Laboratory)	3-11	3.30	3.40	3.50	3.00	3.34
Permanent Magnet Development for Automotive Traction Motors	Iver Anderson (Ames)	3-14	3.58	3.42	3.50	3.08	3.43
High-Temperature Air-Cooled Power Electronics Thermal Design	Scot Waye (National Renewable Energy Laboratory)	3-18	3.14	3.14	3.21	3.00	3.13
† Characterization, Modeling, and Reliability of Power Modules	Allen Hefner (National Institute of Standards and Technology)	3-22	3.42	3.25	3.08	3.08	3.25
Development of SiC Large Tapered Crystal Growth	Philip Neudeck (National Aeronautics and Space Administration)	3-25	2.83	2.33	2.67	2.50	2.52
North American Power Electronics Supply Chain Analysis	Christopher Whaling (Synthesis Partners)	3-27	3.70	3.50	3.70	3.40	3.56
Reliability of Electrical Interconnects	Doug DeVoto (National Renewable Energy Laboratory)	3-30	3.29	3.14	3.14	2.93	3.15
† Two-Phase Cooling of Power Electronics	Gilbert Moreno (National Renewable Energy Laboratory)	3-33	3.17	3.17	3.08	3.08	3.15
Next Generation Inverter	Sean Gleason (General Motors LLC)	3-36	3.30	3.20	3.60	3.40	3.30
Unique Lanthide-Free Motor Construction	Jon Lutz (UQM Technologies, Inc.)	3-39	3.20	3.20	3.30	3.20	3.21
Alternative High-Performance Motors with Non-Rare Earth Materials	Ayman El-Refaie (General Electric Global)	3-43	3.33	3.42	3.42	3.08	3.35
Power Electronics Packaging	Zhenxian Liang (Oak Ridge National Laboratory)	3-47	3.50	3.50	3.29	3.29	3.45
Inverter R&D	Madhu Chinthavali (Oak Ridge National Laboratory)	3-52	3.70	3.50	3.50	3.60	3.56
Converters and Chargers	Gui-Jia Su (Oak Ridge National Laboratory)	3-55	3.33	3.33	3.33	3.67	3.38
Advanced Low-Cost SiC and GaN Wide Bandgap Inverters for Under-the-Hood Electric Vehicle Traction Drives	Adam Barkley (APEI, Inc.)	3-58	3.50	3.63	3.38	3.50	3.55
High Temperature DC-Bus Capacitors Cost Reduction and Performance Improvements	Angelo Yializis (Sigma Technologies International)	3-61	3.50	3.25	3.38	3.38	3.34
High Performance DC Bus Film Capacitor	Dan Tan (GE Global Research)	3-64	3.25	3.25	3.50	3.38	3.30
Cost-Effective Fabrication of High-Temperature Ceramic Capacitors for Power Inverters	Balu Balachandran (Argonne National Laboratory)	3-67	3.38	3.13	3.50	3.25	3.25

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Scalable Non-Rare Earth Motor Development	Tim Burress (Oak Ridge National Laboratory)	3-70	3.50	3.30	3.30	3.40	3.36
† Performance and Reliability of Bonded Interfaces for High-Temperature Packaging	Doug DeVoto (National Renewable Energy Laboratory)	3-73	3.33	3.25	3.17	3.17	3.25
Convective Cooling and Passive Stack Improvements in Motors	Kevin Bennion (National Renewable Energy Laboratory)	3-76	3.50	3.42	3.42	3.42	3.44
Overall Average			**3.37**	**3.27**	**3.33**	**3.23**	**3.30**

Note: † denotes poster presentations.

Benchmarking EV and HEV Technologies: Tim Burress (Oak Ridge National Laboratory) - ape006



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that this project helps with program planning and the establishment and verification of all DOE 2020 targets. The reviewer also noted that this program was well-focused on the barriers and targets.

Reviewer 2:

The reviewer acknowledged that the benchmarking effort allows the U.S. industry to understand the current suppliers' capability and also helps to set up the next generation design target.

Reviewer 3:

The reviewer applauded the excellent approach and work; adding that it was nice that the researchers showed the history and progression from previous years (FY 2008) to the current work (FY 2013). The reviewer also mentioned that incorporating an evaluation of not just main inverter, but also the recent charger developments, was a nice benefit and addition.

Reviewer 4:

The reviewer said that it seemed like a good approach; although widespread dissemination of the data was important, but it did not seem to be a priority.

Reviewer 5:

The reviewer commended that PI had done an excellent job of examining the performance and operational characteristics during teardown of sub-systems. However, the reviewer cautioned that the team overall was not doing well to conduct a more valuable analysis for assessing design, packaging, and fabrication innovations. For example, the team observed that the 2013 Toyota Camry powertrain control unit power density and specific power were the highest without conducting further root cause analysis. The reviewer concluded by stating that in short, the team had done a great job for the second overall objective, but not so well for the first and third objectives.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that this work provided a valuable benchmark for progress towards the DOE goals.

Reviewer 2:

The reviewer commented that the comparison of DOE targets, over the time of the various teardowns, was well done and provided an evolution of the technology.

Reviewer 3:

The reviewer observed very nice work here; however suggested that additional inputs on specific barriers and opportunities for R&D work would additionally compliment this area.

Reviewer 4:

The reviewer praised that the team had done a great job for the second overall objective described in Slide 3, but not so well for the first and third objectives.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer asserted that the work seemed well-integrated with other efforts at ORNL and at other national laboratories. The reviewer, however, suggested that it would be valuable to release data more widely.

Reviewer 2:

The reviewer noted the nice expansion in this area. The reviewer also mentioned the modeling work and that the presenter highlighting opportunities was a well-stated need. The reviewer suggested that perhaps more input from component suppliers could be sought, although the reviewer presumed this had been pursued and suppliers were hesitant to provide detail on new products or products in development. Instead, the reviewer suggested that if a product was in production, however, there should be less to protect as global reverse engineering would be possible after these products were sold to the general public.

Reviewer 3:

The reviewer emphasized that it required many skill sets to reverse engineer the controls and the hardware to allow testing and analysis of someone's else hardware; however the team that is brought together gets the job done. The reviewer also suggested that perhaps there could be some leveraging by using some of the work that is being done by commercial teardown facilities, like a2mac (there are others) to do the teardowns. This would allow ORNL to focus more of the work on the analysis and controls of the hardware. This person noted that the question that would need to be answered if the commercial teardown information could be provided to a wider audience.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed that the project seemed to be very well-aligned, and also pointed out that the BMW i3 looked to be a nice candidate for evaluation. The reviewer looked forward to next year's presentation.

Reviewer 2:

The reviewer described that the next steps appeared to be looking at whatever came next, from a non-American vehicle original equipment manufacturer (OEM). This person remarked that it would be useful to have more of a strategy for what gaps needed to be addressed, though. The reviewer inquired about what is most valuable to learn next, rather than what is available next.

Reviewer 3:

The reviewer noted that the future work is a continuation of the present work. However, the reviewer highlighted that the relevance statement on the summary slide indicates that the core function of this project is to confirm power electronics and electric motor technology status and identify barriers and gaps to prioritize/identify R&D opportunities. The reviewer noted that, although barriers and targets were seen, this reviewer did not see a Barriers and Gaps slide. Furthermore, this reviewer reported that no gaps were mentioned.

Reviewer 4:
The reviewer commented that there is no plan to conduct more valuable analysis other than simply teardown and do some measurement.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that understanding the factors which will reduce cost of EDV will lead to greater sales of these vehicles, and thereby decrease petroleum use.

Reviewer 2:
The reviewer highlighted that the work was very relevant and well-presented. The reviewer noted that the material shows a living timeline of the technical milestones and industry offerings that are relevant to this work.

Reviewer 3:
The reviewer asserted that knowing the state-of-the-market of transportation power electronics helps to establish targets of where the technology is going, and how fast it is changing. The reviewer explained that this helps the recipients to know this information to improve their hardware and to better compete in the marketplace by improving and lowering the cost of their products to enable the EDV marketplace.

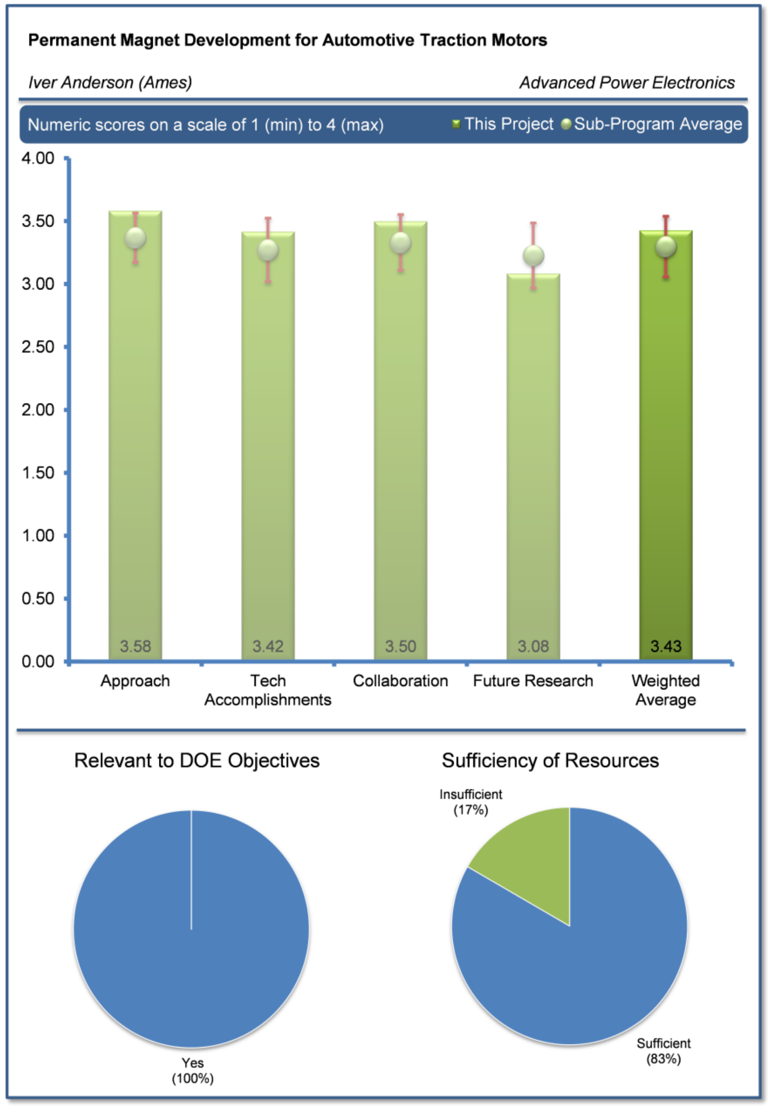
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that this was not discussed specifically, but the resources seemed to be sufficient.

Reviewer 2:
The reviewer explained that it requires many skillsets to reverse engineer the controls and the hardware to allow testing and analysis of someone’s else hardware; the team that is brought together gets the job done.

Reviewer 3:
The reviewer noted that the resources are well-suited to the tasks and that the use of the national laboratories seems to be well-aligned. The reviewer suggested that additional industry resources would be an excellent addition, but the hesitancy of industry participants is well-understood. The reviewer looked forward to next year's presentation.

Permanent Magnet Development for Automotive Traction Motors: Iver Anderson (Ames) - ape015



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

Although this reviewer cannot evaluate this project from the perspective of a materials expert or metallurgist (which this reviewer is not); the reviewer spent time researching the subject matter in brief prior to the review and saw the technical approach and diligence to this effort to be beyond extraordinary. The reviewer asserted that the PI's depth of knowledge is truly exceptional.

Reviewer 2:

The reviewer noted that the approach thus far has been to cast a rather broad net to look for permanent magnet (PM) improvements (low rare-earth [RE] content and short- and long-term zero-RE content magnets). The reviewer explained that the individual research areas within that effort have been both theoretical/computational and experimental which the reviewer thought has been an excellent approach, and very appropriate for this stage.

Reviewer 3:

The reviewer summarized that the project seeks to achieve comparable PM performance without use of RE materials. The reviewer noted that the following three paths were investigated: near-term RE magnets with reduced dysprosium (Dy); near-term non-RE magnets; and long-term non-RE magnets.

Reviewer 4:

The reviewer agreed that the research targets the appropriate tasks (i.e., heavy RE element elimination and non-RE activities). The reviewer noted that research in the AlNiCo area could yield useful materials if intrinsic coercivity is increased, even at the expense of residual induction and if these improvements are applicable to "motor-sized" magnets.

Reviewer 5:

The reviewer concluded that the team was doing an excellent job in a very fundamental research area for both simulation and testing. The reviewer suggested that the team be aware of the gap between simulation and testing in multi-scale (nano-, micro-, and macro-) levels, especially where direct testing is not possible. In addition, a great amount of process uncertainty (e.g., AlNiCo processing) should be considered and the influence to magnetic properties should be studied. Ideally, the team needs expertise in material uncertainty quantification and propagation analysis, and multi-scale model validation and verification, which will greatly help address the second and third remaining challenges shown in Slide 22. The reviewer offered that a recent publication (citation provided below) could be a good reference for addressing this issue. The papers' authors studied the gap between simulation and testing for mechanical properties of the carbon nanotube by considering the material processing uncertainty. The reviewer suggested that although the research was not for coercivity analysis, the idea in that paper could be adopted in this project. However, the reviewer acknowledged that given the remaining time left for this project (September 2014 finish), it seemed impossible to address the remaining challenges. This reviewer also provided the following reference: Xi & Youn, Predictive carbon nanotube models using the eigenvector dimension reduction (EDR) method, Journal of Mechanical Science and Technology 26 (4), 1089-1097, 2012.

Reviewer 6:

The reviewer explained that anisotropic die-upset neodymium-iron-boron (Nd-Fe-B) magnets can reach a $(BH)_{max}$ of slightly above 40 megagauss-oersteds (MGOe). In comparison, sintered Nd-Fe-B can reach $(BH)_{max}$=52-54 MGOe and Hci=12 kOe without any dysprosium (Dy) addition. The die upset magnets have a higher temperature coefficient of coercivity than the sintered counterparts. A possible increase in Hci due to the nanocrystalline structure in die upset magnets is counterbalanced by the platelet shape of the grains with an out of plane texture. The reviewer commented that an Hci of less than 10 kOe for compositions, even containing 1.3 wt% or 3 wt% of Dy, is not particularly notable. The reviewer stated that this low Hci juxtaposed with the loss of squareness of the demag curve in the magnet samples with less Dy results in a rather low $(BH)_{max}$ of 17.2 MGOe. The reviewer offered that it would be interesting to know the value of the saturation magnetization since the remanence is low. In other words, the reviewer wanted to know if this single stage hot deformation of Nd-Fe-B induced a good texture without requiring the intermediary hot pressing step. The reviewer observed that the role of zinc (Zn) in increasing the coercivity seemed interesting to be explored. The reviewer also thought it would be interesting to know what the mechanism of Zn migration to the grain boundaries was (for example, could it be via Nd-rich phase, or could it be squeezed out.). The reviewer also wondered what the mechanism was under which the coercivity is maintained at the same value when decreasing the Dy content from 3.0 wt% to 1.3 wt%. The reviewer cautioned that prediction of high coercivity in AlNiCo for Fe-Co (or rather Fe or Co as shown for the zero-temperature case in the presentation slides) rod diameter below 20 nm may be difficult to put in practice due to the difficulty of prediction of optimum magnetic annealing temperature. The reviewer suggested that using a gas-atomized powder precursor should prove to have a significant advantage over the conventional process, in order to economically produce new grades with better performance.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that the results to date have given a good understanding of underlying mechanisms for coercivity in AlNiCo magnets, and potential paths forward for new alloys and processing.

Reviewer 2:

The reviewer commented that some targets that were established during the last meeting (e.g., 300% AlNiCo coercivity improvement) have not been achieved and that the bar has been lowered. The reviewer acknowledged that this was the nature of advanced science, but stated that it was still disappointing to those who would be able to make good use of these achievements. This reviewer still applauded the focus and work on the right goals, and that the researchers' understanding that stretch goals were inherently difficult to achieve.

Reviewer 3:

The reviewer noted that this effort has resulted in new methods for improving PM materials. The reviewer pointed out that the progress related to AlNiCo 8H coercivity was very encouraging and that the specialized annealing/heat treatment profiles that were developed for AlNiCo 8H show promise to further improve the material's magnetic properties. The reviewer also asserted that the new electric machine designs, optimized for the low coercivity properties of AlNiCo, from the project partners are also an outcome of this research. This person acknowledged that the project has resulted in an impressive number of technical publications. The reviewer questioned, with the project nearing completion (96%) combined with previous years of funding, whether any of the project findings have been transitioned to commercial PM production processes.

Reviewer 4:

The reviewer reported that the technical milestones for the magnetic performance of the new magnets to be developed were not very well-defined. The reviewer commented that milestone for 2014 on AlNiCo were reported on schedule, and seemed to be towards the main goal of maintaining, or enhancing, the performance of AlNiCo 8 at a 30% reduction in cost associated with a 40% reduction in Co content. The reviewer described that the magnetic performance reported is promising, if it is for the composition with 40% less Co. Good progress has been made towards enhancing the coercivity and energy product, although not yet at the level of the commercial magnets. Demag curve tests at higher temperatures would have been useful in assessing the thermal stability of the AlNiCo samples with the highest coercivity. The reviewer explained that it would have been good to have known the size of the magnet samples and the level of result reproducibility. This person also thought that a more clear correlation between the microstructure, processing conditions, and the achieved magnetic properties would have given a clearer picture on the feasibility of reaching the desired optimum microstructure.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer expressed that there appeared to be very good communication with both industrial and university partners, and a willingness to acknowledge and use progress from wherever it came. The reviewer also applauded that it was great to see the recognition given to all collaborators.

Reviewer 2:

The reviewer indicated that, apparently, there is core collaboration in this area, while respecting independent in the application between several of these DOE programs on this subject matter. The reviewer pointed out that this synergy is necessary to achieve the objectives in motor development.

Reviewer 3:

The reviewer observed that the engagement with formal and informal collaborators continues to be strong; also suggested that the researchers please continue to stay connected with industry.

Reviewer 4:

The reviewer described that there are several key partners in this work, including Arnold Magnetics, University of Nebraska-Lincoln, University of Maryland, and ORNL, as well as numerous industry and academic collaborators. The reviewer also mentioned that the project included annual Beyond Rare Earth Magnets workshops to share results and coordinate future research with the project collaborators.

Reviewer 5:

The reviewer suggested that it may be a good idea to analyze the spinodal decomposition mechanism when involving Fe_8CoMo phase, instead of FeCo, and to also model the extrinsic magnetic properties of such a morphology (i.e., FeCo rods replaced by Fe_8CoMo with K~20- 30 miueV/atom, as determined by density functional theory and GA).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed with the overall recommendations for future work, emphasizing experimental verification of alloys/mechanisms suggested by computational models, and attention to bulk processes that would increase coercivity of AlNiCo on a macro-scale.

Reviewer 2:

The reviewer mentioned that the program was winding down and will hopefully continue through another program. The reviewer requested that if the work continues, to please continue working on AlNiCo and FeCo magnets, Co reduction, and to look at the mechanical properties associated with the research. The reviewer concluded by stating that improved AlNiCo mechanical properties (i.e., reduced brittleness) are desired.

Reviewer 3:

The reviewer stated that the FY 2014 future plans are comprehensive and very well-defined, as necessary, in order to assure a good progress for the project. The reviewer cautioned that the extent of these plans is significant, however, is far beyond one year given the achievements since the beginning of the project. The reviewer agreed with the previous reviews on the need for concrete target magnetic parameters, which can be formulated under different scenarios (e.g., [i] 40% reduction of Co and Fe-Co in new AlNiCo grade: Hci = x, BH_{max} = y, [ii] Fe_8CoMo with magnetocrystalline anisotropy instead of Fe-Co rods with shape anisotropy: Hci=x, BH_{max}=y, [iii] bulk $HfCo_7$ + Fe-Co: Hci = x, BH_{max} = y, and [iv] others).

Reviewer 4:

The reviewer summarized that the key challenge was identified that AlNiCo coercivity levels and maximum energy product values achieved are insufficient to permit AlNiCo magnet use in an advanced PM traction drive motor. Given that finding, the reviewer inquired about the values that would be required for adoption, and how closely the planned FY 2014 work would approach the needed metrics.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that PM motors are still the most efficient motor types, and high-energy PMs are the key components of these motors. The reviewer added that it has been well-documented that magnets using heavy REs (i.e., the current state-of-the-art) will soon be in short supply, so alternative and less expensive compositions and processes must be identified.

Reviewer 2:

The reviewer explained that dependence on heavy REs specifically, and all REs in general, may derail electrification activities if the sources of these materials are unstable.

Reviewer 3:

The reviewer indicated that the electrical machines that are developed that use this technology support further vehicle electrification and hybrid-electric applications, which will result in less fuel consumption. The reviewer explained that less RE content will significantly reduce the cost of advanced electric machines, which will contribute to increased adoption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources for this program are appropriate.

Reviewer 2:

The reviewer noted that this project is in its final year and has had very significant progress throughout its duration; a lack of resources was not apparent.

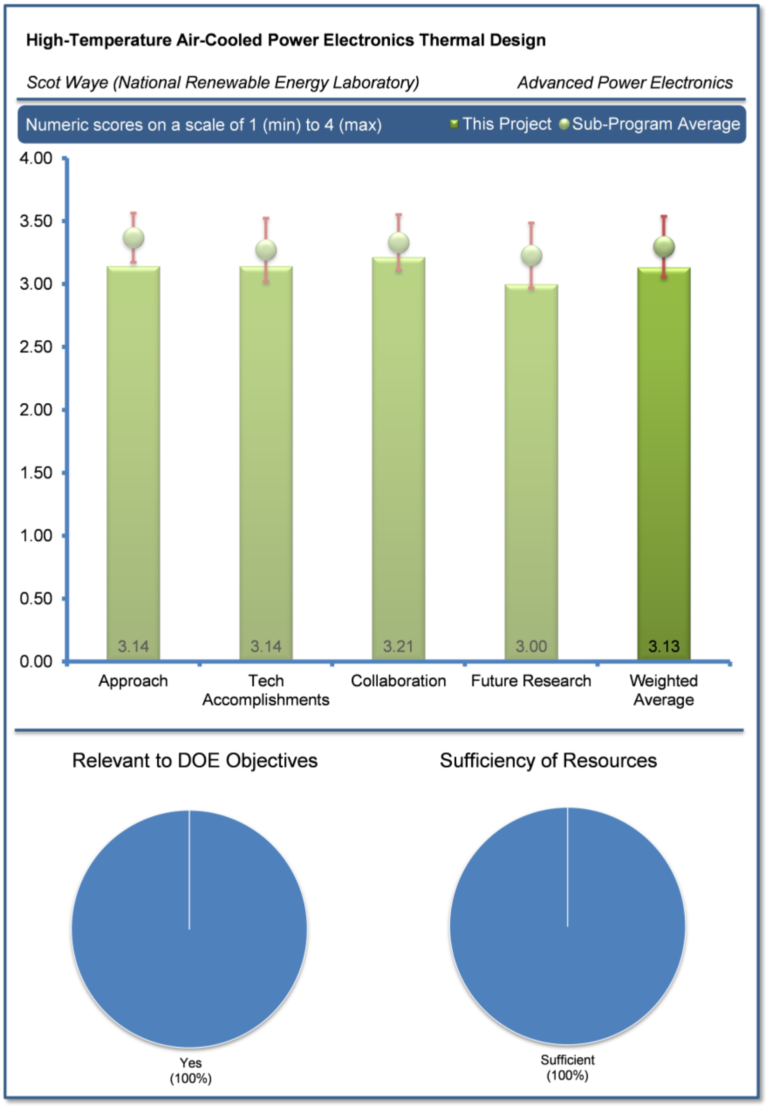
Reviewer 3:

The reviewer doubted that the stated future work will be accomplished within the remaining project time because this project is already 96% complete. The reviewer, however, thought the right collaborators were engaged.

Reviewer 4:

The reviewer pointed out that some of the tasks have been aborted due to insufficient funding. In this reviewer’s opinion, the funds for this extended project should have been sufficient, but the reviewer acknowledged not knowing the operating costs at the Ames Laboratory (Ames). The reviewer agreed that the team has the needed available infrastructure to perform the work.

High-Temperature Air-Cooled Power Electronics Thermal Design: Scot Waye (National Renewable Energy Laboratory) - ape019



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the scalability to higher power levels may have issues that were not well-identified here.

Reviewer 2:

The reviewer pointed out that the cooling approach was most relevant to power systems based on WBG devices and systems. This person also voiced that the issue of air filtration did not appear to have been addressed. Once addressed, the reviewer explained that there was a need to address intake air filtration requirements and the impact on the fan/blower power requirements. The reviewer suggested that it would be useful to have a cost comparison of a full-up air-cooled system versus a full-up liquid-cooled system where the cost for each system would include all components required to enable the cooling system. The reviewer inquired about the location of an air-cooled system under the hood and the air intake and discharge ducting issues for a vehicle.

Reviewer 3:

The reviewer agreed that the development of a 10 kilowatt (kW) (ORNL design) air-cooled (NREL design) inverter is good start, however the reviewer cautioned that its scalability for 30 kW (continuous) / 55 kW (peak) needs significant testing to meet the requirements of a commercial application. The peak loading duration (18 seconds) is known; however the frequency that this peak loading occurred at was not clear from the presentation or project report. The project evaluator also cautioned that the researchers, assuming that external ambient and/or cabin air shall be available for air-cooling, could place extra burden on cabin environment management systems and that customers may not be willing to accommodate required changes on vehicle platform. The reviewer did mention that the collaborative activities between NREL and ORNL could bring useful results.

Reviewer 4:

The reviewer agreed that the overall project goals were pertinent to DOE goals; however mentioned that the premise that air-cooling for work for high-power traction inverters in the underhood environment is of concern. The reviewer pointed out that the state-of-the-art slide indicated a single high-power inverter in a vehicle that was not in production, while one could look under the hood of any EV today and find liquid-cooled power electronics. The reviewer described that the use of air-cooling on lower power systems (with values under 15 kW) had been done with the electronics packaged in the trunk and having access to conditioned cabin air. The reviewer observed that the team had done a good job in identifying the advantages and disadvantages/challenges of air-cooling, but indicated the need to add audible noise control (not just the fan, but also the air ducting and exhaust) to the challenge list. The reviewer voiced that the specific goals identified for FY 2014 were very appropriate for this project. The reviewer added that a 10 kW power stage is achievable, and within the range that air-cooling makes sense, and could be used to obtain reasonable performance data for extrapolation to higher power levels.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated the technical details were well-presented.

Reviewer 2:

The reviewer applauded that proving out an air-cooled inverter that is projected to meet 2020 targets is commendable. The reviewer suggested that hot spots in the temperature profile of the 10 kW inverter's parts as a function of airflow rate should be useful data at 100%, 50%, and 25% of the peak rated loads. The reviewer explained that this data could be used for ANSYS simulation to produce the design data that is required to scale the power level to the targeted 30 kW (continuous) and 55 kW (peak) rating.

Reviewer 3:

The reviewer voiced that the analysis and modeling results showed promise for meeting the DOE goals based on the assumptions made. The reviewer was concerned with whether the assumptions are realistic and if the scaling from 10 to 55 kW is achievable. The reviewer remarked that the underhood environment of a hybrid vehicle, with the internal combustion engine operating, can be very hot and dirty at times, which will have a large impact on the quality of the cooling air available to an underhood mounted traction inverter. The reviewer suggested that this might be more appropriate for an EV which does not have an internal combustion engine to contend with. The reviewer acknowledged that the advances in the design of the heat exchanger and the module are excellent. One concern the reviewer noted was how the connections to the power in/out and the control signals would be made while still keeping the other parameters (e.g., inductance of the bus and attachment to the bus capacitor) acceptable. The reviewer suggested that one method could be to mount the bus capacitors on the bottom side of the heat exchanger in order to provide cooling for it.

Reviewer 4:

The reviewer suggested that the project could study different packaging alternatives, types of fans, and inverter/cooler interface options.

Reviewer 5:

In response, the reviewer inquired about the following: the inlet air design temperature (42.5°C or 45.0°C); the impact of higher inlet air temperature on system performance and electronic operating temperature; the maximum practical inlet air temperature; and the impact on power module life and reliability considering the range of air inlet temperature that would need to be accommodated (i.e., an Alaska winter operation versus a southern United States summer operation).

Reviewer 6:

The reviewer commented that the presentation was missing experimental data to support system level performance improvement over the liquid-cooled approach.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that collaboration among team members was very good and was encouraged to see the team reaching out to vehicle OEMs and Tier 1 suppliers regarding challenges/issues with air-cooling. Continued encouragement of this collaboration was expressed by the reviewer.

Reviewer 2:

The reviewer asserted that the collaboration between NREL and ORNL was great and commendable. This person also mentioned that an industrial partner could be desired to have to test verify the usefulness of developed 10 kW inverter with air-cooling.

Reviewer 3:

The reviewer suggested that the effort would benefit from the participation of an inverter manufacturer regarding air-cooling system design specification, packaging, and integration relative to the inverter electronic system. The reviewer also mentioned that the effort would benefit from the participation of a vehicle manufacturer regarding system specifications and under the hood integration (i.e., the reviewer wanted to know if there was adequate space within the engine compartment to integrate overall power module system).

Reviewer 4:

The reviewer noted the project team had a lack of collaboration with an automotive Tier 1 supplier and OEM.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer summarized that the PI identified the remaining challenges and barriers as including location of inverter under the hood. The reviewer noted that it would be a commendable accomplishment if this was achieved. The reviewer explained that power loss and thermal management requirements for inverter's parasitic losses were good objectives for future research.

Reviewer 2:

The reviewer asserted that if the air-cooled system proof-of-concept testing demonstrated that the approach could meet the program goals, then the future work should include an integrated air-cooled inverter system that is installed and tested in a vehicle.

Reviewer 3:

The reviewer reinforced that the researchers needed to address the potential issues with scalability to higher power levels.

Reviewer 4:

The reviewer noted that the researchers continuing to follow the plan should result in meeting the goals of the project. The reviewer commented that it will be difficult to meet the 12 kW/L goal with a 10 kW system when the estimates for the capacitor are greater than 1 L. However, the performance and packaging density required for a 55 kW can be extrapolated from the test results. The reviewer reported that building a system test bench and representative power modules will be a valuable step for providing data to support the final conclusions. The results of the parasitic loss testing on the new bench and the testing of the 10 kW power stage and finally an inverter will provide valuable insight into the future of air-cooled power electronics. The results of the parasitic loss testing on the new bench and the testing of the 10 kW power stage, and finally an inverter, will provide valuable insight into the future of air-cooled power electronics. The reviewer suggested the researchers should add some audible measurement capabilities and the ability to add duct work (versus flexible hose to direct the air flow) into the test bench design, but this could be done as a future project. The reviewer expressed interest in seeing an analysis of the efficiency predictions as a function of operating temperature. This would answer questions such as what happens to the losses as the device temperature exceeds 150°C and the cooling air temperature increases. The reviewer stated that interior air can be considered to be conditioned, but cautioned that it still gets quite warm when sitting in the sun with the vehicle off, so takes some time to cool to 25°C or so.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the work was consistent with DOE objectives.

Reviewer 2:

The reviewer indicated that efficient cooling is a major factor in the overall efficiency of EVs.

Reviewer 3:

The reviewer affirmed that if the packaging density and power density targets are met and the overall cooling system design is simplified, this could result in size and weight reductions of electric drivetrains for vehicle applications. This size reduction should result in fuel consumptions reductions over the life of the product.

Reviewer 4:

The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement as it was providing an alternate cooling method that may prove to be more cost-effective in some vehicle implementations.

Reviewer 5:

The reviewer explained that air-cooling was simpler than liquid-cooling, therefore there was cost saving benefits if it was proved to work.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

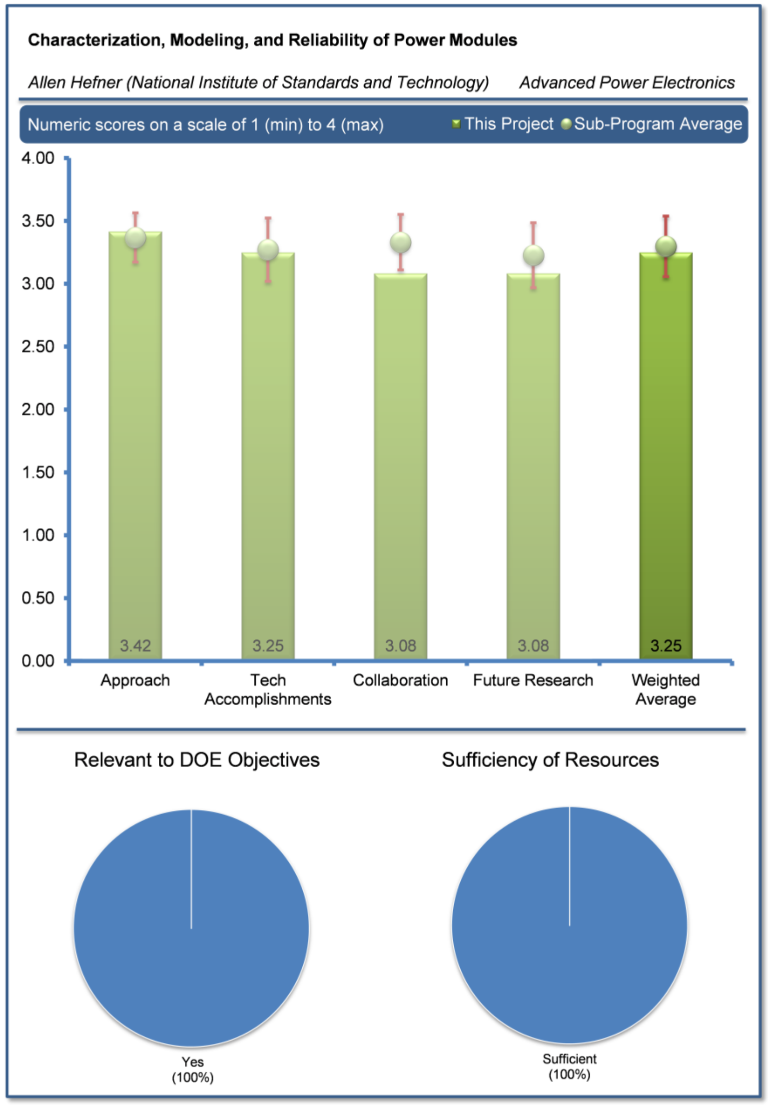
Reviewer 1:

The reviewer indicated that the resources had been sufficient for the project to date as the progress had been as planned.

Reviewer 2:

The reviewer indicated a desire to have an industrial partner to test the developed technology to verify the performance in a real-world application.

Characterization, Modeling, and Reliability of Power Modules: Allen Hefner (National Institute of Standards and Technology) - ape026



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

From the poster presentation, it appeared to this reviewer that the project tasks were on track and that the approach could overcome identified barriers.

Reviewer 2:

This reviewer noted that the project was well-designed, took advantage of existing simulation tools/methods, and was adding to the theoretical understanding of stresses acting upon power modules used in EV applications with a goal of improving the performance of these devices. The project was using two different power models for modeling and testing as well as investigating new measurement techniques and products.

The project plan is detailed enough that it was easy to see the interactions and was put together in a logical format. The plan plus the list of milestones/decisions enabled a better understanding of the tasks and progress being made on this project.

The projects goals were very noble and valuable, but to be useful to industry at large, they needed to be combined into an “analysis package” that could be used during the development of new power electronics. The reviewer said that hopefully the combination of this task and the NREL bonded interface material (BIM) task collaboration shown on the plan as future work for this year would be a start for this package.

Reviewer 3:

To this reviewer, the program was focused on developing modeling tools for inverters and converters. The reviewer added that it was unclear if the work would produce a computer design/simulation tool that could be used to evaluate different inverter and converter designs relative to performance and reliability.

Reviewer 4:

To this reviewer, validation work could be done in a significantly more systematical way rather than comparing the test measurement with simulation results. In addition, the reviewer was suspicious that the listed “validation results” may be calibration results, which means that some mysterious model parameters are tuned to fit the test measurement. For typical validation work, it is necessary to quantify the validity of the model, which is missing in this project. These issues are important because reliability analysis/prediction (Slide 26) relies on uncertainty characterization and quantification that comes from not only loading uncertainty (e.g., thermal cycling) but also parameter and model uncertainty. Otherwise, reliability prediction may not be actually credible. This reviewer also included the following systematic model validation references: Youn et al., 2011, A hierarchical framework for statistical model calibration in engineering product development, Computer Methods in Applied Mechanics Engineering; Xi et al., 2013, Model bias characterization in the design space under uncertainty, International Journal of Performability Engineering; and Xi et al., 2013, State of Charge Estimation of Lithium-ion Batteries Considering Model and Parameter Uncertainties, Annual Conference of the PHM Society.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed that the project had very good progress to date. Test data and simulation results matched, new test methods had been developed and models of the test fixture created. These advances had enabled characterization of two different module type's thermal performance during short circuit conditions. Basically, the goals of the project had been met per the plan – integration with the NREL package task in progress.

The reviewer added that the results to date indicate that this approach would be very useful during the early design phase of an EV power module/inverter development project. If this project was reduced to a set of analysis software with test equipment the reviewer believed it would significantly reduce the design iterations and/or over designing of the power module/cooling method interface and perhaps enable the optimum sizing of switching devices within the module thus reducing size and cost.

Reviewer 2:

This reviewer commented that thermal cross-coupling effects between devices in the power module packages could be quite useful for real-world application. Thermal network, parameter extraction, modeling and measurement related tasks and completion of these tasks is also quite useful if the developed method is adopted for design and performance verification in real-world applications.

Reviewer 3:

According to this reviewer, the presentation contained a significant amount of detailed information regarding the electro-thermal-mechanical modeling of power modules. It would be useful to show how the electro-thermal-mechanical simulation would be applied to the evaluation of a generic inverter or converter. It would be useful to show how the modeling would be used to conduct a trade-off study of a generic inverter or converter to support the assessment and optimization of electrical efficiency, package thermal performance, system reliability, and system cost.

Reviewer 4:

The reviewer noted that the project completed electro-thermal simulations of SiC WBG modules, which can be used to simulate computer designs.

Reviewer 5:

This reviewer stated that it would be good to benchmark the test data versus the simulation data in order to verify the effectiveness of the model.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer noted that the collaboration among team members was very good based on the results shown; it would have been rated excellent, but no reason was given for the deleted tasks.

Reviewer 2:

This reviewer observed that the project investigators at the National Institute of Standards and Technology had collaborated with Delphi on electro-thermal-mechanical tasks and planned to collaborate during the remainder period of the project with NREL on reliability aspects of the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer noted that significant work may be needed to complete the reliability investigation. This requires collaborative efforts with NREL and could fulfill project objectives to investigate module reliability.

Reviewer 2:
According to the reviewer, future work per the plan is needed to complete the goal of this project. Once the complete module can be modeled and performance simulated the addition of more capabilities per the proposed future work on a separate task would be valuable. The reviewer suggested to start implementation now of the last item on that slide (i.e., utilize the advanced technology electro-thermal network simulation tools developed by this project to support industry transition of the technologies into products).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This reviewer stated that the WBG SiC models would allow engineers to simulate designs before prototyping the circuits.

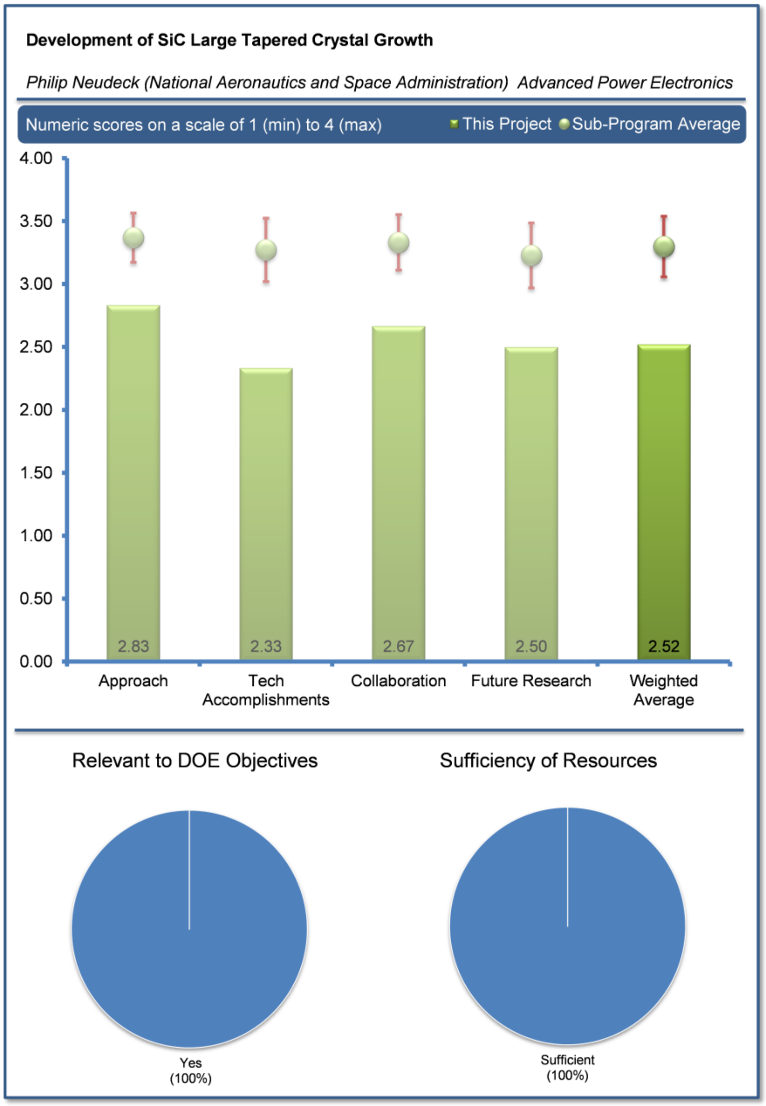
Reviewer 2:
This reviewer noted that if developed, the technology helps reduce electric-drivetrain costs and helps improve reliability of electric-drivetrain. This would result in adoption of electrified vehicle platforms, which directly and indirectly shall reduce consumption of petroleum fuel for transportation applications.

Reviewer 3:
This reviewer commented that this task was relevant to the stated DOE objective of petroleum displacement as it is has the potential to enhance the process of providing reliable and cost-effective high temperature power modules which would enable smaller, lighter, more efficient traction systems.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer stated that the resources have been sufficient for the project to date and the progress has been as planned.

Development of SiC Large Tapered Crystal Growth: Philip Neudeck (National Aeronautics and Space Administration) - ape027



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the project had encountered barriers.

Reviewer 2:

The reviewer indicated that the approach to improve the quality and reduce the cost of SiC was innovative.

Reviewer 3:

The reviewer explained that the goal of this project was very aggressive with very tough challenges to be overcome at the basic science level. Not being a device physicist, the reviewer stated that the researcher's approach seemed to be reasonable and logically-organized. The reviewer, however, noted that the project suffers from a very large technical challenge to overcome, especially when faced with issues that required a significant loss of time to implement corrective actions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that while the goals were not met per the original plan, significant progress had been made. The reviewer noted the addition of the thermal imaging within the chamber is outstanding and should allow a deeper understanding of the process. The reviewer agreed that the safety upgrades, while time consuming, were necessary and would provide a piece of mind during future efforts. The reviewer also remarked that progress towards understanding what is happening during the growth process was made, and added that alternative methods had been identified but the decision factors to implement these methods were not identified. In summary this reviewer believed that this project is making good progress based on the length of the project and the issues seen to date.

Reviewer 2:

The reviewer voiced that, as this is a high-risk R&D project, it is not surprising to find many technical challenges that cannot be solved in the project.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer affirmed that the collaboration team members appeared to be the correct ones, but suggested that perhaps it might be useful to seek input from commercial crystal vendors using similar processes. The reviewer was not sure how the potential lack of funding may impact this program.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project funding was complete.

Reviewer 2:

The reviewer expressed that the proposed future work aligned very well with the current progress and stated goals of this project. The next steps are a logical progression for continued development to take place. The proposed future work included a primary path as well as a back-up plan in case the primary did not provide the desired results – good planning. The reviewer remarked that there was good potential here if the National Aeronautics and Space Administration continued to provide support.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

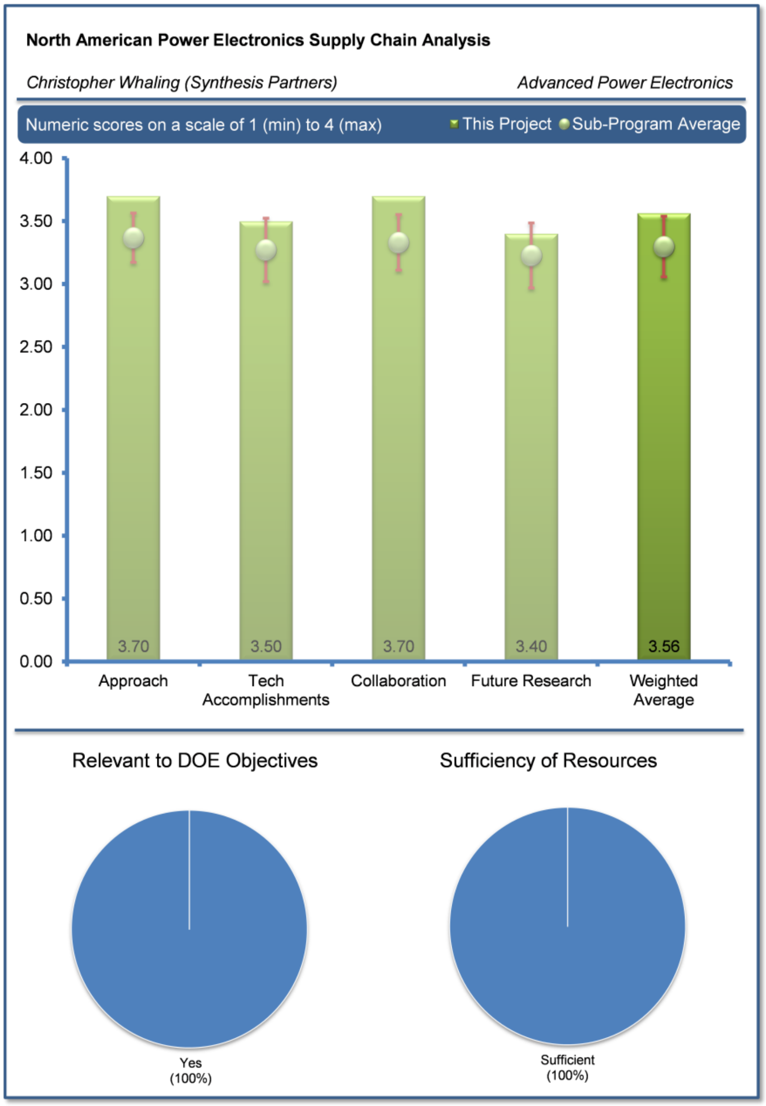
The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement as it addresses the basic component required to produce SiC devices at a reasonable cost. The reviewer explained that having a large defect-free crystal at a low price will directly result in a more cost-competitive SiC switch.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer indicated that the resources had been sufficient for the project to date, for the progress had been reasonable even with the setbacks due to safety issues. The reviewer suggested that additional resources may be required to make up for the lost time.

North American Power Electronics Supply Chain Analysis: Christopher Whaling (Synthesis Partners) - ape032



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach looked excellent for the application.

Reviewer 2:

The reviewer confirmed that the approach to the work was very solid considering the widely dynamic and constantly changing environment in which this work was being pursued.

Reviewer 3:

The reviewer pointed out that an interaction between all players was essential for all to achieve their individual goals.

Reviewer 4:

The reviewer agreed that using interviews with suppliers and OEMs and information from publications and analyzing that information to provide recommendations was a good approach.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer liked what was discussed, but noted that progress was not covered in much detail.

Reviewer 2:

The reviewer affirmed that a good amount of results were reported. The reviewer praised that the need to, and ability to, perform the networking and relationship building is non-trivial and difficult. So, overall good work in this area.

Reviewer 3:

The reviewer commented that it was essential to be able understand and facilitate information exchange and overcome impediments in developing and maintaining an industry.

Reviewer 4:

The reviewer said that the FY 2014 project presentation should contain some recent survey conclusions.

Reviewer 5:

The reviewer noted that progress looks encouraging regarding the Interim Report topic of identifying the supply base (to collect views and interviews). The reviewer asked whether the pie chart on the North American organizations could be further broken down by Tier and potential products (e.g., motors, inverters etc.),and then be broken down again into finer detail of components by products. The reviewer also inquired about power electronics companies that are not automotive suppliers who may have a technology for automotive power electronics, whether they are one of the lower Tier suppliers, and if they are included in the analysis.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated the collaboration looked great; this was a fundamentally collaborative project, and looked like this was being done well.

Reviewer 2:

The reviewer confirmed that the collaboration is excellent. This reviewer described that the number of contacts needed, the amount of information extracted, and the organization of the presentation material seemed to be the highlight of this work.

Reviewer 3:

The reviewer commented that collaboration required an understanding on both sides of the table; this means further cooperation is essential.

Reviewer 4:

The reviewer highlighted that this project had participation with numerous partners and institutions.

Reviewer 5:

The reviewer voiced that it appeared that the researchers are collecting information from many sources from the automotive supply base.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer reported that the future work is a continuation of the ongoing work.

Reviewer 2:

The reviewer requested the researchers and DOE to please continue this work. The reviewer explained that more challenges lay ahead in the area of gathering material in the intellectual property intensive space of WBG development. The reviewer added that this work was highly confidential and intensely competitive, both technically and commercially.

Reviewer 3:

The reviewer indicated that in order for the U.S. to take advantage of the power of its people, cooperation is essential. This implies that collaboration between two complimentary groups results in a significant ability to solve problems and identify new processes, while any animosity or perceived threat can be disastrous.

Reviewer 4:

The reviewer described that it appeared that the main proposed future work was for the completion of the project.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that reducing costs of EDVs will reduce petroleum displacement.

Reviewer 2:
The reviewer agreed that the work was very relevant and badly needed. The U.S. industry and technical presence is the area where the DOE has placed priority; therefore, this work was very relevant.

Reviewer 3:
The reviewer commented that cooperation is essential.

Reviewer 4:
The reviewer agreed that this project was very relevant to EVs, and that the project's conclusions would help to determine where additional focus was required.

Reviewer 5:
The reviewer explained that improving the supply base offered more choices for lower cost power electronics to enable EDV adoption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

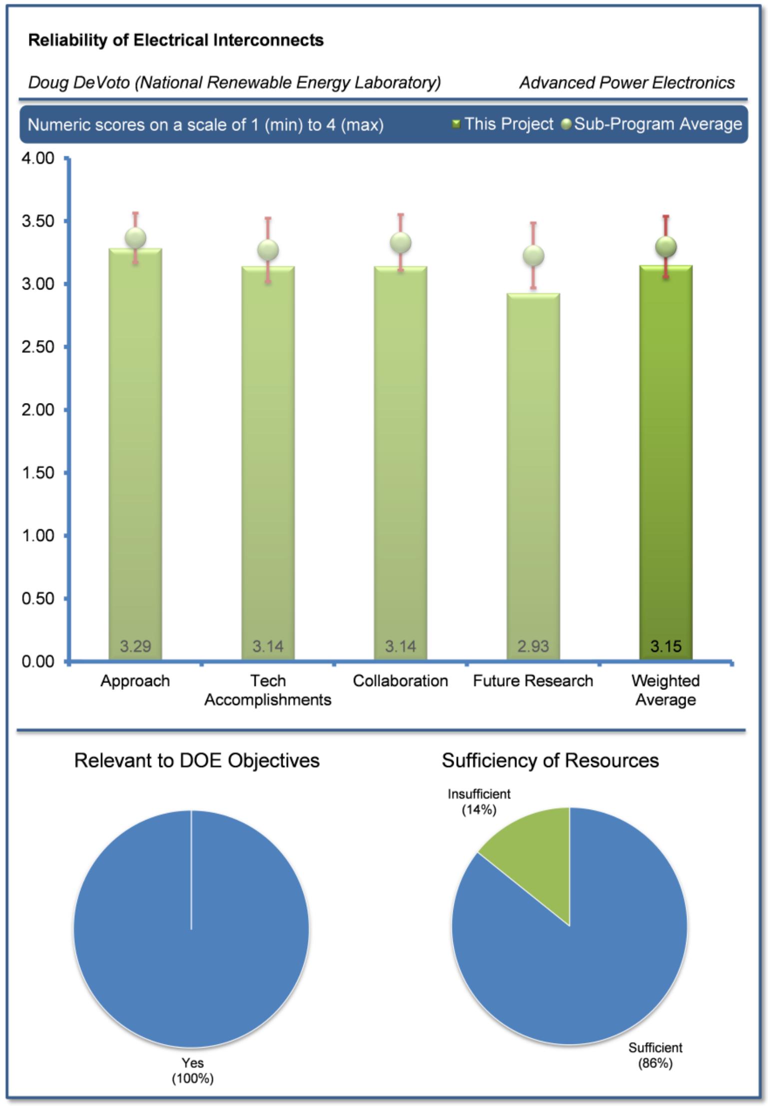
Reviewer 1:
The reviewer commented that this was not discussed in detail, but the level mentioned in the introduction seemed reasonable.

Reviewer 2:
The reviewer indicated the resources were okay.

Reviewer 3:
The reviewer agreed that the resources appeared sufficient for today's work and the presentation's scope.

Reviewer 4:
The reviewer stated that the resources were sufficient and that it appeared the results were progressing.

Reliability of Electrical Interconnects: Doug DeVoto (National Renewable Energy Laboratory) - ape036



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach was very practical.

Reviewer 2:

The reviewer commented that the work conducted was comprehensive and methodical and addressed all aspects of electrical interconnects.

Reviewer 3:

The reviewer agreed that the researchers' technical approach to replace wire bonds in power semiconductor devices by ribbons was appropriate, but mentioned that the cost and benefit analysis could have been clearer. The reviewer also noted that accelerated testing and evaluation after accelerated testing was appropriate and that the project team had devoted the desired time and resources to this effort.

Reviewer 4:

The reviewer reported that this project was generating knowledge regarding the Physics of Failure of ribbon bonded power devices; this was absolutely required to ensure that the EV market gets reliable, high-performing devices. The reviewer indicated that the planned approach, as presented, was well-thought out and appropriate for the task at hand. The reviewer agreed that the sample size and test patterns should provide adequate data to complete the task and that the overall project schedule was credible.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer acknowledged that there had been encouraging progress to date.

Reviewer 2:

The reviewer said that it would seem that the results of the work could be used to identify several "preferred or best designs" for power module interconnects. The reviewer, however, thought it would be useful to have results from extended testing of a larger sample size for the "preferred or best designs" in order to establish life and reliability.

Reviewer 3:
The reviewer reported that the project tasks were on track and that most of the tests were complete. The reviewer also agreed that reducing the number of tests needed to verify ribbon reliability was a great idea.

Reviewer 4:
The reviewer noted that this project was progressing nicely and that test data was being gathered that indicated the failure modes as a function of stress and cycles. The reviewer asserted that the development of the deformation patterns was a good addition. The project evaluator asked whether there was a significant increase in the bond time as a result of using a pattern versus a spot connection. The reviewer commended that the layout of the test samples was very good work – getting a reasonable number of samples of each wire pattern on a single sample was great. The reviewer asked whether the researchers had noticed any variability between the samples. This reviewer also asked how the researchers intend to do power cycling – on each “circuit” on each sample board – and how the researchers will get the power to the circuit. The reviewer did not see any connection areas on the sample board photos.

Reviewer 5:
The reviewer suggested that it would be better to adopt some industrial test standard for the reliability evaluation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer offered that the collaboration team members appeared to be an appropriate mix of industry experts and NREL experts. The reviewer thought it would be beneficial to enlist an outside person to review the final models/data either from industry, academia, or another national laboratory.

Reviewer 2:
The reviewer suggested that it would be useful to have inverter manufacturers as collaborators on this project.

Reviewer 3:
The reviewer pointed out that the NREL PI was collaborating with appropriate partners such as Curamik, Kulicke, and Soffa. The reviewer, however, commented that industrial partners, such as power device manufacturers, were missing from the project team.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer agreed that the proposed future work addressed the challenges identified during the progress to date. The reviewer emphasized that completing the testing was high on the list and that providing a summary to the industry would be important. The reviewer suggested that the task of validating the lifetime estimation models needed to have more definition at this time. The reviewer asked who would be creating these models and what the validation would involve. The reviewer also questioned whether it could be done in the time left for this project.

Reviewer 2:
The reviewer reported that the validation of lifetime estimation model was identified as one of future research areas in the project. The reviewer recommended that a lifetime estimation model needed to be properly developed, test verified, and improved. The reviewer added that this model should also be extended to estimate the life of various thermal, mechanical and electrical interfaces in power devices using ribbon bonds.

Reviewer 3:
The reviewer commented that the proposed future work did not seem to address overcoming the remaining challenges and barriers of the project (i.e., wisely choose key experiments and ribbon bonding geometries for credible reliability prediction and validation). The reviewer recommended reviewing the research paper cited below for developing a plan to address the remaining challenges. The

reviewer stated that this paper reported a methodology to assess reliability accurately with an eigenvector sampling technique, which requires only 2N+1 analysis (where N is the number of random variables).

Paper citation: Youn, Xi, and Wang, 2008; Eigenvector dimension reduction (EDR) method for sensitivity-free probability analysis, Structural and Multidisciplinary Optimization.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that this work appeared to be consistent with DOE objectives.

Reviewer 2:

The reviewer commented that this better bonding could improve WBG reliability.

Reviewer 3:

The reviewer stated that improved low costs and reliable power devices in electric drive system shall accelerate adoption of electric powertrain for traction application resulting in reductions in petroleum fuels.

Reviewer 4:

The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement, as it was addressing the processes required to manufacture a reliable and cost-competitive power module for the EV traction industry.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

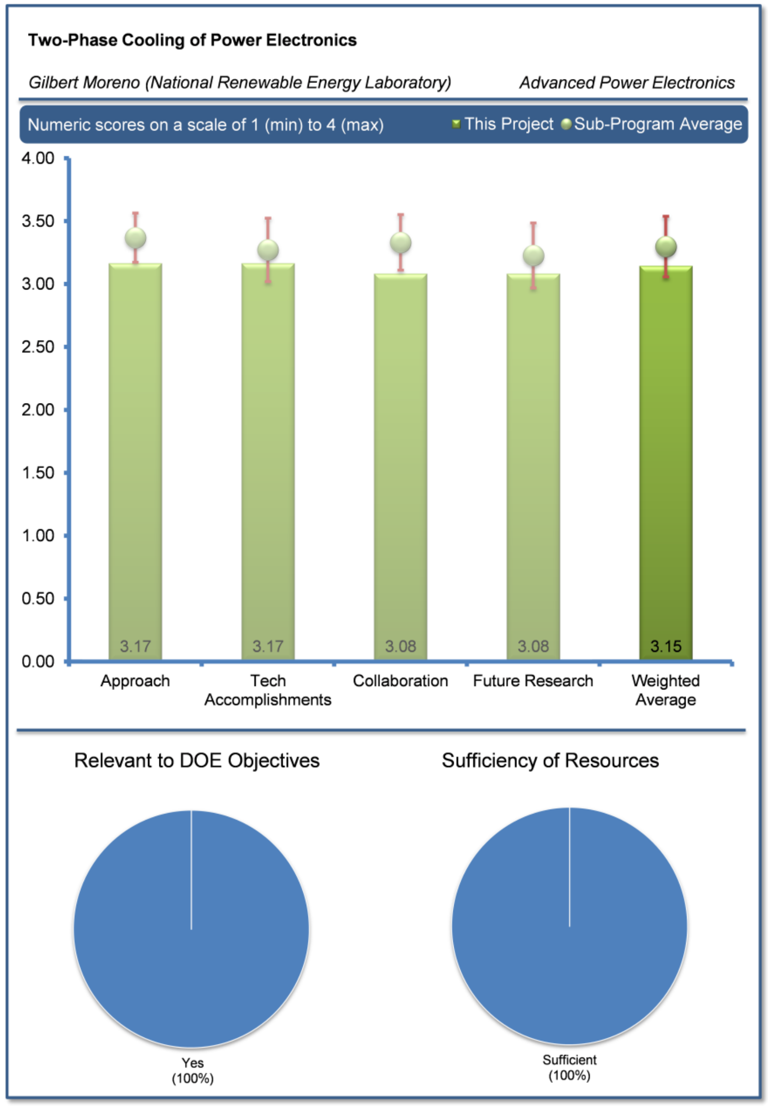
Reviewer 1:

The reviewer stated that the resources had been sufficient for the project to date as the progress had been carried out as planned.

Reviewer 2:

The reviewer asserted that the NREL PI should have access to at least one manufacturer of power device both in discrete and modular packages. The reviewer explained that this could have made developed technical know-how more relevant and useful due to the availability of real-world applications.

Two-Phase Cooling of Power Electronics: Gilbert Moreno (National Renewable Energy Laboratory) - ape037



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer suggested that it would be useful to develop a cost for the two-phase cooling approach and benchmark it against a water-ethylene glycol-based approach and a heat pipe approach.

Reviewer 2:

The reviewer agreed that the technical approach taken in the project had the desired pathway for technology development and demonstration. This reviewer explained that the project had started with fundamental research progressing to inverter scale demonstration by deploying phase change thermal management technique for power devices and modules.

Reviewer 3:

The reviewer stated that the overall goals of this project were pertinent to DOE goals. The reviewer explained that the potential for this cooling approach to be successful is very good and this approach should identify the benefits and alleviate some of the concerns. The reviewer commented that the approach shown on Slide 5 (identify the fundamentals, develop at a small level, and then demonstrate at the final power) is excellent. The reviewer noted that the concern was to ensure that the final development also include the complete cooling system including the heat exchanger located in a reasonable position for use in a vehicle. The reviewer praised that the continued evaluation of alternative coolants, plus additional uses of the heat exchanger, were all good.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that achieving a heat transfer rate up to 200,000 W/m2-K, while requiring only 250 ml of phase change material, was commendable. The reviewer suggested that reducing thermal resistance by 65% could attract applications from industry where two-phase cooling could be quite beneficial. The reviewer concluded that the project’s tasks were on track to be completed. The reviewer reported that the investigator had demonstrated that the developed technique could heat sink up to 3.5 kW of power loss, and if adopted in application, this level of heat-sinking was quite appropriate for the majority of automotive power electronics systems rated up to 100 kW maximum power. The reviewer concluded that if this two-phase cooling technique were deployed in WBG power electronics, it could be useful for inverters for trucks and delivery vehicles with up to a 500 kW power rating.

Reviewer 2:

The reviewer stated that the project represented excellent work and that the sample proof-of-concept system test results were impressive. The reviewer agreed that using ceramic heaters of an appropriate size for today's modules was good, but asked whether the researchers had considered future devices which may be significantly smaller and thus have a smaller footprint with increased heat flux. The reviewer believed that the estimate of 3.5 kW was realistic, but pointed out that it was higher than the 2.7 kW used by the Air-Cooling Team.

The reviewer highlighted that the improvements in the fluids used as well as the enhancements to the tube design were very impressive. The reviewer also thought that including the condenser investigations was encouraging, but asked whether the researchers had met with automotive condenser suppliers regarding alternative designs. The reviewer also asked whether the researchers had considered a liquid-to-liquid heat exchanger since the vehicle may have already had a coolant available for this purpose.

The project evaluator indicated that the progress to date has been related to the cooling system, since that is the point of this project, but asked whether the researchers have considered the impact on the rest of the inverter design. The reviewer also inquired about how this cooling method would change today's inverter designs. If the condenser is still required to be higher than the condenser, the reviewer wanted to know what this would do to the interior structure of the inverter (e.g., connector locations, mounting, and volume requirements). The reviewer suggested that this should be a subject of discussion with the research team's industry collaborators, or perhaps the subject of an Electrical and Electronics Technical Team meeting.

Reviewer 3:

The reviewer commented that the work addresses all the major issues related to the design and performance of a two-phase cooling approach. The reviewer said that, assuming the performance and cost of the approach, the progress was acceptable. This person also suggested that there was a need to address the impact of a two-phase cooling approach on the life and reliability of the power device being cooled.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the collaboration among team members was very good, and that it was encouraging to see the team reaching out to OEMs and Tier 1 supplier companies regarding challenges/issues with two-phase cooling. The reviewer encouraged to continue this collaboration.

Reviewer 2:

The reviewer proposed that it would be useful to include a vehicle manufacturer collaborator, regarding the under-the-hood integration of a two-phase cooled inverter/converter system.

Reviewer 3:

The reviewer recognized that the PI had developed a good team that consisted of industrial partners for part and material supply and universities; however, the team lacks an end-user of developed technology and technical know-how.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the PI had identified future research tasks and plans to work with Delphi.

Reviewer 2:

The reviewer agreed that the plan for future work was very logical, well thought out, and goals-oriented. This person stated that demonstrating this cooling approach using actual power modules should be very beneficial and would also provide a sense of relevancy to the project. The reviewer emphasized that the data from the planned testing would also be a valuable aid in getting an industry partner to assist with this project.

Reviewer 3:

The reviewer stated that the future work included bonding a Delphi power module to the advanced evaporator using a thermoplastic, but the reviewer asked why the researchers were not using a solder interface.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer suggested that if this project could resolve cooling issues, it could make EVs more efficient.

Reviewer 2:

The reviewer explained that reducing inverter size and improving power density shall eventually reduce the costs of power electronics, resulting in adoption of electric powertrain in automotive traction applications. Thus, this should directly and indirectly reduce consumption of petroleum fuel.

Reviewer 3:

The reviewer confirmed that this task was relevant to the stated DOE objective of petroleum displacement, as it was providing an alternate cooling method that may prove to be more cost-effective in some vehicle implementations.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

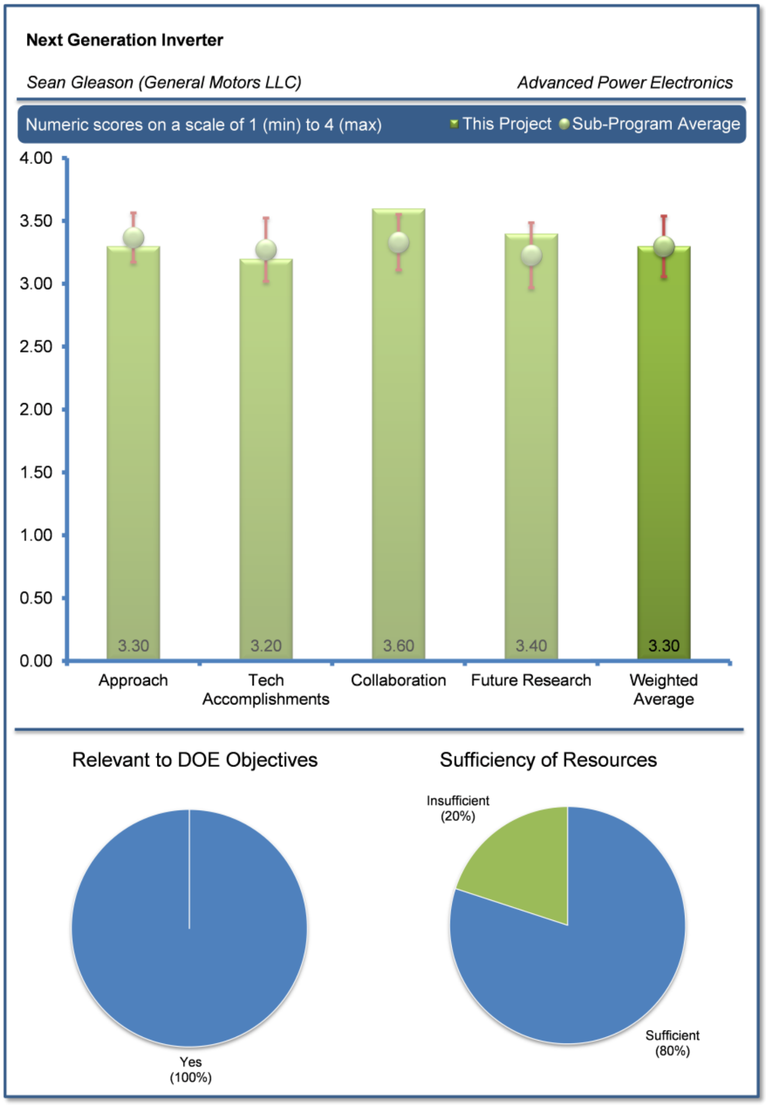
Reviewer 1:

The reviewer commented that the resources had been sufficient for the project to date as the progress had been carried out as planned.

Reviewer 2:

The reviewer suggested that the PI should work with industry partners and find a real-world example that could adopt the developed technology.

Next Generation Inverter: Sean Gleason (General Motors LLC) - ape040



Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer Sample Size

A total of five reviewers evaluated this project.

Reviewer 1:

The reviewer commented that the approach was sound and well-grounded in basic objectives.

Reviewer 2:

The reviewer explained that the project is to help Tier 1, 2, and 3 companies to co-develop technology for lower cost and increases performance is essential in today's international market.

Reviewer 3:

The reviewer said that the use of production processes in the manufacture of prototypes was an excellent approach.

Reviewer 4:

The reviewer applauded that the project has a great technical approach. The reviewer explained that the project's targets were to develop a supply chain for inverter parts and inverters, themselves, that are targeted to be scalable and modular; therefore it meets DOE's objectives for modular and scalable design of the inverter resulting in multi-platform applications to realize 100,000 inverters per year manufacturing using global supply chain and manufacturing facilities. The reviewer pointed out that the project report had a missing cost analysis and it was highly doubtful that cost targets (e.g., a real possibility of 3.3$/kW power electronics) were on track.

Reviewer 5:

The reviewer stated that overall, the project seemed interesting, but the details were not defined and it was not clear how this effort integrated with other related efforts within the DOE portfolio.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated the importance for components to be made from a common manufacturing process in order to lower cost with ability to produce a superior product at the lower cost.

Reviewer 2:

The reviewer reported that five inverter units were built as per project report and the gate drive circuitry was tested. The reviewer said that the device-level work seemed like it was completed. The reviewer explained that the investigator stated in the project report that no design issues were found, however, it was hard to state conclusively that inverter design has no issues without extensive testing of inverter under loaded conditions. Overall, the reviewer agreed that the technical progress on the project seemed to be on track.

Reviewer 3:

The reviewer remarked that the progress was described as good, but this was not really demonstrated. The reviewer cautioned that, given the amount of expenditure so far, it seemed that the tangible results were limited.

Reviewer 4:

The reviewer stated that the technical goal statements and progress to these statements were intelligently-presented. However, the reviewer commented that there were fewer details than desired on the actual technical milestones. The reviewer wondered what power levels (voltages and currents) were tested and what conditions the inverters were run and tested at. The reviewer also specified that the technical objective of cost reduction, while stated as a major goal in the program now more than halfway completed (FY 2011-2016 program, with this the FY 2014 update), was not elaborated upon. The reviewer stated that it would be beneficial to know where the cost goals have been achieved, and where additional cost challenges existed. The reviewer was encouraged that GM had prototyped a power inverter product in-house at a GM facility. The project evaluator asked whether it had been tested in a GM vehicle yet, and if so, this would have been a very nice point on which to elaborate. If it had been tested, then the reviewer affirmed that this would be excellent; if not, the reviewer asked where the barriers existed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the informal communication with other OEMs was positive.

Reviewer 2:

The reviewer observed that collaboration and coordination appeared to be both wide and deep. This seems to be the case at both the industry and also national laboratories' levels. The reviewer acknowledged that this seems to be a highlight of the work and seems prudent to continue.

Reviewer 3:

The reviewer described that the researchers demonstrated that prototype builds of common components lowered device cost, as well as improved reliability and availability.

Reviewer 4:

The reviewer praised that this project had a capable team consisting of partners from supply chain for all vital parts and components of inverter. The reviewer also recognized that the investigator was collaborating with DOE laboratories.

Reviewer 5:

The reviewer indicated that this was not discussed in the presentation, but was in the PowerPoint slide deck. The reviewer mentioned that it would have been good to discuss this more.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed that the future proposed work and goals seemed appropriate and well-focused, based on the program scope and objectives.

Reviewer 2:

The reviewer commented that the future plans were not discussed in detail, but the final goal seemed to be clear and responsive.

Reviewer 3:

The reviewer pointed out that common product design did not mean that there was no competition; rather it resulted in each side making a better more reliable product.

Reviewer 4:

The reviewer recommended that two units from first batch of prototypes need to be thoroughly tested under all operating conditions before the design is finalized for early build.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reported that reducing the cost and increasing market share for EDVs would be valuable in reducing petroleum use.

Reviewer 2:

The reviewer agreed that the work was consistent with the stated DOE objectives.

Reviewer 3:

The reviewer stated that the project is very relevant to meeting DOE’s goal, as GM is the world's largest automotive manufacturer. The reviewer mentioned looking forward to next year's updated presentation.

Reviewer 4:

The reviewer confirmed that the ability to produce new high-performance devices with higher reliability and utility would help everyone, including the automotive industry as well as higher performance car users.

Reviewer 5:

The reviewer commented that DOE objectives could be far better supported if this project meets the power electronics cost targets of $3.3/kW.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer indicated that the resources seemed sufficient. The reviewer explained that GM had expansive resources globally, and was well-networked to pursue nearly any automotive objective from virtually any perspective. The reviewer remarked that it would be interesting to see how GM focused these resources to continue work on these important program objectives.

Reviewer 2:

The reviewer said that the resources were hard to judge, but in the present environment, assistance and cooperation could be beneficial in developing a product advance.

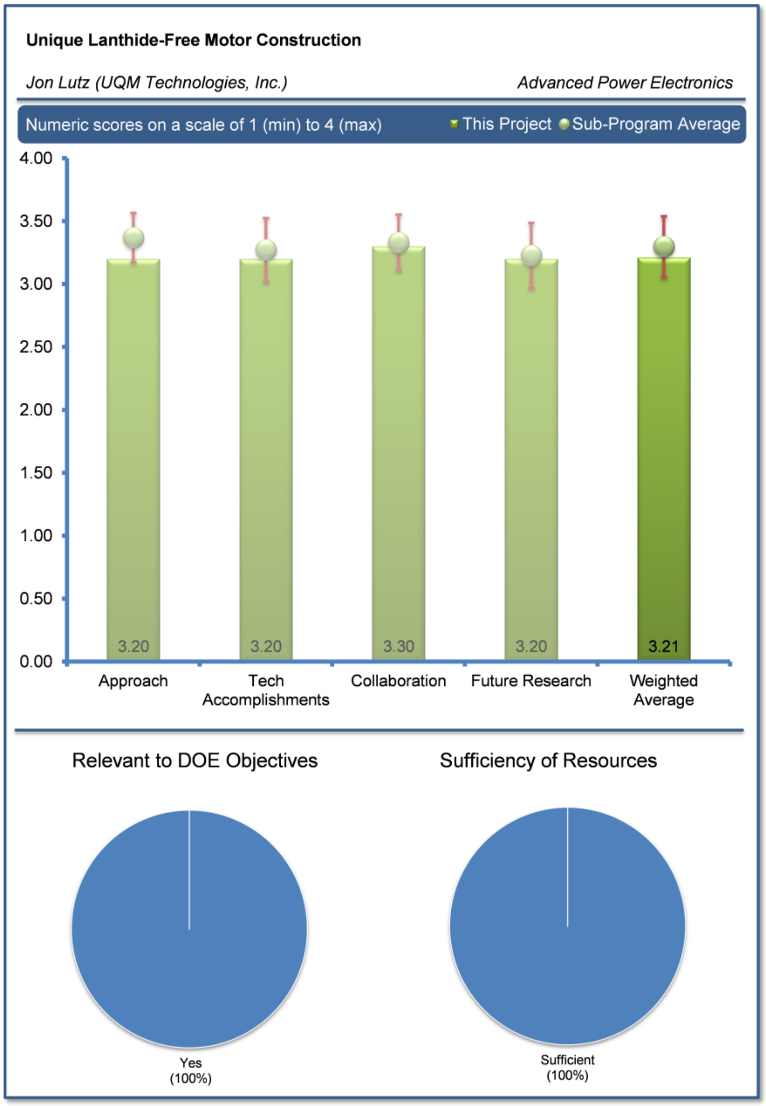
Reviewer 3:

The reviewer stated that access to a vehicle platform for inverter’s deployment is desired. This reviewer recommended that the PI identify at least one vehicle platform for inverter application and to put the name of that vehicle in the FY 2015 project report submitted for the DOE-Annual Merit Review. The reviewer commented that merely saying that the inverter could be useful for multiple GM vehicle platforms is not enough.

Reviewer 4:

The reviewer expressed that this was not discussed in detail. The reviewer added that the spending seemed high, but these programs were complex at the OEM level.

Unique Lanthide-Free Motor Construction: Jon Lutz (UQM Technologies, Inc.) - ape044



Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer Sample Size

A total of five reviewers evaluated this project.

Reviewer 1:

The reviewer stated that the approach seemed to be solid and well-experienced. The reviewer looked forward to the POC 1 results next year.

Reviewer 2:

The reviewer agreed with the logical approach to develop the AlNiCo motor (i.e., decrease the slope of the PM load line by using a long magnetic PM path, and use a high pole count to minimize demagnetizing armature reaction magnitude). The reviewer also agreed that it made sense to use a direct current (DC)-DC converter to compensate for the low constant power speed range of surface PM motor, provided this was within the scope of the original project intent from DOE. The reviewer asserted that the parallel research to increase coercivity of AlNiCo was also a good approach, as it was very challenging to meet DOE specifications with current PM material grades.

Reviewer 3:

The reviewer commented that this seemed to be a technically very well-managed project. The reviewer acknowledged the success in reaching the DOE targets also depended on the performance of the AlNiCo material to be developed by Ames. This person proposed that a design with a higher permeance coefficient and low armature reaction field was necessary when using an AlNiCo material, even if the coercivity was doubled compared to the current state-of-the-art. Given this, the reviewer commented that the chosen configuration of the magnet texture or magnetization direction seemed to work well. The reviewer pointed out that the team's responses to reviewer's previous comments were clear, including the information on the DOE approval on a lower rotational speeds level for an increased torque. The reviewer agreed that potting of the end windings seemed to have been a good choice, while the recommended oil-cooling of end windings may be problematic at 10,000 revolutions per minute (rpm).

Reviewer 4:

The reviewer summarized that the project was developing an AlNiCo-based design with a unique magnetic circuit (i.e., high permeance coefficient >> 3) to overcome the low coercivity of the magnets. The reviewer explained that since the motor was not capable of field-weakening, an integrated boost converter was required in the inverter to permit a variable DC bus voltage. Currents resulting from a stator winding or inverter fault may result in demagnetization. The motor was only designed for a 65-70°C inlet coolant temperature. The reviewer cautioned that the fiberglass magnet retention strategy had not been validated at high speeds yet, and asked whether it was possible to develop a model to predict the maximum speed achievable using the magnet retention strategy.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the technical accomplishments had been good, given the fact that only current AlNiCo magnets had been available, versus higher coercivity material magnets. However, the reviewer commented that it looked like the basic thermal design of the motor was not intended to meet the original DOE requirement of 105°C inlet coolant temperature (as far as the reviewer knew, this was the requirement shown in General Electric's (GE) presentation number ape045). The reviewer pointed out that the UQM Annual Merit Review presentation stated that the design goal was a 60-65°C inlet coolant. The reviewer added that the researchers had done a good job navigating around the need for a PM "keeper" for the rotor, and the difficulties that posed in assembly.

Reviewer 2:

The reviewer indicated the researchers were waiting on results from POC 1 and 2, but nothing negative had been disclosed.

Reviewer 3:

The reviewer stated that the work seemed to be on schedule.

Reviewer 4:

The reviewer suggested including the breakdown of losses and motor efficiency into the presentation Also, it appeared to the reviewer that the no-load losses were very high. The reviewer inquired about how the no-load losses compared to the no-load losses of surface PM and internal PM machine, and what the implications were of the no-load losses for practical applications. The reviewer suggested that a Fast Fourier Transform analysis of the back EMF voltage was needed to assess the total harmonic distortion of the back EMF. The reviewer indicated that it appears that there were some harmonics of the voltage that needed to be quantified. The reviewer also inquired about the current and improved characteristics of the AlNiCo magnets and the weight and volume difference expected by using traditional and improved AlNiCo magnets. Finally, the reviewer suggested including a 2-D cross-section of the machine with clearly marked flux paths and finite element analysis (FEA) in future reports.

Reviewer 5:

The reviewer described that the thermal enhancement modeling resulted in the design with end turn potting/encapsulation, which led to an approximately 20°C reduction in maximum end turn temperature compared to the baseline design. With this, UQM would be able to stay with water ethylene glycol cooling, rather than migrating to oil-cooling. The reviewer explained that one aspect of the design was that the magnetic circuit must be maintained, which required the need for the magnet keeper any time the rotor was not installed or during overhaul and service to avoid demagnetization. The reviewer summarized that the motor had been tested to 3,000 rpm so far and that the magnet retention strategy was a higher risk aspect of the program, to be tested prior to delivery of the motor to ORNL. The reviewer asked whether it was possible to add any design features into the rotor to provide additional mechanical retention of the magnets. The reviewer summarized by saying that UQM provided great technical details of the motor design and explanation of previous-year reviewer's concerns.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that there appeared to be good coordination with NREL on motor thermal modeling. However, the reviewer stated that it was too early to expect much engagement with Ames on improved coercivity AlNiCo.

Reviewer 2:

The reviewer acknowledged that there was apparent core collaboration in this area, while respecting independent application between several of these DOE programs on this subject matter. The reviewer highlighted that this synergy is necessary to achieve the objectives in motor development.

Reviewer 3:
The reviewer recognized that the team was well coordinated and that the collaborators were the top experts for the ascribed tasks, each of which were important for the success of the project.

Reviewer 4:
The reviewer explained that this project had some collaboration including three national laboratories supporting PM development, thermal management, and motor testing. However, the reviewer cautioned, no industry or academic partners were included. The reviewer also pointed out that no publications had resulted from this effort.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the second test motor had been completed, and so now with two motors available, the UQM would be increasing the strenuous testing of the design. In the event that one motor needed to be disassembled, work can continue with the second motor. The reviewer reported that further investigation and optimization of the motor cooling strategy is planned. The reviewer added a quote from the presentation stating "ultimately, UQM expects improved magnet coercivity to be a requirement prior to product release."

Reviewer 2:
The reviewer said that the future work plan seemed to address the remaining design and test goals. If, however, the DOE goal was 105°C inlet coolant temperature, then the work and test plan should reflect this.

Reviewer 3:
The reviewer reported that the team admitted that given the current design, a voltage boost inverter was required; so this should be included in the future work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that the near-term problems with heavy RE material supply had been well-documented. This research focused on the development of a motor topology built around available magnets (though at least incremental improvement is likely required) without near future supply concerns.

Reviewer 2:
The reviewer agreed that improved motor efficiency helped to achieve better miles per gallon (MPG) or miles per gallon-electric (MPGe). The reviewer also mentioned that the use of non-RE PM was a good compromise in terms of not using expensive magnets and efficiency.

Reviewer 3:
The reviewer agreed that the electrical machines developed under this effort supported further vehicle electrification and hybrid-electric applications, which would result in less fuel consumption. The project evaluator also explained that less RE content would significantly reduce the cost of advanced electric machines, which contributes to increased adoption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

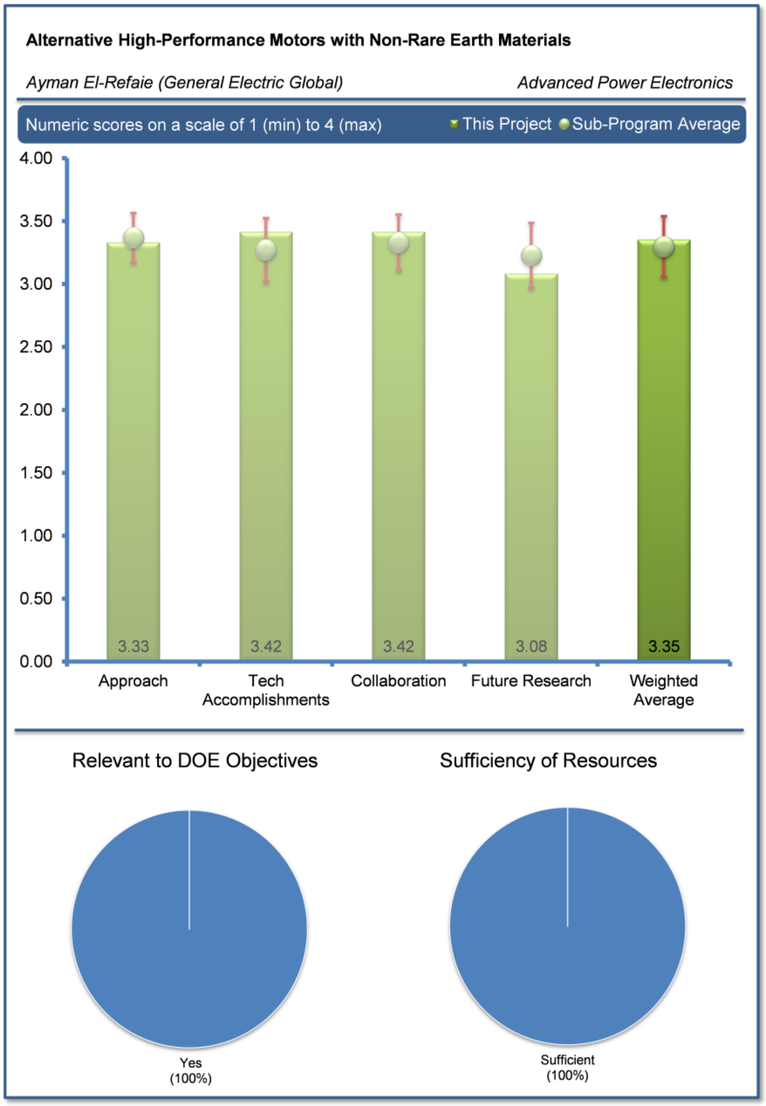
Reviewer 1:
The reviewer remarked that the resources appeared to be well-matched with the project requirements.

Reviewer 2:
The reviewer considered the project budget to be sufficient for this project.

Reviewer 3:

The reviewer stated that a lack of resources was not apparent.

Alternative High-Performance Motors with Non-Rare Earth Materials: Ayman El-Refaie (General Electric Global) - ape045



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that this was an outstanding R&D effort, with a broad scope of technical choices. This person further remarked that with 10 variants being evaluated, this project should yield a high-value and efficient motor.

Reviewer 2:

The reviewer summarized that the project focused on high-speed designs without RE PMs, but that additional technologies were being developed under this project including novel insulation materials, controls, and thermal management approaches leveraging oil spray-cooling.

Reviewer 3:

The reviewer acknowledged that the work plan appeared to be a logical and systematic approach to meeting objectives, starting with broader categories of no heavy REs, no REs, and no magnets. The reviewer praised that the materials development being done in parallel also makes sense. However, the reviewer questioned the value of developing a slot liner that can withstand 250°C since operating at higher temperatures seemed counter to the direction of high efficiency.

Reviewer 4:

The reviewer recognized that since there were many different possible motor architectures to pursue that met the goal of reduced or eliminated RE elements, that starting the program by evaluating the possibilities was appropriate. Although, the reviewer commented that the down-selection process has proven to consume a large portion of this program. The reviewer summarized that at this point, the three candidates (i.e., no dysprosium, ferrite, and synchronous reluctance) were good choices with different pros and cons.

Reviewer 5:

The reviewer reported that although the material development group had developed a new grade of AlNiCo with higher coercivity for a $(BH)_{max}$ = 10 MGOe, the motor group had finished building a second prototype using some ferrite magnets instead. It was not clear to this reviewer if replacing the ferrite magnets with the new AlNiCo was straightforward, or if a new motor design would be needed. The reviewer however acknowledged that, regardless of the timing for the development of the high coercivity AlNiCo with respect to the schedule of this project, the reported performance was of notable importance for the research and industry communities outside of this project. The reviewer concluded by asking whether the eddy current losses in PMs were significant at the targeted 14,000 rpm rotational speed. If yes, the reviewer wanted to know how these losses are or would be addressed, especially for the magnets with the electrical conductivity of a metallic-type.

Reviewer 6:

The reviewer questioned what kind of machines are/would be used for the second and third prototypes and how the selections would be done. The reviewer suggested that more results should be shared with the reviewers to be able to assess the progress. The reviewer noted that details of the breakdown of weight, volume, and cost were needed for reviewers to understand how the program objectives were being met. The reviewer also mentioned that it would be nice to list the patents and papers published for further evaluation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that, overall, it looked like good progress. The project evaluator reported that motors were built for two research categories, and that the results looked similar to the design predictions. The reviewer also mentioned the good progress on non-RE PM and dual-property lamination development as well.

Reviewer 2:

The reviewer highlighted that the 10 motor variants and nine patents demonstrated significant progress in this effort.

Reviewer 3:

The reviewer affirmed that the test results of the first two motors were showing promise, but suggested that it would be useful to see how these motors compared with the DOE targets (e.g., size, weight, and power profiles) rather than just the sample measurements shown in the presentation. On the materials side of the program, the reviewer agreed that the areas of work and accomplishments were useful. The reviewer stated both the use of ArKomax® 800 and “locally non-magnetic laminations” would have value in the motor designs.

Reviewer 4:

The reviewer summarized that more than 10 motor topologies seemed to have been evaluated, and that the team was designing and building three selected motor prototypes. The reviewer explained that that first motor prototype using Dy-free, Nd-Fe-B magnets seems to meet the torque and power targets at 3,000 rpm; however no specification of thermal management, weight, and volume was provided. The reviewer proposed that it would have also been useful to have concrete targets for the properties of the materials to be developed.

Reviewer 5:

The reviewer reported that the trade studies and down-selection activities had been completed and that the first two test motors had been built and were being evaluated. The reviewer also reported the following: new 250°C insulation materials are ready to be scaled-up; new directionally-oriented AlNiCo magnets with improved properties have been demonstrated; and a method to tailor the permeability across a lamination to control flux paths has been demonstrated. The reviewer highlighted that the researchers’ submission of nine patent applications with others pending is very encouraging.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the collaborators are numerous and appropriate, which is leading to good research elements.

Reviewer 2:

The reviewer described that there is apparent core collaboration in this area, while respecting independent in the application between several of these DOE programs on this subject matter. The reviewer emphasized that this synergy is necessary to achieve the objectives in motor development.

Reviewer 3:

The reviewer noted that the project had numerous motor and materials collaborators. The reviewer listed that motor collaborators included North Carolina State University, University of Akron, University of Wisconsin, NREL, ORNL, and McCleer Power, while materials collaborators included Ames Laboratory and Arnold Magnetics.

Reviewer 4:

The reviewer pointed out that there was no concrete description of the work done by the other project partners. However, the presentation, and in general, the course of the project may have been affected by the current unavailability of the PI. The reviewer supposed that with their return, the project may quickly correct its course.

Reviewer 5:

The reviewer indicated that while progress to date seemed good, more information was needed regarding coordination of the partners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the future work plan was a logical extension of the work to date, including the building of a magnet-free proof-of-principle motor and the final down-selection between the three motor types.

Reviewer 2:

The reviewer agreed that continuing to test three different motor technologies and integrating materials research was a good direction. The reviewer suggested that it would be useful to see how these technologies would be evaluated against each other and also when compared to standard RE motors, prior to the completion of testing. The project evaluator emphasized that setting the criteria in advance would help evaluate which idea(s) was the most promising for future commercialization.

Reviewer 3:

The reviewer reported that the next steps included finishing testing on the two test motors, and final motor topology selection and build. This reviewer also noted that the manufacturing processes of key materials would be scaled up. The reviewer asked whether GE would be providing a test motor to DOE/ORNL for independent verification of the advertised metrics.

Reviewer 4:

The reviewer noted that the remaining challenges and barriers were succinctly enumerated, but pointed out that there was no concrete plan on how to address them. The reviewer asked whether GE was making the prototypes and also who exactly would perform the testing. The reviewer also wondered who would scale-up the synthesis/production of the newly developed materials. The reviewer mentioned that one of the confirmed challenges is “developing the advanced materials with the required properties.” However, the reviewer saw no reference to these required properties for any of the categories (i.e., soft magnetic; hard magnetic; electrically insulating). The reviewer also remarked that there was no description of the thermal management and how to address the possible mechanical challenges that resulted from a high rotational speed level operation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project focused on meeting DOE's high performance and efficiency motor targets with zero heavy RE or zero RE content. The reviewer agreed that this was directionally correct for the goal of widespread electric vehicle use with sustainable material supply.

Reviewer 2:

The reviewer stated that the high-performance alternatives to RE motors would prevent vehicle electrification from being derailed due to potential disruption in RE supplies.

Reviewer 3:

The reviewer agreed that the electrical machines developed under this effort support further vehicle electrification and hybrid-electric applications, which would result in less fuel consumption. The reviewer added that less RE content would significantly reduce the cost of advanced electric machines, thus contributing to increased adoption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

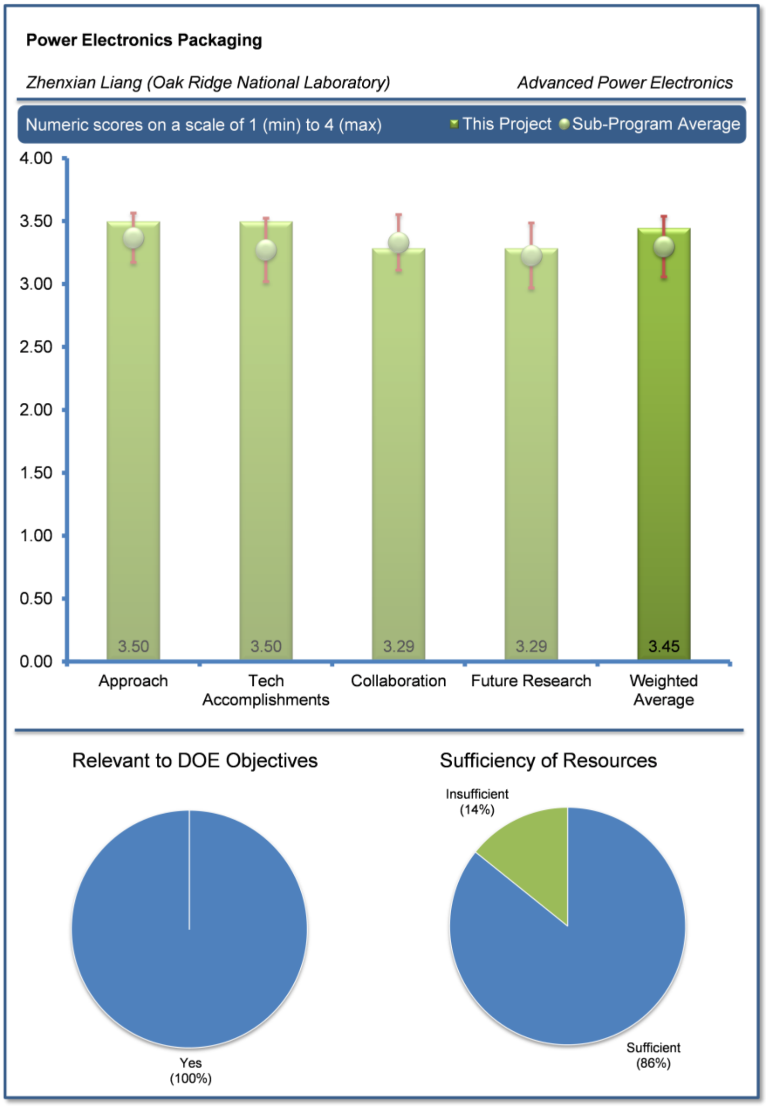
Reviewer 1:
The reviewer indicated that a team this large should be able to meet the stated goals on time.

Reviewer 2:
The reviewer noted that the resources for this program appeared to be appropriate.

Reviewer 3:
The reviewer thought that the $12 million budget was sufficient for this project.

Reviewer 4:
The reviewer said that a lack of resources was not apparent.

Power Electronics Packaging: Zhenxian Liang (Oak Ridge National Laboratory) - ape049



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that automotive inverter designs need modification to meet the DOE Advanced Power Electronics and Electric Motors program target. The reviewer noted that Si power modules were being developed to meet the new requirements.

Reviewer 2:

The reviewer commented that the project looked like good work, but was unclear how this work contributed to the larger system-level goals.

Reviewer 3:

The reviewer reported that the desired approach was adopted by the investigator to develop novel packaging ideas and test verification of the developed ideas. The reviewer agreed that replacing Si semiconductor material with WBG material was a great idea. However, the reviewer reported that to use performance of WBG devices, the package should be developed with the minimum possible stray parameters for electrical, mechanical, and thermal; that was exactly what the investigator was striving to achieve through this project.

Reviewer 4:

The reviewer praised that the project addresses most of the important issues within the power module with very impressive goals. The reviewer liked the planar connection approach, but had some concerns relative to spacing (e.g., clearance spacing outside the module) and the impact of connecting to bus bars within the inverter as well as the signal interfaces. The reviewer also noted that the power module package appeared to be very compact, but that the dimensions were not provided (the assumption was based on views relative to the quarter shown in the photos). The reviewer also indicated that the drawings did not include a means for mounting the power module in the inverter. This may create problems in the final package in order to provide the required support and still meet creepage and clearance requirements. The reviewer asked if any thought had been given relative to making the connections to the gate drive circuitry such as connectors or board mounting provisions if press fit pins were used.

Reviewer 5:

The reviewer remarked that the approach to performing work was very sound and effective. The reviewer suggested that goals for which applications were being targeted would be helpful in the first part of the presentation as “Power Module Packaging” can be directed at many different applications from main inverter at high power and low frequency to accessory applications at lower power and higher frequencies.

Reviewer 6:
It was not clear to this reviewer how the double-sided power elements were assembled to create a full-size power module. The reviewer indicated that it was difficult to assess the practicality of the approach without having an understanding of the details of the design.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer observed interesting progress and looked forward to seeing the results of integration of the third-generation device into a system.

Reviewer 2:
The reviewer explained that it was commendable that the researchers were finishing the project tasks related to packaging and test evaluation of the Generations 1 and 2 SiC devices and modules for the inverter. The reviewer also noted that the PI had also developed packaging ideas for the Generation 3 devices for the inverter module. Overall this person thought the technical tasks for project seems to be on track to complete.

Reviewer 3:
The reviewer commented that the new advanced design power module for inverters, and etc. had been developed where Si-based devices replaced by SiC and GaN devices. The reviewer explained that a significant 40% cost reduction and a 60% power increase had been achieved in the new devices.

Reviewer 4:
The reviewer commended that the packaging concepts were highly integrated and highly technical. However, it was not clear to this person if wire-bonded semiconductors would be used in the most advanced package type. The reviewer explained that there was a picture on Page 5 showing a wire-bonded device, then on Page 12 die attach appeared to be direct-bonded; thus this would be a nice area to clarify. This person summarized by indicating that the overall technical accomplishments looked very promising and well-founded. The reviewer added that the researchers had done nice work.

Reviewer 5:
The reviewer suggested that the researchers needed to develop a cost assessment of the proposed third-generation package design to demonstrate that the 40% cost reduction was achieved. This person also thought that it would be useful to benchmark the third-generation package design cost against a current power module cost.

Reviewer 6:
The reviewer agreed that the packaging approach has made very good progress in terms of size reduction with excellent thermal performance, as seen in the performance charts. The reviewer commented that the electrical performance indicated some areas that needed improvement, such as noise on the output signals, but appeared to be good overall. The reviewer affirmed that the module's simulated performance showed very good switching results for this package in terms of voltage overshoot. This performance was based on a circuit attached to a copper baseplate, versus the planar package being proposed. The reviewer asked when these tests would be repeated with a more representative package. The reviewer indicated that the assembly process shown on Slide 14 showed two different jigs for the assembly of the module with the jig on the right side most closely matching what the project team thought would be the pin out of the module to support the three- phase package shown in Slide 12. The reviewer asked the researchers to explain which the correct jig was, as the reviewer was not sure that the researchers wanted to have the output exit from the same side as the high-voltage DC input to the module from a crosstalk perspective. The reviewer asked if any thought had been given to what other functions might be included in this module, such as temperature sensing of the switches and current sensing (more for fault control than control at this time). The reviewer also asked if the cooling plate properties had been modeled; specifically, the reviewer wanted to know the flow rate and pressure drop of a single plate and of the proposed full model using a 50% water/50% ethylene glycol mixture. The reviewer emphasized that this was an important parameter in the construction of the traction system, as it directly impacts the size and thus the cost of the pump. In summary, the reviewer believed that this project was making good progress based on the length of the project to date.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer affirmed that it looked like the level of collaboration was appropriate to the requirements.

Reviewer 2:

The reviewer acknowledged the excellent collaboration and coordination were incorporated. The reviewer pointed out that many key industry partners and other national laboratories were engaged appropriately.

Reviewer 3:

The reviewer stated that the achievements in the project were achieved through cooperation that will benefit industry.

Reviewer 4:

The reviewer voiced that the PI had put together an excellent team consisting of industry partners, academic experts, and partners from NREL. The reviewer suggested that the PI should find an industry partner such as an end-user of developed packaging ideas for increased power density, reduced costs, and improved performance.

Reviewer 5:

The reviewer observed that the effort would derive benefits from participation of inverter/converter manufacturer(s) and vehicle manufacturer(s) regarding system design specification and system integration into a vehicle.

Reviewer 6:

The reviewer commented that the collaboration within the DOE labs, university work, and with the device and packaging industry partners appears to be good and is providing excellent results. What the reviewer saw as missing was active participation with the eventual users of this technology – the Tier 1 and 2 suppliers and vehicle OEMs. The reviewer admitted that it may be that it was too early for their active involvement, but still believed that they should be reviewing the proposed packages to provide constructive input as to what the appropriate form factor should be for incorporation into their product, or at least have some time to determine its impact on their product.

Reviewer 7:

The reviewer indicated that Slide 15 stated that the new power module reliability would be done in collaboration with NREL in response to a comment in FY 2013; however, no such reliability analysis had been done in this year's report. In addition, this person indicated that, according to the table in Slide 6, NREL would work on thermal analysis, which implied that only reliability of the thermal performance may be conducted. The reviewer cautioned that conducting only thermal reliability analysis was not sufficient because any other reliability issues could hurt the commercialization of the technology, even though the cost and power density targets were met.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer suggested continuing the program in order to optimize other technologies.

Reviewer 2:

The reviewer agreed that the future research appeared to be well-aimed and properly focused. The reviewer suggested that providing a very clear break out of what industry applications were being targeted for the solution (e.g., automotive inverters, automotive DC-DC applications, motor drives, industrial applications, etc.) would be a nice addition to the work. The reviewer asserted that while not a deficiency to this presentation, this would be a well-received addition to the material to help the audience better understand what industry application challenges could be addressed by this exciting work.

Reviewer 3:

The reviewer highlighted that the PI was willing to provide packaging support to the Advanced Power Electronics and Electric Motors program projects underway at various national laboratories and industries, which the reviewer found to be a commendable offer made through the project report. The reviewer also concluded that the PI had identified enough tasks to keep making the desired progress during the remaining period of FY 2014 and for all of FY 2015.

Reviewer 4:

The reviewer commented that the proposed future work aligned very well with the current progress and stated goals of the project. The reviewer explained that the next steps were a logical progression for the development to take place. This person suggested that the addition of some environmental tests, such as vibration and thermal testing to validate the model, would be helpful and would both validate the model and help identify areas that are in need of improvement. The reviewer would have also liked to see the module be subjected to some of the standard module tests, such as thermal and power cycle testing to determine its long-term performance.

Reviewer 5:

The reviewer reported that the next step appeared to be the integrated unit, but it was not clear what this would actually be used for and how this contributed to integrated systems.

Reviewer 6:

The reviewer requested that the future work include a proof-of-concept full-scale inverter/converter performance demonstration. This person also explained that the future work should address the life and reliability of the third generation package design.

Reviewer 7:

The reviewer suggested that the plan to enhance the reliability for only (or most likely) thermal performance needed better justification because any other reliability issues (e.g., electrical, mechanical, lifetime, etc.) could hurt the real application of the technology. In addition, the reviewer was concerned that the team seemed to lack expertise in reliability analysis. This person indicated that NREL probably will work on thermal analysis, rather than reliability analysis of the thermal performance, according to the table in Slide 16.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer confirmed that reducing the costs of EDVs would lead to reductions in petroleum displacement.

Reviewer 2:

The reviewer applauded that the work was very relevant. The reviewer emphasized that power electronics packaging was among the key areas where future advances were needed.

Reviewer 3:

The reviewer said that the project benefits all of the involved companies.

Reviewer 4:

The reviewer affirmed that smaller packages for power inverters with reduced costs and improved performance are key enablers for the rapid deployment and adoption of HEV and EVs for transportation systems. Efforts through this project should achieve these objectives resulting in reductions in consumption of petroleum fuel.

Reviewer 5:

The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement, as it is addressing the power module which is a significant and unique piece of the electric traction system. This person explained that the power module had a huge impact on the performance, size, mass, and reliability of the system, as well as the impact of driving the size of other components, such as the bulk capacitor.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer described the project's resources as adequate.

Reviewer 2:
The reviewer stated that the resources were not discussed in details, but seemed to be adequate.

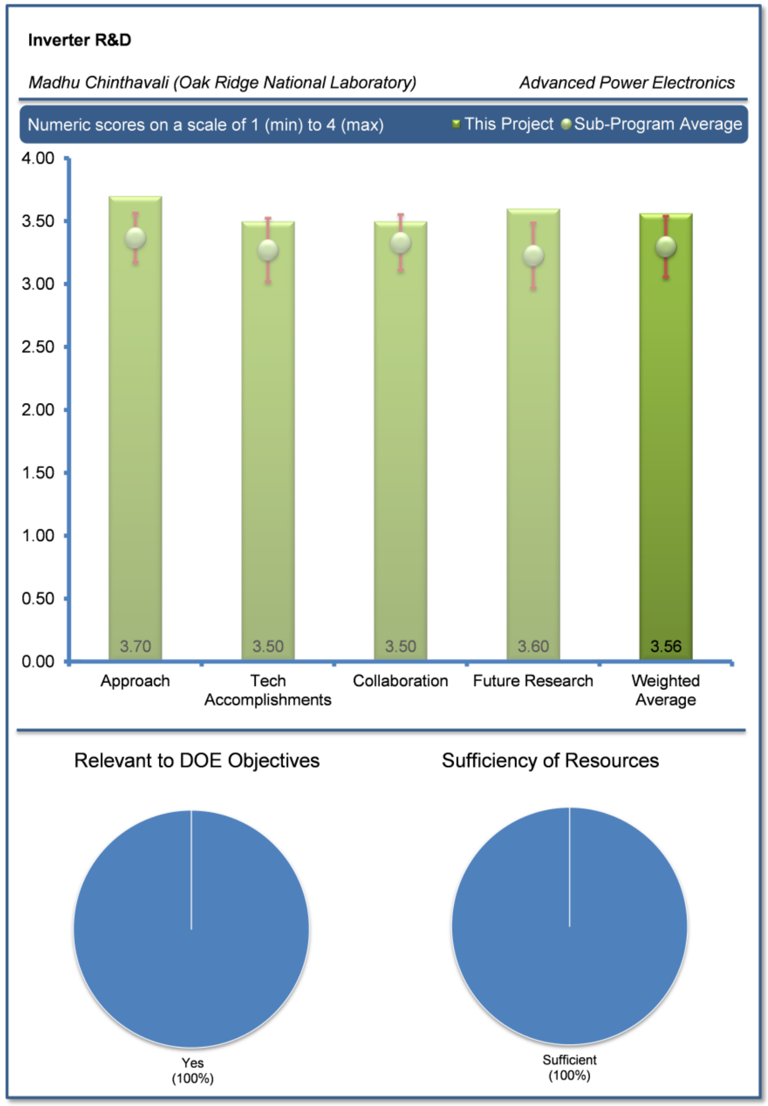
Reviewer 3:
The reviewer commented that the project resources seemed well-positioned and correctly weighted for this work.

Reviewer 4:
The reviewer stated that the resources had been sufficient for the project to date as the progress had been reasonable. The reviewer suggested that the mix of expertise may need to be changed to include testing and perhaps some input from an OEM and/or Tier 1 inverter supplier regarding how to package the module and the features required to support it.

Reviewer 5:
The reviewer recommended that the PI should find an industrial partner as an end-user of the developed technology.

Reviewer 6:
The reviewer commented that the team may have underestimated the work in reliability analysis for the packaging technology. Hence, the resources may be insufficient if reliability analysis would be seriously considered in the future work. In addition, the team would need to add a person whose expertise was in reliability engineering.

Inverter R&D: Madhu Chinthavali (Oak Ridge National Laboratory) - ape053



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that it appeared that a variety of approaches, many of which have the potential for significant gains, had been attempted.

Reviewer 2:

The reviewer noted that the approach compared liquid-cooled and air-cooled technologies.

Reviewer 3:

The reviewer agreed that the approach was very sound. This person explained that much good information on supplier and component was offered, but suggested that elaborating on more specifics would be helpful to the audience.

Reviewer 4:

The reviewer recommended that differences between the other funded 55 kW WBG inverter project (APEI) and this project should be clearly cited, as this would distinguish the contribution of this project from the other projects in a strong manner.

Reviewer 5:

The reviewer confirmed that this project had adopted a great approach to reducing the overall costs of the electric drivetrain by the inverter package using lower cost and reduced size materials and parts, such as copper bus bars in the inverter assembly. The reviewer explained that reducing the parts count, without compromising inverter's functionalities and inverter performance, is quite commendable if it is achieved and deployed in real-world application. This person commended that combining circuits' functionalities to reduce the part count was quite an attractive approach. The reviewer agreed with the researchers that building a 10 kW WBG inverter using commercially-available parts was the right approach to verify the design for manufacturability. However, the reviewer asked if this inverter design could be scaled-up to operate at higher voltages to exploit the high-voltage properties of SiC devices and modules. The reviewer reinforced that this needed to be answered conclusively by the PI.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that it seemed that there were a number of promising preliminary results, and looked forward to the 55 kW results.

Reviewer 2:
The reviewer stated that there had been encouraging progress and results to date.

Reviewer 3:
The reviewer expressed that the technical accomplishments and benchmarking were excellent. The reviewer suggested that more information on cost would be a very nice addition to the material.

Reviewer 4:
The reviewer suggested that it would be beneficial to show the breakdown of weight and volume of the converter designs and total weight and volume. This should include SiC and GaN devices, gate drive board, controller board, any sensors, mechanical packaging, any AC and/or DC capacitors, any AC and/or DC inductors, heat sink, any connectors, and miscellaneous items for cables, etc. The reviewer explained that this approach would clearly show how the objectives of the weight and volume were being met in detail.

Reviewer 5:
The reviewer summarized that the power density achieved using the ORNL packaging idea was 5.88 kW/l, which is quite a bit lower than the 12.00 kW/L DOE FY 2015 targets and 13.40 W/L DOE FY 2020 targets). The reviewer requested that the PI verify if the lower right corner graph shown on Page 7 was correct. The reviewer also summarized that discrete and modular SiC devices had been characterized in laboratory testing, but had yet to be tested in an inverter setup to predict efficiency of the 10 kW SiC inverter, (air-cooled and liquid-cooled versions). The reviewer pointed out that the inverter offered 99.3% efficiency; however, determining the inverter efficiency over a load range (e.g., 10% of load to full load) is recommended. The reviewer also recommended that the PI to develop a protection scheme for the various vital inverter parts and to document how these schemes work under high dV/dt environment without any false trip of inverter operation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer voiced that this project has excellent collaborative efforts with team partners drawn from ORNL, NREL, inverter part suppliers, and WBG device manufacturers companies.

Reviewer 2:
The reviewer mentioned that the collaboration and coordination with other industry partners and institutions was nicely integrated into the presentation.

Reviewer 3:
The reviewer reported it looks like the collaboration is great, although it sounds like more collaboration on advanced capacitors could be helpful.

Reviewer 4:
The reviewer recommended that it would be nice to see a couple of universities as collaborators as well to make the team stronger.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that scaling plans appeared to be in place, and was looking forward to the results.

Reviewer 2:
The reviewer acknowledged that eliminating the liquid-cooling should enhance the efficiency.

Reviewer 3:
The reviewer agreed that the future proposed work was well-aligned with the scope and objectives of the program.

Reviewer 4:
The reviewer praised that the investigator had commendable and challenging tasks identified to scale-up the 10 kW inverter to a 55 kW inverter design. The reviewer recommended that all attempts should be made that this scalability is achieved with minimum possible design changes in the inverter parameters and dimensions related to electrical, mechanical, and thermal, etc.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that decreasing EDV costs would lead to petroleum use reductions.

Reviewer 2:
The reviewer stated that the work was consistent with DOE objectives.

Reviewer 3:
The reviewer confirmed that this work was very relevant, as it aimed to better understand the work that was progressing to solve many needed and targeted application solutions.

Reviewer 4:
The reviewer agreed the research presented was relevant to DOE because it achieved significant efficiencies of converters using SiC and GaN technology. Hence, future cars would achieve better MPG or MPGe due to the inverter efficiency increase.

Reviewer 5:
The reviewer explained that if the air-cooled 55 kW SiC inverter design was proved-out in a vehicle application, this could open new applications of the WBG power electronics deployed in the light-duty transportation vehicles. Due to the high operating efficiency and smaller size of the WBG inverter, the developed product could become an enabling technology to reduce consumption of petroleum fuels.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

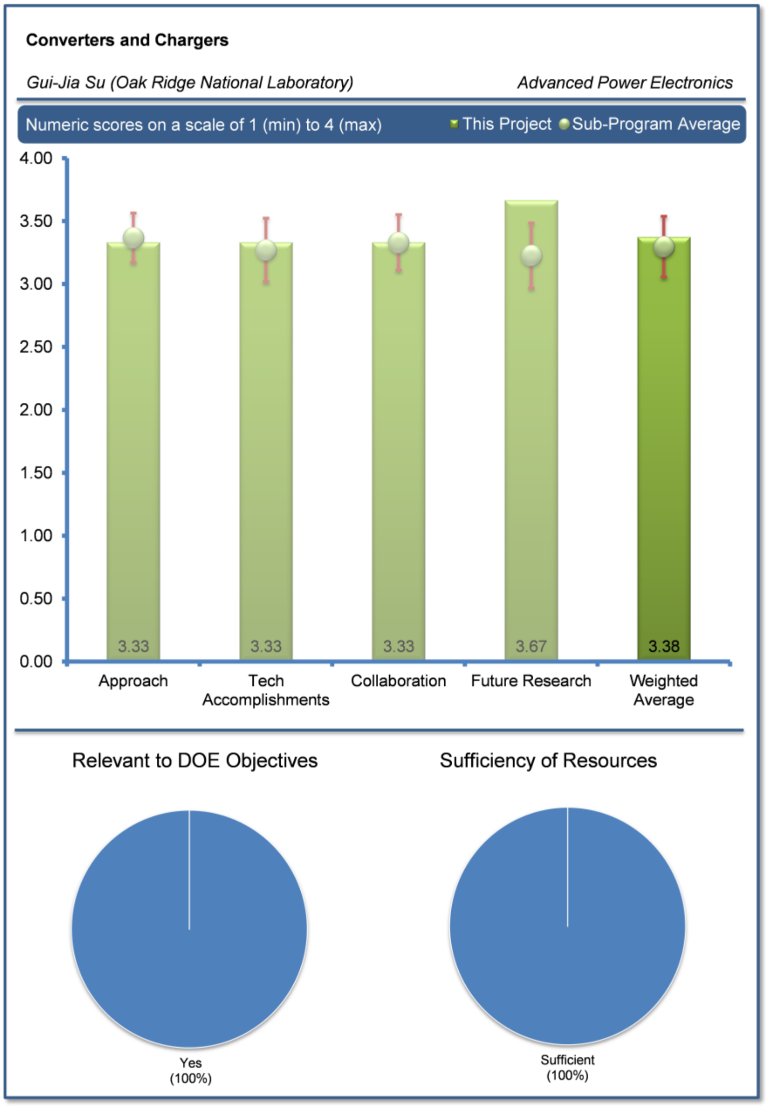
Reviewer 1:
The reviewer commended the team’s nice work and well-laid out project. The reviewer reported looking forward to seeing next year's contribution.

Reviewer 2:
The reviewer reported that the resource level was not really discussed, but there did not seem to be gaps.

Reviewer 3:
The reviewer indicated that the resources appeared to be sufficient and well-placed to achieve the program objectives. The reviewer suggested that commercial resources may be able to be included to address the areas of cost, as R&D efforts must be focused on application solutions that are cost-effective paths to production.

Reviewer 4:
This reviewer recommended that the project team should strive to work with an industrial partner who could adopt the air-cooled 55 kW SiC inverter, including providing a commercial vehicle platform for performance verification of the developed air-cooled WBG inverter.

Converters and Chargers: Gui-Jia Su (Oak Ridge National Laboratory) - ape054



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer indicated that it was a valuable approach to evaluate the possibility of reducing the cost by sharing the power stage with traction inverter and motor.

Reviewer 2:

This reviewer highlighted that the goals of this project were very aggressive and that several barriers were being addressed. One concern the reviewer had was the use of the drive motor(s) as part of the charging implementation. The reviewer asked whether all of the costs and other impacts had been documented and a plan identified to address them. This person noted that there was a cost associated with bringing the neutral point of the motor(s) out of an oil-cooled drive unit. The reviewer liked the combined charger/auxiliary power module (12 VDC APM), as this combined the two functions that needed to be operating during charging. The issue with this approach was the efficiency of the APM at very light loads (less than 250 watts or so) since this power cannot be used to charge the battery. The reviewer also explained that another potential issue that needed to be addressed was the overall vehicle safety during charging. The reviewer asked if this approach limited the leakage path back to the electric vehicle supply equipment (EVSE) while it maintained isolation of the high-voltage bus. The leakage current needed to be modeled and compared to the allowable limits. The identified designs assumed either a dual motor system or a single-motor boosted system which may not cover all implementations. There are single-motor non-boosted systems that still require a charger – could be a slight change in the location of the "boost" inverter which would impact size of the unit. The project evaluator asked what the impact was to the function in a dual-motor system that uses motors of different sizes, and thus different inductances. The reviewer also commented that no mention was made regarding the size, cost, or mounting location for the contactor, which could be significant. There are charger-only units (3.3 kW) under development that are in the 900 W/L range, so the market was also reducing size and increasing power density. The reviewer would have liked to see a standalone implementation of just the charger and APM.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer expressed that additional design details were needed to assess the feasibility of the proposed integrated on-board charger. The reviewer asked whether the required DC-inductor value and the machine winding inductance compatible with each other; this was critical to find out whether this topology was viable. The reviewer recommended that a traditional charger topology would be compared to the proposed integrated on-board charger from the perspective of part count, weight, and volume. The reviewer also commented that it would be beneficial to show the breakdown of weight and volume of the converter designs and total weight and volume. This should include SiC and GaN device, gate drive board, controller board, any sensors, mechanical packaging, any AC or DC capacitors, any AC or DC inductors, heat sink, any connectors, and miscellaneous items for cables, and etc. This approach would show how the objectives of the weight and volume are met in detail.

Reviewer 2:

This reviewer admitted that while the reviewer was not a fan of using the inverter/motors as part of the charging system, the project had made good progress on the basic charger design. The reviewer's questions related to the impact on the system cost of using the inverter/motors but other areas are being identified such as the need for a new magnetic material capable of supporting the higher frequencies that are desired. Test data from the breadboard unit indicated that the topology was viable even in Si, and should be usable as a baseline for comparison purposes. The reviewer reported that testing of WBG devices had started with preliminary results that matched data from other sources. The reviewer asked whether the test data shown used the gate drive circuit in the presentation or another pre-existing design. The project evaluator agreed that the planar transformer design looked good, but asked what experience the researchers' vendor had with heavy copper boards at 120 amps (for APM). The reviewer also agreed that a 2.0 kW APM is a reasonable values as typical units are 1.8 kW or 2.2 kW in the reviewer's company's product portfolio. The reviewer asked if any analysis had been performed on the number of additional hours that the inverter/motor will be subjected to if used as part of the charger. The reviewer also asked what the voltage/current stress was on the bulk capacitors. The reviewer noted that these questions needed to be addressed to adequately judge the cost impact of this approach. In summary, the reviewer believed that this project is making good progress based on the length of the project to date.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer suggested that it would be nice to add a couple of universities to the project in order to diversify the team which would strengthen the team's depth and breadth.

Reviewer 2:

This reviewer affirmed that the collaboration with device suppliers was showing results. However, only one of the three magnetic material suppliers was mentioned. What the reviewer saw as a missing piece was active participation with the eventual users of this technology – the Tier 1 and 2 suppliers and vehicle OEMs – input required to address cost, reliability, and safety impact of the design.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This reviewer reported that the proposed future work aligned very well with the current progress and stated goals of the project. This person agreed that the next steps were a logical progression for the development to take place. The reviewer questioned whether addition of the 3.3 kW GaN charger, rather than going straight to the 6.6 kW charger design, was based on device availability or another reason. The design of two 6.6 kW chargers is ambitious especially if the topologies are going to be significantly different to take advantage of the device characteristics. The reviewer asked whether the PI plans to use a common design, or modify the design to take advantage of both technologies. This person stated that an apples-to-apples comparison would be very helpful once both designs were tested.

Reviewer 2:

This reviewer proposed that it would be good to test the proposed on-board charger module in the real car and EVSE (i.e., charger environments).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement as it is addressed the reduction in size of the charger and APM by combining them with the inverter/motor. The reviewer pointed out that this one possible implementation, but the reviewer thought that the combination of the charger and DC-DC was viable if the size was easier to package than the current use of separate units; sometimes two small units are easier to package than one slightly larger unit.

Reviewer 2:

This reviewer explained that low-cost onboard charging modules are critical devices for PHEV and EV vehicles.

Reviewer 3:

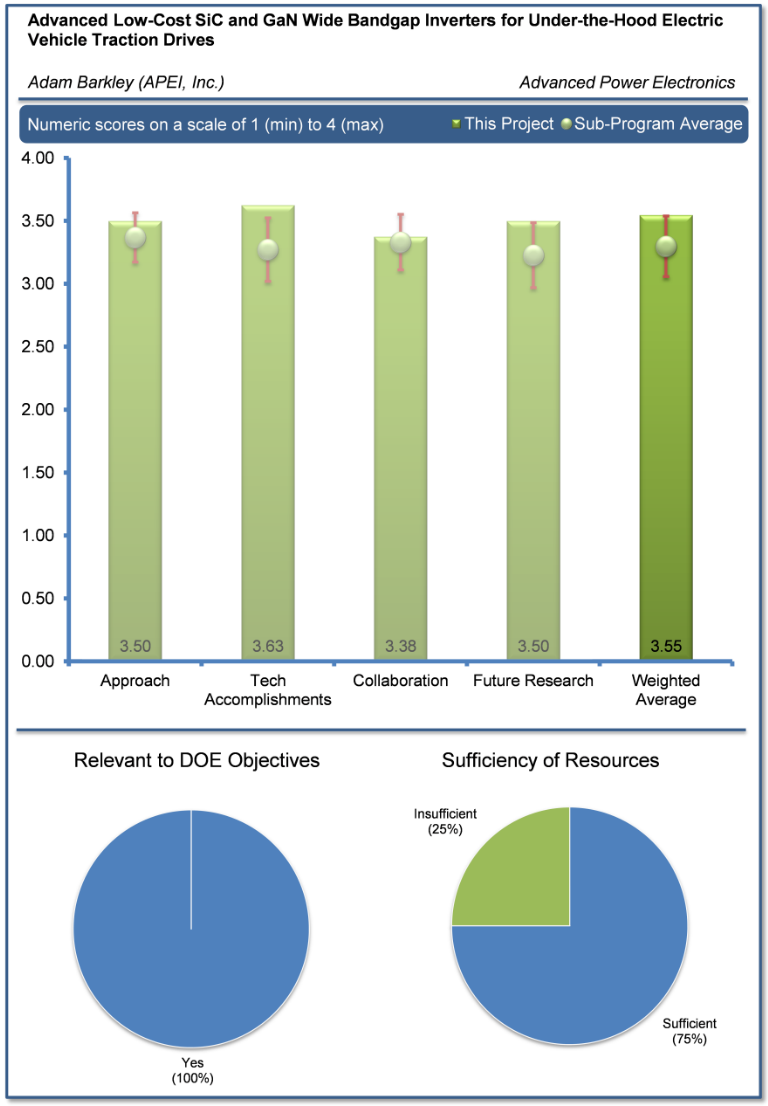
The reviewer voiced that the PI needed to add a slide to show how this objective was met. The reviewer answered yes, because the battery charger uses utility power, and it could be assumed that the charger efficiency increase indirectly contributed to petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer indicated that the resources had been sufficient for the project to date as the progress had been reasonable. The reviewer remarked that more use of the magnetic material suppliers would probably be required to increase the probability of success in case the nano-material did not work out. The reviewer recommended also including an OEM or system integrator to assist with some of the safety concerns with this implementation.

Advanced Low-Cost SiC and GaN Wide Bandgap Inverters for Under-the-Hood Electric Vehicle Traction Drives: Adam Barkley (APEI, Inc.) - ape058



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer agreed that comparing the two WBG technologies seemed to be very interesting. The reviewer suggested, however, that the work may have too much of a near-term focus on component selection and topology, given the somewhat speculative nature of the devices, but this would at least create a benchmark.

Reviewer 2:

This reviewer stated that the project's approach was to eliminate wire bonds.

Reviewer 3:

This reviewer stated that the approach and focus were well-articulated and clearly explained.

Reviewer 4:

This reviewer commented that a better approach could be to focus on one inverter design for research investigations followed by inverter's parts design and development and manufacturing of inverter prototypes required for design verification and design improvements. The reviewer explained that the project work and tasks on both GaN and SiC inverters could not get optimum results due to the divided efforts between the two incompatible deigns. During the FY 2014 DOE Annual Merit Review, the APEI presenter stated that the APEI team was far ahead on the SiC-based inverter and this researcher questioned this approach as SiC devices are better suited for higher voltage (greater than 1,000 VDC) inverters, rather 380 VDC nominal bus voltage inverters. Successful market penetration followed by significant capture of business segment by SiC devices is unknown for lower DC bus voltage inverters, as SiC devices at lower voltages are not competitive with the GaN devices due to cost and performance considerations and untapped capability of SiC devices (e.g., paying for capability but not using it). The reviewer noted that APEI plans to use its proprietary ASIC technology; more information would be helpful to understand the potential impact to encouraging WBG power electronics manufacturing in the United States at a large scale.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer noted that the project was still at an initial phase, but appeared to be on target.

Reviewer 2:

This reviewer stated that the technical details were well-presented.

Reviewer 3:

This reviewer praised the excellent data presentation and technical merits of different approaches that were communicated effectively. The reviewer pointed out that due to the nature of WBG technology, the differences in efficiency at light loads of WBG materials versus Si should have been elaborated upon. The reviewer indicated that the cost, weight and volume ratios were well-presented, but suggested that they could be additionally expanded upon. The reviewer remarked that this seemed to be the area of work that the audience was most interested in.

Reviewer 4:

This reviewer explained that at least four conceptual designs were depicted in the project report used for presentation during the DOE Annual Merit Review. The reviewer recommended that the investigator carry out a comparison analysis among all four concepts and share this analysis data with DOE for pros and cons of each concept. The reviewer proposed that this could become a decision analysis exercise and could have valuable information for future design revisions during the course of this project. The project evaluator asserted that it could have been quite useful for reviewers if the investigator had shared the high-level technical specifications, including results from modeling and simulation tasks completed. The reviewer recognized that the electrical and thermal characterization results from the SiC packages were commendable to show, and prove, the promise of WBG power electronics. Sharing pictures of project work underway was greatly appreciated by this reviewer.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer noted that it seemed like the project team had a promising set of partners.

Reviewer 2:

This reviewer reported that the collaboration was well-presented. Due to the increased numbers of WBG suppliers over recent years, it seemed to the reviewer that a wider inclusion of offerings would be a nice addition to this work. The commenter understands that intellectual property protection and the competitive nature of this landscape made this a difficult addition, but it seemed like a beneficial path to pursue nonetheless.

Reviewer 3:

This reviewer recognized that the PI demonstrated that APEI team was working in close collaboration with Toyota, GaN Systems, NREL, and the University of Arkansas. The reviewer perceived the APEI team to be an excellent one with complementary capabilities drawn from partner companies to make overall team quite strong. The commenter stated that this should not only help in completing the project tasks, but also to achieve the project goals and DOE objectives for this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

This reviewer commented that most of the project goals were still in the future, but they seemed logical and achievable.

Reviewer 2:

This reviewer expressed that the future work appeared to be well-targeted and properly focused as this program moved toward final phases. The reviewer suggested that if DOE granted an extension, then wider inclusion of WBG suppliers would be a nice future goal.

Reviewer 3:

This reviewer stated that the PI identified relevant, yet challenging, tasks in the form of the proposed future work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
This reviewer indicated that reducing the costs of EDVs would decrease petroleum use.

Reviewer 2:
This reviewer agreed that the research appeared to be consistent with DOE's objectives.

Reviewer 3:
This reviewer stated that the research was very relevant to DOE. The reviewer explained that technology advances in semiconductors appeared to be just a matter of time, so this work was very relevant. The reviewer thanked the presenter for a nice presentation.

Reviewer 4:
This reviewer indicated that if cost and performance objectives are met, WBG inverters designed, manufactured, and deployed across numerous applications could support reductions in the consumption of petroleum based fuels and energy resources in the United States.

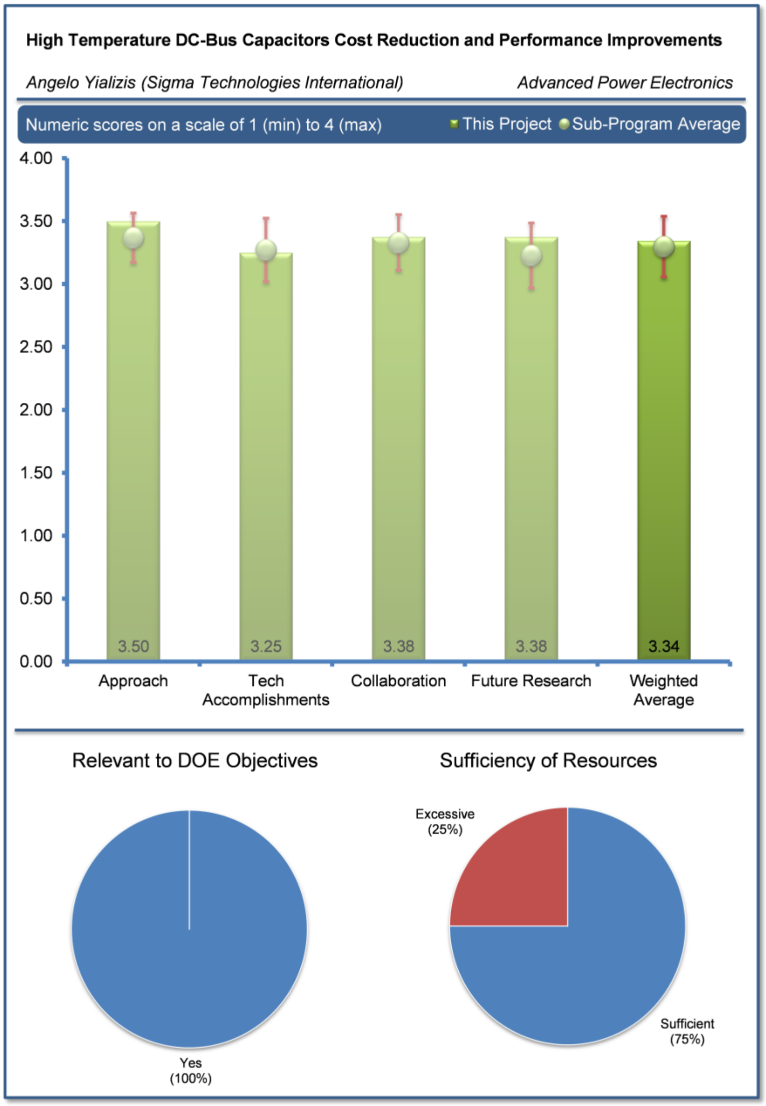
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
This reviewer said that this was not addressed directly, but was presumably sufficient.

Reviewer 2:
This reviewer noted that the program appeared to be sufficiently resourced.

Reviewer 3:
It would have been interesting to this reviewer if the data were made available to see how the cost target of $182 unit cost (at an annual production volume of 100,000 inverters) was tracking. The reviewer explained that APEI lacked the mass manufacturing capability and infrastructure required to produce 100,000 WBG inverters per year. Thus, the reviewer was unclear as to how the $182 unit cost is tied with any manufacturing facilities needed, and also noted that this was not discussed in project report and/or in the presentation during the FY 2014 DOE Annual Merit Review.

High Temperature DC-Bus Capacitors Cost Reduction and Performance Improvements: Angelo Yializis (Sigma Technologies International) - ape059



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer highlighted that this looked like a very interesting approach. The reviewer is looking forward to the commercialization details.

Reviewer 2:

The reviewer reported that this project is developing a new process for capacitors with the intent of providing a more robust, smaller, and cheaper bus capacitor. This person stated that the plan was feasible and had a logical flow from requirements through development and testing to final product. The reviewer also concluded that the appropriate team members are assigned tasks in their areas of expertise.

Reviewer 3:

The reviewer described that this project would develop compact high-temperature polymer capacitors using an integrated manufacturing process. The reviewer explained that the unique machine can integrate the polymer formation, electrode deposition, and capacitor production in a single process to reduce the capacitor cost, while the vacuum-based deposition process can reduce the defects and improve the dielectric breakdown strength. The reviewer recognized that the project gets around the expensive and challenging thin-film manufacturing process as the dielectric layer is formed in-situ on a carrier. If successful, the reviewer asserted that the project had the potential to significantly reduce the size and weight of the DC link capacitors and the high temperature stability can be achieved by proprietary polymer chemistry. As the PI pointed out, the end connections may be very challenging as it is very difficult to end-spray molten particles to get connected to the thin metal layer as there is no "offset" as with the classical capacitor winding process. The reviewer emphasized that good electrical connections at the two ends are critical for the EDV application which requires high ripple current and low contact resistance. The reviewer also mentioned that the project proposed to use plasma etching to assist in the end connections, so it will be very interesting to this reviewer to see the test results as plasma may remove both the polymer and the thin metallization.

The reviewer voiced that achieving a high-speed coating process will be critical to reduce the capacitor cost, as the machine will cost greater than $10 MM. It was unsure to this commenter whether the UV or electron beam curing of 1 µm acrylate and the metallization could be completed in such a short time if the machine was running at 1,000 m/min. The reviewer also stated that high-voltage performance may also be a challenge, as the other two ends would be cut with a diamond saw and there may be a corona around the edges without un-metallized margins.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the team had demonstrated the capability to produce polymer multilayer capacitors for other low-voltage applications and the technology had been used by Japanese companies.

Reviewer 2:
The reviewer remarked that the project was just starting, but seemed to have a good starting point.

Reviewer 3:
The reviewer noted that this was a new project, and as such, did not have much to report on in terms of progress. The progress that was reported on was good and was consistent with the program plan.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the collaboration team members appeared to be a good mix of industry and national laboratories.

Reviewer 2:
The reviewer commented that the team had a very strong experience in polymer film capacitor and power inverter design.

Reviewer 3:
The reviewer noted that the project was still at an initial stage, but the collaboration looked good. The reviewer offered that it seemed like it would be helpful to have a capacitor manufacturer involved.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked that the proposed future work aligned very well with the current progress and stated goals of this project. The reviewer affirmed that the next steps were a logical progression for the continued development to take place. The reviewer described that the plan had identified expected challenges but not decision points or alternative approaches at this time.

Reviewer 2:
The reviewer agreed that the proposed research was very critical to examine the several technical challenges that were raised in the "Approach" session where the end connection quality is sufficient for high ripple current and whether the cutting process will limit the operating voltage of the polymer multi-layer.

Reviewer 3:
The reviewer explained that the project was in initial stages, so most of the goals are in the future; however it looks like a good roadmap.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer pointed out that improving the cost of EDVs would reduce petroleum displacement.

Reviewer 2:
The reviewer explained that the focus had been on high-temperature semiconductors, but now low-cost and high-temperature capacitors were required for EVs.

Reviewer 3:

The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement, as it was addressing the need for a smaller, denser, high-voltage, high-temperature robust capacitors for use as a bus capacitor.

Reviewer 4:

The reviewer reported that the success of the project would produce compact high-temperature film capacitors to reduce the size of the EDV power inverters.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer agreed that the resources had been sufficient for the project to date, as the progress had been reasonable for a new program.

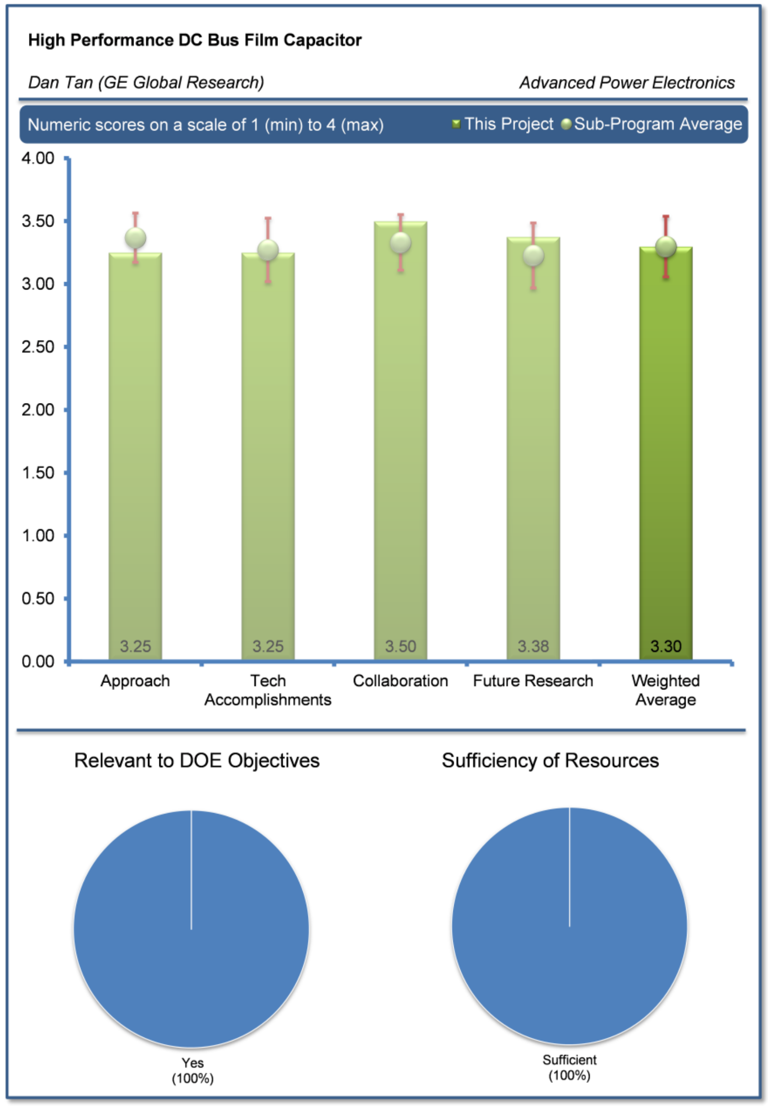
Reviewer 2:

The reviewer affirmed that the team had all the resources to work on the project in a timely fashion.

Reviewer 3:

The reviewer commented that the project resources were not described in detail, but looked to be sufficient.

High Performance DC Bus Film Capacitor: Dan Tan (GE Global Research) - ape060



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer concluded that this project had identified technical barriers and had a plan to succeed.

Reviewer 2:

The reviewer summarized that this project was developing a new process for capacitors with the intent of providing more robust, smaller, cheaper bus capacitors. The reviewer asserted that the plan was feasible and had a logical flow from requirements through development and testing to final product. The commenter reported that the approach was based on an internally-developed material, but will be using outside suppliers for support due to limited internal capacity access.

Reviewer 3:

The reviewer observed that Polyetherimide Ultem™ 1000 was one of the best polymers that could meet the technical performance requirement of the EDV DC link capacitor, while still having a relatively low cost. The reviewer noted the proposal to use extrusion to produce the film can potentially reduce the film cost. The commenter reported that the use of a carrier film to solve the winding issue would greatly improve the film quality. However, the reviewer commented, that the team should be aware of the potential cost of the carrier film.

Reviewer 4:

The reviewer commented that the approach was not explained in enough detail. It was clear to the reviewer that making thin films was critical, and that this led to good physical properties for capacitance, but it was not clear specifically how this work would lead to capacitors that meet the DOE targets. The reviewer also asked what the intermediate materials targets were.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that this project appeared to be on schedule.

Reviewer 2:

The reviewer praised that the team had made impressive progress in producing thin capacitor film using Ultem™ 1000 resin with steadily improving quality over the years. The reviewer pointed out that this approach was low-risk compared with other technologies.

Reviewer 3:
The reviewer highlighted that this was a new project, but the reported progress was good and consistent with the program plan. The commenter agreed that the progress indicated that the approach was promising and that the development plan was reasonable. The reviewer mentioned that challenges were identified, but appeared to be manageable with the selected technology. The commenter stated that there was good progress in terms of the film shown from the previous work indicating a high probability of success at least as far as the film was concerned.

Reviewer 4:
The reviewer commented that it appeared that some materials production targets had been achieved, but it was not clear how much this contributed to achieving of the overall DOE goals. The reviewer suspected that this would improve as the project progresses; however should be maintained as a subject for future presentations.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged that the team had very important members from the resin manufacturer, the dielectric engineers, the film production capability, and an EDV power inverter developing expert.

Reviewer 2:
The reviewer stated that the collaboration team members appeared to be a good mix of capacitor component suppliers and an automotive supplier. The reviewer suggested that adding additional capacitor suppliers to team in specific areas – should strengthen the team.

Reviewer 3:
The reviewer remarked that project team’s collaboration was described at a high level, but not in detail.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer explained that the project was at an initial stage, so most of the goals were in the future; in this sense there was a defined road map.

Reviewer 2:
The reviewer commented that the proposed future work aligned very well with the current progress and stated goals of this project. The reviewer noted that the next steps were a logical progression for continued development to take place. The commenter also indicated that the team had added collaborators with the required knowledge to continue the progress.

Reviewer 3:
The reviewer affirmed that the efforts to improve the film quality and reduce the film thickness were very important.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that decreasing costs would increase the sales of EDVs, leading to petroleum reductions.

Reviewer 2:
The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement, as it was addressing the need for a smaller, denser, high-voltage, high-temperature, robust capacitors for use as a bus capacitor.

Reviewer 3:
The reviewer explained that the focus had been on high-temperature semiconductors, but now low-cost and high-temperature capacitors were required for EVs.

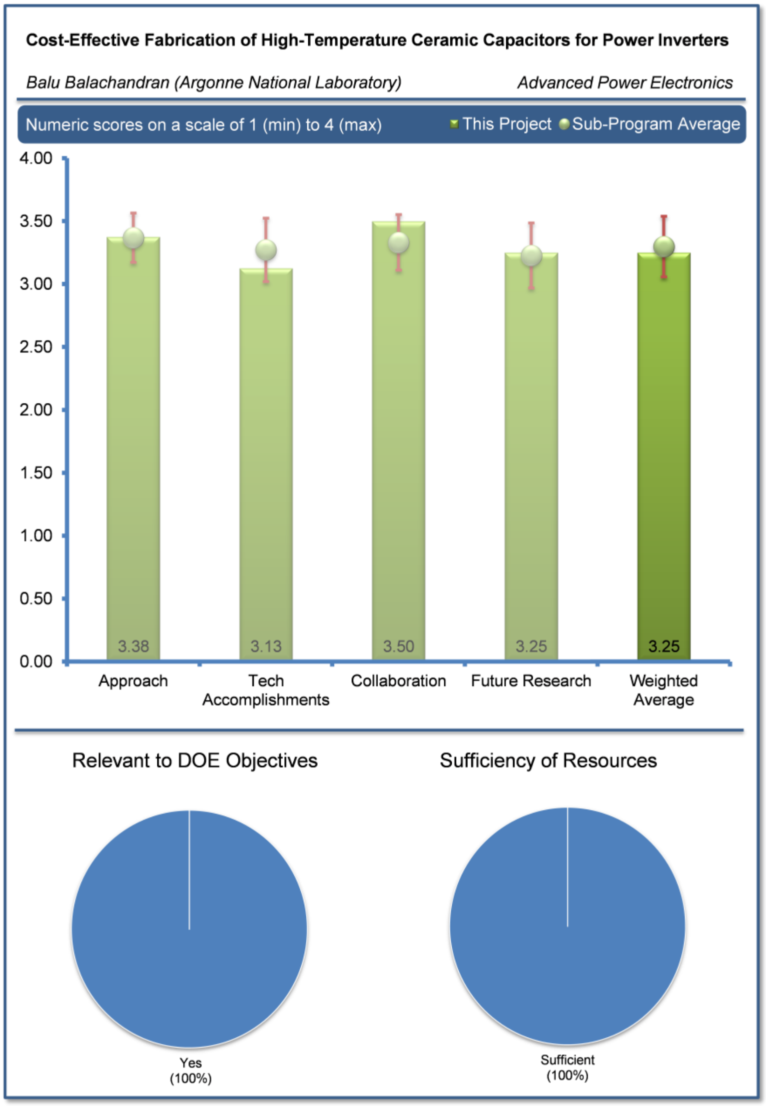
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer reported that the resources had been sufficient for the project to date, as the progress had been reasonable for a new program.

Reviewer 2:
The reviewer noted that the team had all the resources to complete the project, though more investment on film extrusion facilities may speed up the project.

Reviewer 3:
The reviewer reported that the resources were not discussed in detail, but seemed to be sufficient.

Cost-Effective Fabrication of High-Temperature Ceramic Capacitors for Power Inverters: Balu Balachandran (Argonne National Laboratory) - ape061



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that this project was developing a new process for capacitors with the intent of providing a more robust, smaller, and cheaper bus capacitor. The commenter indicated that the plan was feasible and had a logical flow from requirements through development and testing to final product. The reviewer described that the approach was based on different combination of materials on film than the previous capacitor projects reviewed this year.

Reviewer 2:

The reviewer commented that the lead zirconium titanate (PLZT) ceramic dielectric compositions developed by Argonne National Laboratory had excellent dielectric and high-voltage performance for DC link capacitors in EDVs. The commenter explained that the team proposed to overcome the low-breakdown in multilayer ceramic capacitor (MLCC) by using aerosol coating process to achieve high quality dielectric layer with high dielectric breakdown strength.

Reviewer 3:

The reviewer commented that the research seemed to be feasible and well-integrated with other efforts, but more information is needed to determine how the technical goals will lead to achieving overall DOE goals.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer pointed out that this project had only just begun, but progress looked good.

Reviewer 2:

The reviewer indicated that this was a new project and that the progress that was reported on was good and was consistent with the program plan. The reviewer said that the progress indicated that the approach was promising and that the development plan was reasonable. The project evaluator reported that improvements in the thickness of the PLZT application have been made using a commercially-viable application method that indicated good potential for this project. The reviewer stated that the progress had been made in the areas of cost-effectiveness by reducing fabrication time and the selection of the appropriate material. The commenter also recognized that the characterization data (from previous project) indicated that this approach was on the right track, and that progress was being made in the area of fabricating a more robust lower cost capacitor.

Reviewer 3:

The reviewer reported that the team demonstrated the capability to produce a thicker dielectric coating on metallized Kapton film and the coating had good performance. The reviewer explained that the team had initiated a roll-to-roll coating process which was required to fabricate the large size DC link capacitor in this project. The commenter remarked that the team shall be aware that the passive carrier substrate was much thicker than the active PLZT dielectric layer and the volume of the capacitor would be large.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer agreed that this work seemed very well-integrated with other organizations.

Reviewer 2:

The reviewer observed that the collaboration team members appear to be a good mix of national laboratories, university, Tier 1 supplier expertise, and fabrication process knowledge. The reviewer was concerned that two of the collaborators were on one of the competing capacitor development projects, and asked if the project team could support both with the appropriate resources when needed.

Reviewer 3:

The reviewer explained that the team had been actively working with the customer (Delphi) to test the prototype capacitor in EDC power inverters. The commenter also pointed out that Argonne National Laboratory was also working with Sigma who had impressive roll-to-roll processing capabilities.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer affirmed that the proposed future work addressed the challenges that were identified during the progress to date. The commenter confirmed that important issues, such as failing benign, were being addressed early in the development. The commenter also emphasized that the early development of the final capacitor specifications was an important step in ensuring that the program would remain focused on the right final solution.

Reviewer 2:

The reviewer noted that most of the targets were still in the future, so in that sense the targets were well laid out.

Reviewer 3:

The reviewer acknowledged that while the thin carrier layer was required to perform the roll-to-roll production to convert the superior dielectric performance of the PLZT material to large-size packaged capacitors, the proposed 5 µm thick Kapton carrier film was not commercially-available. The reviewer explained that the thinnest Kapton film on the market was only 7.5 µm which costs $2,000/kg. The commenter suggested that the team may consider using low-cost substrates, such as aluminum foil, thin PEN film, etc.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer confirmed that decreasing the cost of EDVs would increase sales and thereby decrease petroleum use.

Reviewer 2:

The reviewer agreed that this task was relevant to the stated DOE objective of petroleum displacement, as it was addressing the need for a smaller, denser, high voltage, high temperature robust capacitor for use as a bus capacitor.

Reviewer 3:

The reviewer stated that the capacitor was critical to achieving the DOE goal on EDV size, weight, and cost.

Reviewer 4:

The reviewer indicated that the focus had been on high-temperature semiconductors, but now low-cost and high-temperature capacitors were required for EVs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the resources were not discussed in detail, but seemed sufficient.

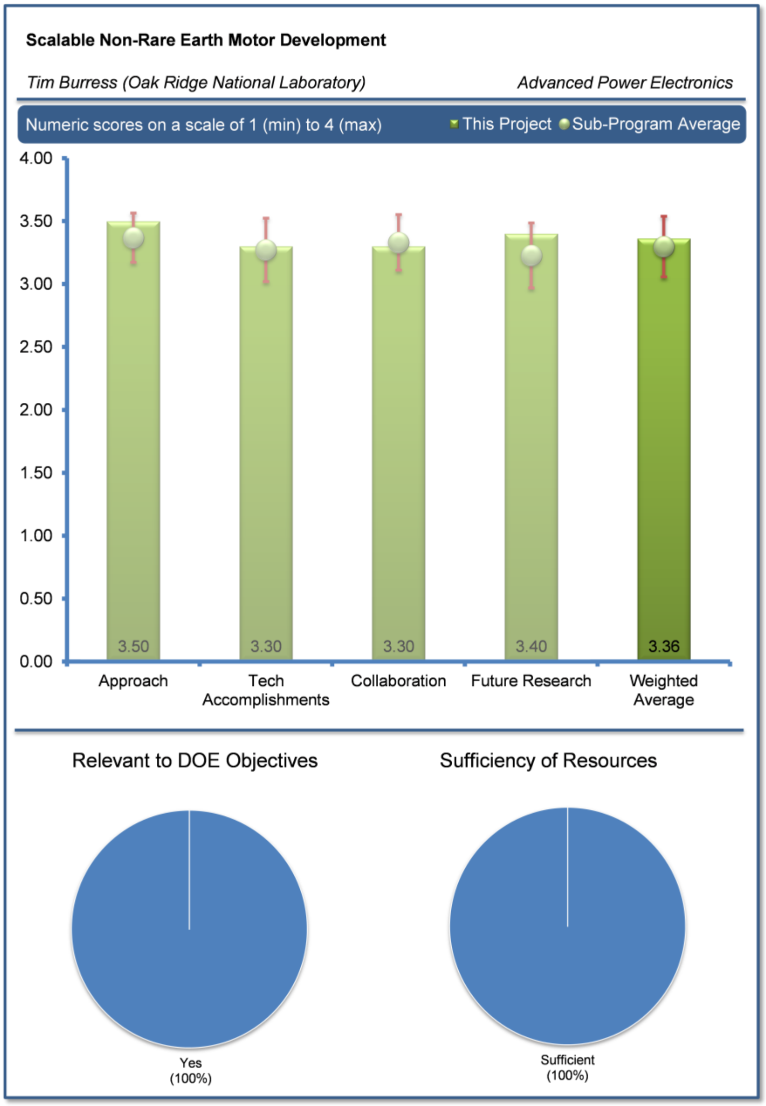
Reviewer 2:

The reviewer said the resources had been sufficient for the project to date, as the progress had been reasonable for a new program.

Reviewer 3:

The reviewer remarked that the team had strong capabilities on material characterization and capacitor test. The reviewer suggested that more resources might be necessary for roll-to-roll aerosol coating.

Scalable Non-Rare Earth Motor Development: Tim Burress (Oak Ridge National Laboratory) - ape062



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach to meet DOE targets had two main components, namely design of unconventional motor technologies starting from a comprehensive analysis of the major motor types and improving the performance of the soft magnetic material. The reviewer commented that compositional doping and new mechanical softening techniques were reported to have been employed to improve the workability of 6.5% Si steel material. The reviewer cautioned that the residual stress generated upon material cutting/stamping was also a matter of concern affecting the magnetization and permeability. The reviewer asked whether a low-temperature stress relief treatment would be considered to address this problem.

Reviewer 2:

The reviewer explained that this effort included fundamental research to improve three dimensional (3-D) finite element analysis (FEA) motor modeling accuracy (e.g., application of lamination stamping understanding and domain calculations) and their effect on lamination magnetic properties and micromagnetics software code. The project evaluator described that the initial simulations of novel designs would result in down-selection to the final design.

Reviewer 3:

The reviewer commented that the program might be too broad in scope, and if this led to a lack of focus and direction, it could fail to achieve useful results. The reviewer said that most of the presentation focused on high silicon content laminations, and if the electrical steel industry had difficulty creating this product at a lower cost it was difficult to see how this research would become a game-changer. The reviewer concluded by stating that electrical steel was big business. The reviewer encouraged the PI to continue looking for research elements that were not well covered right now. For example, most potting compounds were not ideal for motors (relatively high thermal resistance), so perhaps some materials work could be directed toward compounds and encapsulation that were better suited to motors.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer explained that the project was a continuation of development of high (6.5%) silicon steel using chemical vapor deposition, leading to a 40% reduction in core losses. The commenter cautioned that one drawback to this material was that it was more brittle and difficult to work with. The reviewer also explained that advanced analysis of the nonhomogeneous properties of magnetic steels were being observed through use of a custom measurement fixture which was helping to investigate the effect of punching, welding, etc. the commenter also described that scanning electron microscope analysis was being used to determine that stress/strain evident into laminations after punching (significant to ~150 m). The reviewer explained that brushless field excitation and synchronous reluctance machines were among the most promising topologies being modeled, and the performance attributes were being evaluated compared to state-of-the-art hybrid-electric systems.

Reviewer 2:

The reviewer explained that the presentation was focused more on magnetic materials and analysis tools. The reviewer wondered why the non-RE material selection and improvements were not presented. The commenter also suggested that it would have been nice to see the details about the trade study results of machine types. The project evaluator asked the researchers what machine type would be considered for prototyping, and why.

Reviewer 3:

The reviewer pointed out that it was difficult to judge the accomplishments of a new program.

Reviewer 4:

The reviewer summarized that the team identified the 'next generation' synchronous reluctance and 'second generation' brushless field excitation motors as top choices for design optimization with a simulated torque and power performance comparable to 2010 Toyota Prius reference. The reviewer commented that not enough details were given on the respective designs, but the comparison charts showed a very good start of the program. The reviewer cautioned that the accuracy of the employed conventional FEA techniques may raise questions, and the implementation of the designs may bring out technical issues that are yet to be addressed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed that the collaborators were the top experts for the ascribed tasks. During the presentation, the presenter mentioned that the team intended to draw from other material development activities outside the current collaboration, which was a very good strategy.

Reviewer 2:

The reviewer confirmed the good list of collaborators and their planned involvement in the program. The reviewer recognized that this collaboration may evolve as the program was further defined.

Reviewer 3:

The reviewer acknowledged that there was apparent core collaboration in this area, while respecting independent in the application between several of these DOE programs on this subject matter. The commenter highlighted that this synergy was necessary to achieve the objectives in motor development.

Reviewer 4:

The reviewer described that the industry collaboration partners included Remy (controls) and UQM (thermal management). The national laboratory partners include NREL (thermal management) and AMES (Non-Rare-Earth PM development/Beyond Rare Earth Magnets).

Reviewer 5:

The reviewer recommended that a couple of universities be added for collaboration to increase the depth and breadth of the team.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer agreed that the future work was very clear on both motor design prototype and test, and electric steel material optimization.

Reviewer 2:
The reviewer recounted that the near-term goals included continued studies of deformation and residual stress impacts on electrical steel, development of code for analyzing magnetic domain propagation, and finalizing a proof-of-concept design. The first-stage prototype follows in FY 2015 with the final machine in FY 2016.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that continued motor research and motor optimization would increase electrified vehicle market penetration, leading to reduced oil consumption.

Reviewer 2:
The reviewer stated that the proposed research would increase the efficiency of the non-RE PM machines; hence, this work would achieve better MPG or MPGe in the vehicle applications.

Reviewer 3:
The reviewer commented that the electrical machine technologies developed under this effort support further vehicle electrification and hybrid-electric applications, which would result in less fuel consumption. The reviewer explained that less RE content would significantly reduce the cost of advanced electric machines, contributing to increased adoption.

Reviewer 4:
The reviewer applauded the project team's nice work and looked forward to seeing the details of this project in the future.

Reviewer 5:
The reviewer referenced Question 1 comments, and cautioned that there are other innovative ways to increase lower speed efficiency aside from re-invented electrical steel. The reviewer suggested that looking for analogous technologies in other industries (e.g., internal combustion engines) could often help spur new ideas.

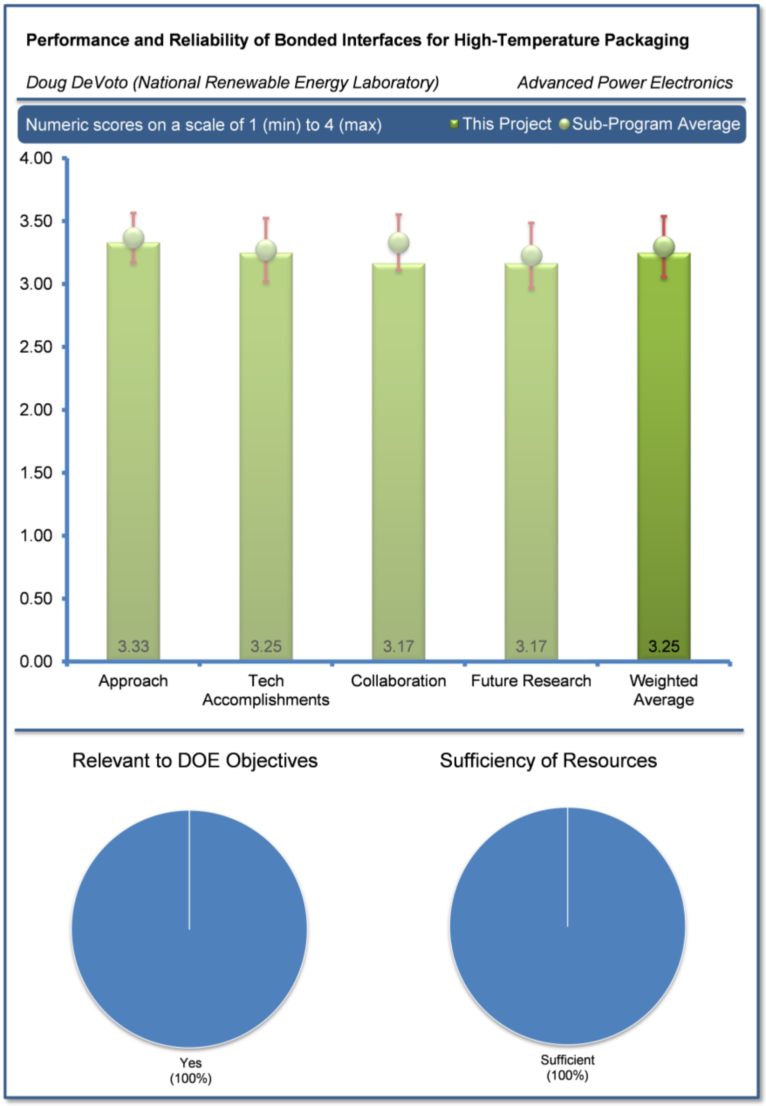
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that ORNL had a good motor team, and combined with collaborators from other institutions; the resources should be sufficient for this program.

Reviewer 2:
The reviewer asserted that an impressive amount of analysis and advancement in FEA techniques was a part of this effort; thus a lack of resources was not apparent from the materials provided.

Reviewer 3:
The reviewer considered that the budget was sufficient for this project.

Performance and Reliability of Bonded Interfaces for High-Temperature Packaging: Doug DeVoto (National Renewable Energy Laboratory) - ape063



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that this project was a new start and was likely to evolve with time. The commenter noted that the current work was focused on a sintered silver bond interface, but also suggested that it would be useful to consider including a brazed bond interface.

Reviewer 2:

The reviewer explained that the method proposed to determine the occurrence of delamination between various layers of different coefficient of thermal expansion materials in power devices was promising and could be useful to develop reliability and product durability models. However, the reviewer cautioned that the developed test samples needed to be thoroughly tested beyond 3,000 cycles. The commenter also commented that 5% delamination occurring after just 1,000 cycles may not be acceptable in certain applications. The reviewer encouraged the investigator to use alternative bonding material in power devices and then to assess the improvements in the elimination of early onset of the delamination phenomena. The reviewer also encouraged the application of bending force, while samples run through thermal cycling tests. The reviewer continued that this could be helpful to assesses if delamination process accelerates due to the presence of additional residual yet uneven distribution of forces in power electronics assembly. Apart from thermal cycling tests, thermal shock tests for assembly were also encouraged by the reviewer, if not already planned in the project.

Reviewer 3:

The reviewer emphasized that the interface modeling needed to be validated; however, the validation would be difficult because the simulation results (i.e., von Mises stress) cannot be directly measured in test. Hence, a better validation plan should be considered, especially if the model would be used for reliability analysis in the future work.

Reviewer 4:

The reviewer explained that this project was related to the fabrication of power modules using devices capable of operating at high temperature and what was required to enable these devices to do so reliably. The commenter indicated that this project was addressing the method of bonding devices to the substrate in a cost-effective and reliable method that can support high temperatures; currently this was an issue and would become a larger issue with the use of WBG devices. The reviewer described that the problem arises from a difference in the coefficients of thermal expansion of the materials and the resulting stress. The reviewer indicated the team was modeling the stress and would then be performing testing to verify the model and processes developed. Finally, accelerated life testing would be performed to create recommended manufacturing processes for this joint. The reviewer expected that the end result would be a manufacturing process that allows the inverter to take advantage of high temperature operation without a loss in reliability.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer recognized that this project was a new start based on previous work which provided input based on modeling and test results from temperature cycling test samples. The reviewer recounted that, based on this data and new model was created and was being used to evaluate the stresses seen in the joint. The reviewer summarized that test samples with different coefficients of thermal expansion were created for use in testing to determine material and degradation characterization. In summary, the reviewer applauded the excellent start for the new project.

Reviewer 2:

The reviewer summarized that the investigator had carried out BIM testing, interface material/layer modeling, and preparation of test samples made of Invar and copper; both were also metalized with silver. The reviewer anticipated that BIM testing, interface material/layer modeling and preparation of test samples should facilitate a desired foundation for the project work and tasks in upcoming budget periods during FY 2015 and FY 2016. The reviewer questioned why it was desired to start module packaging work by selecting materials with different coefficients of thermal expansion. The reviewer also asked why attempts were not made to use materials with compatible and identical coefficients of thermal expansion.

Reviewer 3:

The reviewer noted that the work was in progress and was based upon a sound technical approach.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the collaboration among team members was very good.

Reviewer 2:

The reviewer suggested that the effort would benefit from collaboration with power module manufacturers.

Reviewer 3:

The reviewer indicated that the investigator had identified project partners from ORNL, Heraeus, Henkel, and GM. As such, no details were provided, but this may be due to the project is in its early phase.

Reviewer 4:

The reviewer commented that the team had not demonstrated their expertise in model validation under uncertainty, uncertainty modeling and quantification, which were key elements in reliability analysis.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer asserted that the investigator had identified quite challenging and relevant tasks for the future research and if carried out properly and in a timely manner these tasks had potential to offer excellent results during FY 2015 and FY 2016.

Reviewer 2:

The reviewer commented that the future work was centered on developing a stronger experimental correlation between interface patterning/degradation and junction temperature rise. The steps identified for this were appropriate to provide the data and insight required to enable this correlation to be performed. The reviewer indicated that once this correlation was understood, then it would be possible to develop a sinter-silver-based bonding process that was both reliable and met the cost goals.

Reviewer 3:

The reviewer commented that there was a lack details provided regarding their plan for validation and reliability work in the future. For example, the team would evaluate the delamination rate under various pressure requirements, bond areas, pad geometries, etc. The reviewer explained that without an effective reliability analysis methodology, these activities could be not only costly and time consuming, but could also provide little valuable information for the reliability analysis. The reviewer proposed that the team consider adding such expertise in the future collaboration.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer highlighted that this project had the potential to solve reliability and durability challenges faced by present generation of power electronics. If life, reliability and durability challenges were properly understood and solved satisfactorily, outcomes of this project could increase confidence of industries involved in vehicle electrification activities and projects to develop products for EV and HEV based transportation systems. The reviewer agreed that project outcomes could support a net reduction in consumption of petroleum fuel.

Reviewer 2:

The reviewer confirmed that this task was relevant to the stated DOE objective of petroleum displacement, as it was providing a reliable and cost-effective bonding process for high temperature power modules which would enable smaller, lighter, and more efficient traction systems.

Reviewer 3:

The reviewer stated that high-temperature bonding was required on WBG circuits for EVs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

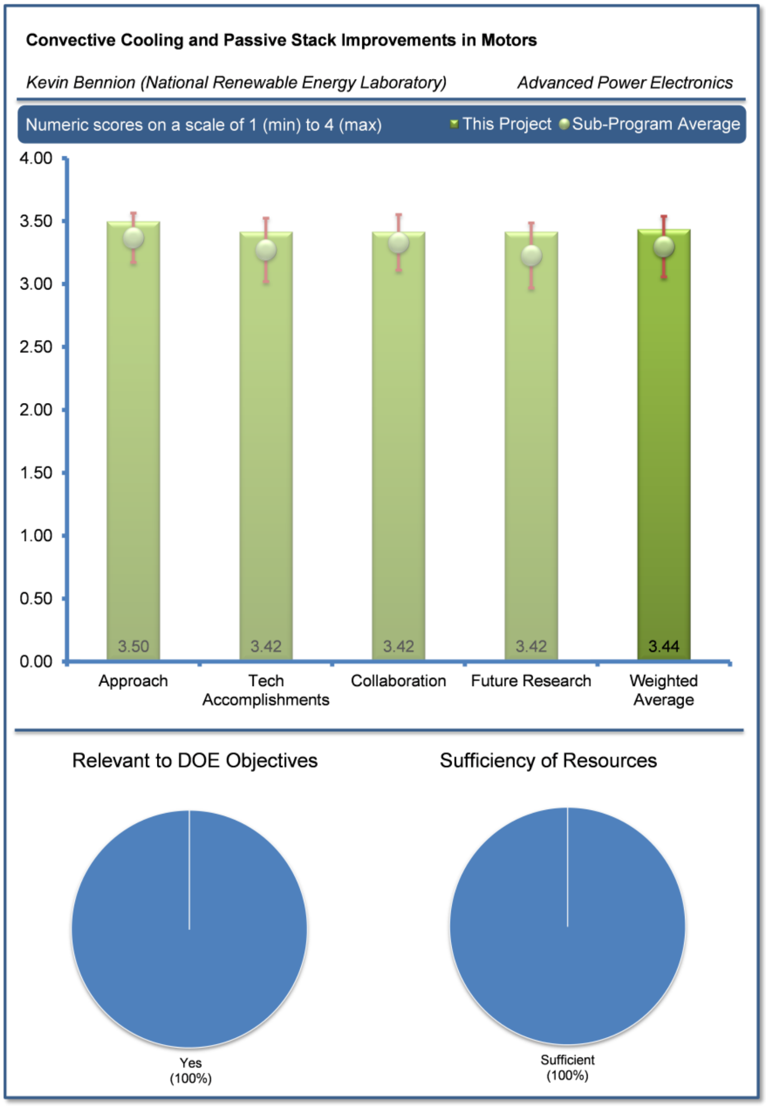
Reviewer 1:

The reviewer stated that the resources had been sufficient for the project to date for the progress had been carried out as planned.

Reviewer 2:

The reviewer encouraged the investigator to increase collaborations with the manufacturers of power electronics parts, devices, and systems solutions.

Convective Cooling and Passive Stack Improvements in Motors: Kevin Bennion (National Renewable Energy Laboratory) - ape064



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that the work plan had used a very systematic and logical breakdown of the cooling mechanisms in electric machines, and made very good use of input from manufacturers and users of motors in industry, to make sure that final outcome of research would be useful to the industry.

Reviewer 2:

The reviewer remarked that this program was well-conceived, starting with the evaluation of the many orthotropic regions of the motor through experimentation. The commenter reported that the pros and cons of the cooling strategies were also well-understood, with foresight shown regarding some of the “hidden” challenges (e.g., heat at the center of the stack with oil spray cooling).

Reviewer 3:

The reviewer noted that the thermal management technologies to be developed by NREL, and the corresponding analysis, was intended to be conceptually applicable to various motor configurations, although different operating conditions may require specific design. The reviewer asked whether the team was sharing the information on the splatter effect with increasing velocity and temperature, with the automatic transmission fluid manufacturers. The reviewer wondered if there was there any work on improving the performance by increasing the viscosity and decreasing the surface tension, while retaining excellent thermal conductivity.

Reviewer 4:

The reviewer stated that this was a FY 2014 start project that was focused on thermal management of electrical machines. Consideration was being made with regard to the cooling fluid, PMs, insulation system, efficiency, operating temperature, etc. The reviewer described that the objectives included data, analysis methods, and experimental techniques to improve and better understand motor thermal management. Analysis was being conducted to exploit the orthotropic (direction-dependent) thermal properties of the materials in the machine. Heat transfer coefficients were being determined. The primary focus was on the stator system to be applicable to as many machine types as possible. The reviewer noted that active rotor cooling was not a focus area, despite significant concerns with the PMs, so the reviewer indicated that additional attention would be useful in this area especially due to the push to reduce PM Dy content, lowering the operating temperature.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted the good work so far developing rigorous test methods for measuring convection and directional conduction properties of windings and lamination stacks.

Reviewer 2:

The reviewer recognized the good start to this program, with a variety of tests already performed and others on deck to be performed. The commenter noted that it was good to see a program that got out of the gates quickly.

Reviewer 3:

The reviewer lauded the significant project accomplishments including the oil impingement test apparatus and results, with consideration to different surface treatments. Additionally, the reviewer mentioned that data was being collected related to lamination-lamination thermal contact resistance determined as a function of pressure, with consideration to the impact of varying numbers of laminations. Measurement of thermal conductivity of in-slot wire bundles with different fill factors was also being completed. The reviewer highlighted that one interesting finding discussed was that the splattering of coolant results in more random heat transfer properties compared to more uniform flow.

Reviewer 4:

The reviewer noted that the milestones seemed to have been met on schedule. The commenter explained that the major milestones for this reporting period were on measuring the automatic transmission fluid heat transfer convection coefficients on target surfaces and orthotropic thermal conductivity. The reviewer suggested that guidance be provided for the lamination material (i.e., thermal resistance, surface roughness, and number of stacks) to ensure effective thermal management. The reviewer also indicated that an analysis of potting materials has not yet been done.

Reviewer 5:

The reviewer suggested including concentrated winding types to the study as some car manufacturers use motors with concentrated windings. The commenter also explained that in motors, typically it was possible to incorporate RTD or other thermal sensors inside the stator to monitor the stator temperature; however, measuring the rotor temperature is not practical. So the reviewer voiced that it would be a great contribution if this project covered the prediction of rotor temperatures. The commenter suggested including modeling and analysis of PMs for thermal characterization.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer agreed that there was a very good combination of industry and government laboratory resources that brought a wealth of knowledge to bear on the subject. The project evaluator confirmed that the work appeared to be well-coordinated, and researchers appeared to be responsive to input from industry, and making mid-course adjustments as needed.

Reviewer 2:

The reviewer acknowledged the good collaborators with other laboratories and history suggests that the PI would also engage industry throughout the project.

Reviewer 3:

The reviewer pointed out that the key collaborator in this work was ORNL, with support from the HEV benchmarking activity, motor design expertise, and materials development. The reviewer also acknowledged that significant industry partnerships providing input and exchanging data include Ford, Chrysler, Tesla, UQM, Remy, and Magna.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer agreed that the proposed combination of experimental work and computational fluid dynamics for test correlation made good sense, and this would maximize value of research to industry.

Reviewer 2:

The reviewer recognized that the future work was well-conceived and the reviewer was looking forward to the insights obtained from the research, especially the effect that orthotropic properties had on the temperature through the length of a motor. The reviewer also noted that almost all of the temperature sensors were placed somewhere in the end windings, independent of the cooling method.

Reviewer 3:

The reviewer commented that the proposed future work was very well-defined, but to their understanding was limited to analyzing the current conventional thermal management technologies and testing their efficiency, rather than to elaborating new concepts or technologies. The reviewer asked whether the concept of heat pipes would be applicable, or introduce excessive weight.

Reviewer 4:

The reviewer explained that the near-term plans included further analysis based on automatic transmission fluid data, simulation and model validation of impinging fluid jets, and end turn thermal analysis. The commenter also noted that the FY 2015 goals included further end turn analysis and motor in-situ measurement of thermal resistances.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer agreed that thermal management was a key technology for improving power/torque density and reliability of electric machines, and reducing the heavy RE content in PM motors. The commenter stated that both of these objectives supported the widespread use of EVs, and therefore petroleum displacement.

Reviewer 2:

The reviewer confirmed that thermal management was critical to electrified vehicles. The commenter explained that poor thermal management may lead to reduced life and low reliability, so this research would help electrification market penetration, and thus reduce oil consumption.

Reviewer 3:

The reviewer asserted that the electrical machine technologies developed under this effort supported further vehicle electrification and hybrid-electric applications, which would result in less fuel consumption. The commenter also stated that improved thermal management would result in less thermal burden on the vehicle cooling system, thereby improving overall powertrain efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources seemed well-matched to the stated objectives.

Reviewer 2:

The reviewer said that the resources for this program appeared to be sufficient.

The reviewer considered the budget to be sufficient for this project. However, if new cooling concepts will be explored, extra funds may be needed.

Reviewer 3:

The reviewer noted that an impressive amount of analysis and advancement in thermal management techniques was a part of this effort. Thus, a lack of resources was not apparent from the materials provided.

Acronyms and Abbreviations

Acronym	Definition
3-D	Three-dimensional
Al	Aluminum
APEEM	Advanced Power Electronics and Electrical Machines
B	Boron
BIM	Bonded Interface Material
Co	Cobalt
DC	Direct Current
DOE	Department of Energy
Dy	Dysprosium
EDR	Eigenvector dimension reduction
EDV	Electric Drive Vehicle
EE	Energy efficiency
EV	Electric Vehicle
EVSE	Electric vehicle supply equipment
Fe	Iron
FEA	Finite Element Analysis
FY	Fiscal Year
GaN	Gallium Nitride
GE	General Electric
GM	General Motors
HEV	Hybrid Electric Vehicle
kW	Kilowatt
kV	Kilovolt
MGOe	Megagauss-oersteds
MLCC	Multilayer ceramic capacitor
MPG	Miles per gallon
MPGe	Miles per gallon-electric
Nd	Neodymium
Ni	Nickel
NIST	National Institute of Standards and Technology
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PI	Principal Investigator
PLZT	Lead Zirconium Titanate
PM	Permanent Magnet
R&D	Research and Development
RE	Rare Earth
RPM	Rotations Per Minute

Acronym	Definition
Si	Silicon
SiC	Silicon carbide
V	Volt
VTO	Vehicle Technologies Office
WBG	Wide Bandgap
Zn	Zinc

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4. Advanced Combustion Engine Technologies

Improving the efficiency of internal combustion engines is one of the most promising and cost-effective near- to mid-term approaches to increasing highway vehicles' fuel economy. The Vehicle Technologies Office's (VTO) research and development activities address critical barriers to commercializing higher efficiency, very low emissions advanced internal combustion engines for passenger and commercial vehicles. This technology has great potential to reduce U.S. petroleum consumption, resulting in greater economic, environmental, and energy security.

Already offering outstanding drivability and reliability to over 230 million passenger vehicles, internal combustion engines have the potential to become substantially more efficient. Initial results from laboratory engine tests indicate that passenger vehicle fuel economy can be improved by more than 50%, and some vehicle simulation models estimate potential improvements of up to 75%. Advanced combustion engines can utilize renewable fuels, and when combined with hybrid electric powertrains could yield further reductions in fuel consumption. The EIA reference case forecasts that by 2040, more than 99% of light- and heavy-duty vehicles sold will still have internal combustion engines, therefore the potential fuel savings are tremendous.

The VTO undertakes research and development activities to improve the efficiency of engines for both light and heavy-duty highway vehicles, whether they run on petroleum-based (gasoline and diesel) or alternative fuels. VTO supports every phase of research in these areas, from fundamental science to prototype demonstration. VTO's research focuses on improving engine efficiency while meeting future federal and state emissions regulations. It does this through three main approaches:

- Developing advanced combustion strategies that maximize energy efficiency while minimizing the formation of emissions within the engine.
- Developing cost-effective aftertreatment technologies that further reduce exhaust emissions at a minimum energy penalty.
- Recovering energy from engine waste heat normally lost through the cooling and exhaust systems.

Commercialization of these advanced combustion engine technologies could allow the United States to cut its transportation fuel use and corresponding greenhouse gas emissions by as much as 20 to 40%.

Research and development is done in collaboration with industry, national laboratories, other federal agencies (such as the National Science Foundation [NSF]) and universities, as well as through the following government/industry partnerships:

- U.S. Driving Research and Innovation for Vehicle Efficiency and Energy sustainability (U.S. DRIVE) Partnership focusing on light-duty vehicles
- 21st Century Truck Partnership, focusing on medium- and heavy-duty vehicles

The major goals of the Advanced Combustion Engine R&D subprogram are:

- By 2015, increase the efficiency of internal combustion engines for passenger vehicles resulting in fuel economy improvements of 25% for gasoline vehicles and 40% for diesel vehicles; and by 2020, improve the fuel economy of gasoline vehicles by 35% and diesel vehicles by 50%, compared to 2009 gasoline vehicles.
- By 2015, increase the efficiency of internal combustion engines for commercial vehicles to 50%, a 20% improvement from the 42% of the baseline 2009 heavy-duty engine. This goal is part of the overall SuperTruck initiative to increase Class 8 truck freight hauling efficiency by more than 50% by 2015. By 2020, further improve engine efficiency to 55% with demonstrations on commercial vehicle platforms.
- By 2015, increase the fuel economy of passenger vehicles by at least 5% using thermoelectric generators that convert energy from engine waste heat to electricity.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Gurpreet Singh (U.S. Department of Energy) – ace000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer observed a well-presented overview on overall strategy and goals.

Reviewer 2:
The reviewer answered yes, and commented that it was a lot to cover in such a brief presentation but that it was well summarized.

Reviewer 3:
The reviewer commented yes, although technical success or progress should not be misinterpreted as retail success or social acceptance of the technology.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer responded yes, and clarified that some of the projects are quite high risk/high potential and some closer to real world production implementation.

Reviewer 2:
The reviewer remarked generally well balanced, although long term could use some more definition.

Reviewer 3:
The reviewer opined that, looking at near-/mid-term research and development (R&D), current internal combustion engine (ICE) technology, including relatively untapped lean burn and ethanol/lean burn, have been fully exhausted in investigation, and new technology, such as homogeneous charge compression ignition (HCCI)/reactivity controlled compression ignition (RCCI) or any other technology that drives a paradigm change in customer behavior, is at best 15 years out or more.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer responded yes.

Reviewer 2:
The reviewer responded yes, the workshops with stakeholders are effective to identify the real issues and find ways to address the hard points.

Reviewer 3:
The reviewer said in a technical sense, yes, and in an implementation sense, no.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer said yes, and commented nice job of working with stakeholders. The reviewer noted that some programs remain high risk, but these risks are properly stated, and successful completion of the tasks will reduce the risks.

Reviewer 2:
The reviewer commented not the implementation challenges.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer commented yes.

Reviewer 2:
The reviewer responded moderately; good presentation of this year's status, not completely compared to last year's status.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:
The reviewer commented yes, and observed a good match.

Reviewer 2:
As the reviewer indicated previously, technical barriers will be more easily overcome than social acceptance, retail and infrastructure challenges.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer commented yes, nicely aligned and clearly focused with stakeholder agreement.

Reviewer 2:
The reviewer said yes.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
According to the reviewer, strengths include the coordination with academia and industry so that the funding directly addresses the real challenges in an effective way. The reviewer observed no major weakness, although more funding would always help.

Reviewer 2:
This reviewer commented on weaknesses. The reviewer believed additional focus on IC as we know it is still in the 0-15 year future for engines, perhaps longer, and advanced combustion is after that.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer stated yes, observing many solid technologies under development that might not have received much attention without DOE encouragement.

Reviewer 2:
The reviewer commented yes.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer commented yes, very good collaboration.

Reviewer 2:

The reviewer noted that oil producers, retailers and other similar parties are part of the equation. According to the reviewer, it may not be appropriate to this discussion, but if the technical solution develops into an implementation nightmare, outside input from those affected parties will be valuable.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:

The reviewer commented yes, a real strength.

Reviewer 2:

The reviewer commented not yet.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:

The reviewer did not see major gaps.

Reviewer 2:

The reviewer identified infrastructure and implementation as gaps.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:

The reviewer commented that off-road vehicles are not directly addressed. Test procedures and emission limits are evolving; there may be unique engine requirements.

Reviewer 2:

The reviewer remarked infrastructure and implementation.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer observed a good portfolio now.

Reviewer 2:

The reviewer identified infrastructure, implementation, and lean burn/ethanol combustion as other areas to consider.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer encouraged the program to keep doing more of the same.

Reviewer 2:

The reviewer suggested the program meet with original equipment manufacturers (OEMs) and oil producers on the business/program side to discuss potential technical solutions. If implementation is too painful or costly to customer, it will not happen.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer commented none at this time.

Reviewer 2:

The reviewer said no.

Project Feedback

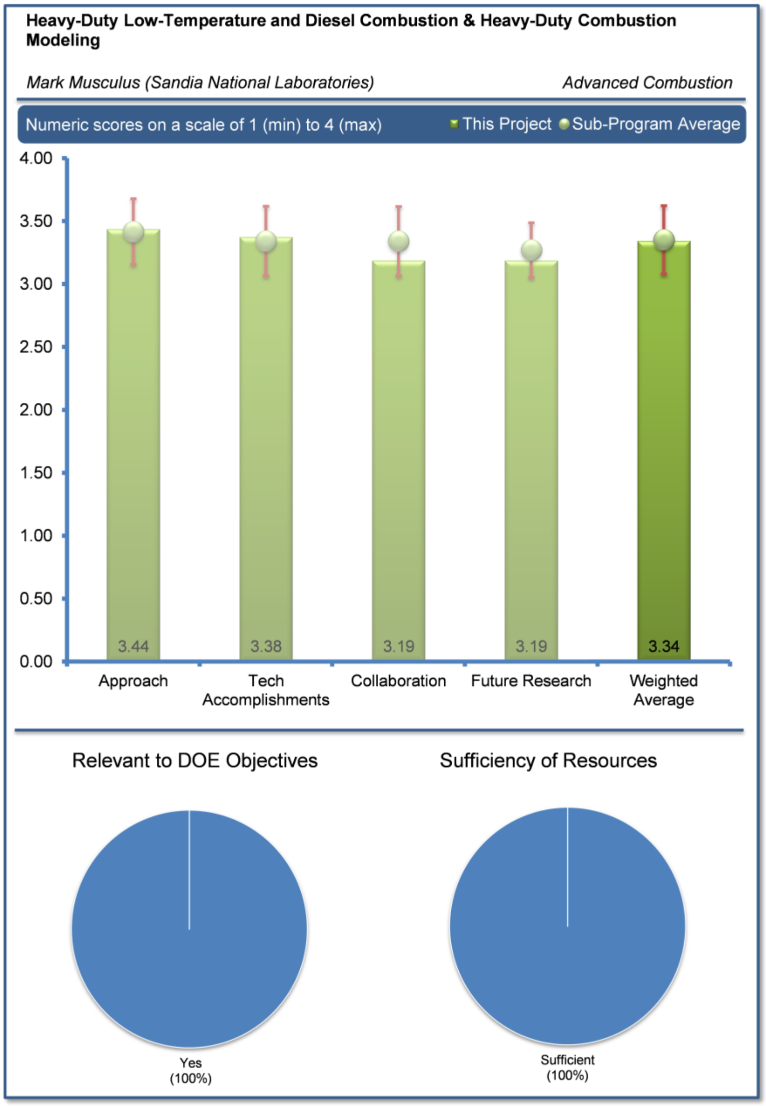
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses (*on a scale of 1.0 to 4.0).* In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Heavy-Duty Low-Temperature and Diesel Combustion & Heavy-Duty Combustion Modeling	Mark Musculus (Sandia National Laboratories)	4-10	3.44	3.38	3.19	3.19	3.34
Light-Duty Diesel Combustion	Paul Miles (Sandia National Laboratories)	4-16	3.50	3.30	3.10	3.10	3.30
HCCI and Stratified-Charge CI Engine Combustion Research	John Dec (Sandia National Laboratories)	4-20	3.44	3.44	3.44	3.31	3.42
Spray Combustion Cross-Cut Engine Research	Lyle Pickett (Sandia National Laboratories)	4-25	3.57	3.50	3.86	3.21	3.53
Automotive Low Temperature Gasoline Combustion Engine Research	Isaac Ekoto (Sandia National Laboratories)	4-29	3.11	3.22	3.22	3.11	3.18
Large Eddy Simulation (LES) Applied to Advanced Engine Combustion Research	Joe Oefelein (Sandia National Laboratories)	4-34	3.50	3.29	3.07	3.43	3.33
Fuel Injection and Spray Research Using X-Ray Diagnostics	Christopher Powell (Argonne National Laboratory)	4-38	3.63	3.50	3.38	3.38	3.50
Use of Low Cetane Fuel to Enable Low Temperature Combustion	Steve Ciatti (Argonne National Laboratory)	4-40	2.58	2.58	2.92	2.75	2.65
Model Development and Analysis of Clean & Efficient Engine Combustion	Russell Whitesides (Lawrence Livermore National Laboratory)	4-44	3.33	3.25	3.25	3.17	3.26
Chemical Kinetic Models for Advanced Engine Combustion	Bill Pitz (Lawrence Livermore National Laboratory)	4-47	3.72	3.72	3.61	3.44	3.67
2014 KIVA Development	David Carrington (Los Alamos National Laboratory)	4-52	2.89	3.00	3.00	3.00	2.97
Stretch Efficiency for Combustion Engines: Exploiting New Combustion Regimes	Stuart Daw (Oak Ridge National Laboratory)	4-57	3.50	3.25	3.00	3.33	3.29
High Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines	Scott Curran (Oak Ridge National Laboratory)	4-60	3.56	3.44	3.61	3.39	3.49
Accelerating Predictive Simulation of IC Engines with High Performance Computing	Kevin Edwards (Oak Ridge National Laboratory)	4-64	3.30	3.30	3.30	3.30	3.30
CLEERS Coordination & Joint Development of Benchmark Kinetics for LNT & SCR	Stuart Daw (Oak Ridge National Laboratory)	4-67	3.67	3.50	4.00	3.17	3.56
CLEERS Aftertreatment Modeling and Analysis	George Muntean (Pacific Northwest National Laboratory)	4-72	3.50	3.30	3.40	3.10	3.34
Particulate Emissions Control by Advanced Filtration Systems for GDI Engines	Kyeong Lee (Argonne National Laboratory)	4-76	3.00	3.00	2.80	2.80	2.95
Enhanced High and Low Temperature Performance of NOx Reduction Materials	Chuck Peden (Pacific Northwest National Laboratory)	4-81	3.88	3.75	3.63	3.50	3.73

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Thermally Stable Ultra-Low Temperature Oxidation Catalysts	Chuck Peden (Pacific Northwest National Laboratory)	4-84	3.75	3.50	3.42	3.50	3.55
Cummins/ORNL-FEERC CRADA: NOx Control & Measurement Technology for Heavy-Duty Diesel Engines	Bill Partridge (Oak Ridge National Laboratory)	4-88	3.50	3.07	3.50	3.21	3.25
Emissions Control for Lean Gasoline Engines	Jim Parks (Oak Ridge National Laboratory)	4-93	3.80	3.50	3.70	3.60	3.61
Neutron Imaging of Advanced Engine Technologies	Todd Toops (Oak Ridge National Laboratory)	4-97	3.50	3.00	3.20	3.30	3.19
Collaborative Combustion Research with BES	Scott Goldsborough (Argonne National Laboratory)	4-100	3.38	3.13	3.25	3.13	3.20
Fuel-Neutral Studies of Particulate Matter Transport Emissions	Mark Stewart (Pacific Northwest National Laboratory)	4-102	3.50	3.50	3.70	3.30	3.50
Cummins SuperTruck Program - Technology and System Level Demonstration of Highly Efficient and Clean, Diesel Powered Class 8 Trucks	David Koeberlein (Cummins)	4-106	3.90	4.00	3.50	3.80	3.89
SuperTruck Program: Engine Project Review	Sandeep Singh (Detroit Diesel)	4-109	3.80	3.90	3.60	3.60	3.80
Volvo SuperTruck - Powertrain Technologies for Efficiency Improvement	Pascal Amar (Volvo Trucks)	4-112	3.70	3.80	3.70	3.70	3.75
ATP-LD; Cummins Next Generation Tier 2 Bin 2 Diesel Engine	Michael Ruth (Cummins)	4-115	3.56	3.56	3.31	3.44	3.52
A MultiAir / MultiFuel Approach to Enhancing Engine System Efficiency	Ron Reese (Chrysler LLC)	4-120	3.30	2.90	3.20	3.30	3.09
Advanced Gasoline Turbocharged Direct Injection (GTDI) Engine Development	Corey Weaver (Ford Motor Company)	4-124	3.40	3.30	3.10	3.60	3.34
Advanced Combustion Concepts - Enabling Systems and Solutions (ACCESS) for High Efficiency Light Duty Vehicles	Hakan Yilmaz (Robert Bosch)	4-128	3.50	3.50	3.75	3.25	3.50
Advancement in Fuel Spray and Combustion Modeling for Compression Ignition Engine Applications	Sibendu Som (Argonne National Laboratory)	4-131	3.50	3.43	3.57	3.29	3.45
Improved Solvers for Advanced Engine Combustion Simulation	Matthew McNenly (Lawrence Livermore National Laboratory)	4-135	3.42	3.50	3.50	3.50	3.48
Cummins-ORNL\FEERC Combustion CRADA: Characterization & Reduction of Combustion Variations	Bill Partridge (Oak Ridge National Laboratory)	4-138	3.40	3.50	3.20	3.30	3.41
Investigation of Mixed Oxide Catalysts for NO Oxidation	Ayman Karim (Pacific Northwest National Laboratory)	4-142	3.50	3.50	3.42	3.00	3.43
Robust Nitrogen Oxide/Ammonia Sensors for Vehicle On-board Emissions Control	Rangachary Mukundan (Los Alamos National Laboratory)	4-146	3.17	3.08	3.33	3.17	3.15
Thermoelectric Waste Heat Recovery Program for Passenger Vehicles	Todd Barnhart (Gentherm)	4-150	3.25	3.42	3.33	3.17	3.33

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Cost-Competitive Advanced Thermoelectric Generators for Direct Conversion of Vehicle Waste Heat into Useful Electrical Power	Jim Salvador (General Motors LLC)	4-156	3.25	3.17	3.17	3.17	3.19
Nanostructured High-Temperature Bulk Thermoelectric Energy Conversion for Efficient Automotive Waste Heat Recovery	Martin Cleary (GMZ Energy Inc.)	4-162	3.33	3.25	3.17	3.17	3.25
High Efficiency GDI Engine Research, with Emphasis on Ignition Systems	Thomas Wallner (Argonne National Laboratory)	4-167	2.92	2.92	2.92	3.00	2.93
Low Temperature Emission Control	Todd Toops (Oak Ridge National Laboratory)	4-171	3.60	3.50	3.40	3.30	3.49
The Application of High Energy Ignition and Boosting/Mixing Technology to Increase Fuel Economy in Spark Ignition Gasoline Engines by Increasing EGR Dilution Capability	Edward Keating (General Motors LLC)	4-174	3.42	3.17	3.33	3.17	3.25
Next-generation Ultra-Lean Burn Powertrain	Hugh Blaxill (MAHLE Powertrain LLC)	4-179	3.25	3.42	3.42	3.17	3.34
Heavy Duty Roots Expander for Waste Heat Energy Recovery	Swami Nathan Subramanian (Eaton Corporation)	4-184	3.43	3.43	3.36	3.29	3.40
Development of Radio Frequency Diesel Particulate Filter Sensor and Controls for Advanced Low-Pressure Drop Systems to Reduce Engine Fuel Consumption	Alexander Sappok (Filter Sensing Technologies, Inc.)	4-189	3.30	3.50	3.70	3.40	3.46
High-Dilution Stoichiometric Gasoline Direct-Injection (SGDI) Combustion Control Development	Brian Kaul (Oak Ridge National Laboratory)	4-193	3.13	3.00	2.94	3.19	3.05
Intake Air Oxygen Sensor	Claus Schnabel (Robert Bosch)	4-197	3.50	3.50	3.20	3.50	3.46
Variable Compression Ratio Engine with Variable Valve Actuation and Supercharger	Charles Mendler (Envera LLC)	4-201	3.00	2.83	2.75	2.83	2.86
Overall Average			**3.42**	**3.34**	**3.34**	**3.27**	**3.35**

Heavy-Duty Low-Temperature and Diesel Combustion & Heavy-Duty Combustion Modeling: Mark Musculus (Sandia National Laboratories) - ace001



Reviewer Sample Size

A total of eight reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this project continued to be an example of a great national laboratory program, noting a solid approach and good results.

Reviewer 2:

The reviewer felt this project had an outstanding approach in leveraging simulation results to define new experiments and identify new areas to investigate.

Reviewer 3:

The reviewer stated that the overall experimental approach to understanding species formation and fuel consumption was truly outstanding, adding that the hardware and test conditions were relevant, and the collaboration with modeling efforts was yielding valuable insight. The reviewer added that the laser-absorption characterization of polycyclic aromatic hydrocarbon (PAH) nanostructure and formation mechanisms was valuable in combination with modeling. The reviewer noted that this was less important in the context of low temperature combustion (LTC), since manufacturers were unlikely to adopt this to a significant degree. The reviewer also added that the companion work in gasoline direct injection (GDI)/spark ignition (SI) would be very useful.

Reviewer 4:

The reviewer remarked that using an optical engine in conjunction with computational fluid dynamics (CFD) modeling was a good approach to understanding in-cylinder combustion phenomena and processes in diesel combustion.

Reviewer 5:

The reviewer commented that the approach of coupling optical engine experiments with CFD modeling was very useful for understanding and elucidating the fundamentals of injection, combustion, and pollutant-formation processes. This reviewer added that it looked like some adjustments had been made in response to the reviewer comments from last year.

Reviewer 6:

The reviewer observed that the current approach combined both experimentation and modeling to derive physical insights. The goal was to develop a new conceptual model to accelerate the design of advanced low-temperature, heavy-duty (HD) engine applications. The project was investigating injection and spray effects, combustion chamber geometry effects, and soot precursors with a variety of toolsets. The reviewer added that, for example, the CFD modeling was driven to compliment the experimentation and provide additional insights that could not be measured.

Reviewer 7:

The reviewer said that the author provided a rather comprehensive approach. This person added that it was accompanied by a good team. There may be improvements possible regarding the connection between the work here at a fundamental level with more real-world operation. Specifically, this reviewer felt that there could have been more clarity with respect to overall engine and power-plant efficiency.

Reviewer 8:

The reviewer asserted that the general approach was good. The experiments were well thought-out and well executed. This reviewer would like to have seen a more rigorous overall approach to the work, adding that the work presented appeared to be more a random collection of topics. This reviewer would like to have seen one topic fully investigated (such as post injections), and the connection shown to how simulations were improved and validated, quantifying the opportunity/savings of the new approach (such as fuel efficiency and/or emissions). This does not preclude the side topics that appeared, but this reviewer would like to have seen a stronger connection of how findings from this project ultimately impacted the performance of the fleet.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted the project team’s excellent work in a critical area.

Reviewer 2:

The reviewer indicated very interesting results on viewing the growth of soot precursors from the laser-induced fluorescence (LIF) tests in the optical engine. The reviewer indicated that there were important observations on the occurrence of dribble after the end of injection showing that it occurred for all injectors (and thus was not just a symptom of “bad” injectors), and that dribble was greater for n-heptane than diesel fuel.

Reviewer 3:

The reviewer highlighted that significant progress had been made in a number of areas. This person added that it was important to quantify the impact of the dribble, and asked if it manifested itself as an unburned hydrocarbon (HC) issue in a full powertrain system or vehicle.

Reviewer 4:

The reviewer was impressed by the findings of how the post injection interacted with the soot formed by the main injection. This reviewer would like to hear a hypothesis as to why it was improved, then to see a test plan to prove (or disprove) it. This person added that it was similar with the PAH work. Results were shown but without a hypothesis as to why. This reviewer noted it was good to see that more representative bowl geometry was now being included.

Reviewer 5:

The reviewer specified that Slide 3 of the presentation showed a progression of conceptual models starting with conventional diesel and LTC diesel. The reviewer added that the current work was focusing on developing the multiple-injection LTC model. This person felt that it would have been helpful to show what the principal investigator (PI) believed was confidently known regarding the conceptual model and what needed further understanding (such as expanding on Slide 23). Additionally, this reviewer asked, of the seven objectives outlined in Slide 4, how these helped clarify areas of uncertainty.

This reviewer said that the project included CFD contributions in KIVA and CONVERGE from different institutions (University of Wisconsin (UW), Cummins) using different modeling approaches for combustion. This reviewer asked how the things learned from these approaches would be consolidated to develop the conceptual model. The reviewer wanted to know if a particular code was uniquely equipped to solve a particular aspect of the problem, and how much time was anticipated to be allocated toward the injector dribble effect. The reviewer added that there had been evidence that dribble could have negative effects on combustion for some engine concepts. The reviewer asked if this work would drive injector suppliers to reduce dribble effects.

Reviewer 6:

The reviewer voiced that the overall experimental approach to understanding species formation and fuel consumption was truly outstanding, but added that the recent work overemphasized the importance of dribble. (The body of work already existed on this effect from about 15 years ago, correlating the effects of fuel pressure and sac volume on dribble and associated emissions.) This reviewer felt that greater focus going forward on end-of-injection mixing should be valuable. This person added that achieving contoured bowl geometry and higher-flow injector was an important milestone, as it would lead to better correlation with metal engine results, as well as give relevant geometry for examining injection strategy and effects on particulate matter (PM) formation.

Reviewer 7:

The reviewer stated that LTC was associated with high efficiency by reduced after-treatment. This person added that the topic could have been treated with greater thoroughness, specifically as LTC had been associated with a large release of UHC. It would have been good to document dribble in modern fuel systems. This reviewer added that the images from Slide 11 were insightful, and inquired about the estimated volume of dribble and what the impact would have been of the nozzle design (mini- or micro-sac, valve covered orifice styles) to the dribble. The reviewer also inquired about the following: the entrainment coefficient and impact on the overall predictability (such as for emissions); some of the basic flow and performance characteristics of the proposed Delphi DFI 21; and the basic nozzle configuration. This reviewer felt the project team could have given additional information regarding the soot model (Slide 22). The reviewer also asked if the work was carried out at the Engine Research Center (ERC). This person lastly added that the presentation could have shown some planar images.

Reviewer 8:

The reviewer remarked that clear evidence of injector dribble being detrimental to engine efficiency and emissions should have been presented before too much more work was done on characterizing dribble. This person added that, if and when the evidence showed that the detrimental effect was significant, then the first action to be taken should have been to present the evidence to several injector manufacturers and then challenge them to modify injector design to eliminate or reduce dribble. The reviewer noted an analogy was made with regard to injector “bounce” from 20 years ago and added, after the above approach was followed, today one did not encounter injector bounce that was significant enough to be a cause of concern. This reviewer said that, in other words, there was no sense in spending more than a certain useful minimum of time and resources on “characterizing” something detrimental when it was to be eventually eliminated.

This reviewer added that soot was a key issue in conventional diesel combustion and asked if soot was the most important problem for low-temperature diesel combustion. This person added that the understanding of soot mass was vastly reduced with LTC combustion, and that meeting soot number density standards “may” still have been an issue. The reviewer noted that, as far as LTC diesel combustion went, perhaps more time should have been spent on understanding the sensitivity of this advanced combustion process (to control variables so that a multi-cylinder engine could find a way into production), and added that this was a very serious barrier to LTC combustion.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed excellent project team collaboration and indicated that the close collaboration with modeling was seeing a payoff.

Reviewer 2:

The reviewer remarked that the project’s collaboration was an example of how lab/industry collaboration should be done.

Reviewer 3:

The reviewer commented that there were a variety of partners mentioned contributing to this project. It was important for the PI to consolidate the lessons learned to achieve the desired objectives.

Reviewer 4:

The reviewer pointed out that the Advanced Engine Combustion (AEC) Working Group was mentioned as a key collaboration with industry. This person added that it looked like a closer collaboration was set up with one of the AEC Working Group members (Cummins). This reviewer was uncertain how close the collaborations with the other AEC members were.

Reviewer 5:

The reviewer said that collaboration with injection system suppliers could be significantly improved.

Reviewer 6:

The reviewer would have liked to see more collaboration with industry, and added that Cummins clearly had a vested interest, given that their hardware was being used. Delphi was similar, in that Delphi had hardware that they would have liked to have evaluated. This reviewer said the rest of the OEM interactions were summed up with “correspondence” and the “AEC,” but added that the work with UW and Convergent was good and should continue.

Reviewer 7:

The reviewer mentioned that the team assembled was very good, with the core team composed of UW, Delphi, Cummins, and Convergent Science; yet the work demonstrated here could have been enhanced by more direct information provided by these partners in their specific areas. The reviewer expressed that little information was given to the soot modeling from University of Wisconsin-Milwaukee (UWM), and that no injector specifications or targets were given that could help the technical community understand the capability of the hardware (such as the accuracy of the injection events).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer asserted that the plans presented should continue the good progress that was being made.

Reviewer 2:

The reviewer indicated a solid project plan to attack significant issues.

Reviewer 3:

The reviewer said for the project team to continue building the conceptual model.

Reviewer 4:

The reviewer commented that upgrading fuel injection hardware was crucial. Also, the reviewer added that the effect of key operating variables on combustion sensitivity (such as combustion noise versus combustion stability), as well as understanding cause and effect, should have been explored as far as the optical engine went.

Reviewer 5:

The reviewer indicated that the PI had shown that post injections could reduce both emissions and fuel consumption. This person asked how many injection events were to be considered. The current approach appeared to focus on a main plus post injection strategy.

Reviewer 6:

The reviewer noted that the focus on gaining a greater understanding of injection strategies, injector characteristics, and state-of-the-art injector hardware was of primary importance, but added that being able to vary the characteristics of the injector may also be useful to understanding the sensitivity.

Reviewer 7:

The reviewer stated that new bowl geometry was a good direction and, as mentioned in the question-and-answer period, there was a need to be careful to not spend too much time on injector dribble. The reviewer said to quantify the impact. If it was significant, it should have been offered back to the fuel injector suppliers as a problem that needs to be solved.

Reviewer 8:

The reviewer noted the future work would focus on the testing with new piston geometry, an attempt to reconcile the work with geometries that were more in keeping with production hardware. This reviewer felt the project could have been more aggressive and innovative towards showing the correlation between this work and improved combustion and cycle efficiency. It gave the impression of staying focused on a narrow work scope.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that developing a fundamental understanding of injection, combustion, and emissions-formation processes should be the key to improving the design of future engines and enabling improvement of engine efficiencies, which supported the Department of Energy (DOE) objective of reducing petroleum consumption.

Reviewer 2:

The reviewer stated that fundamental understanding of in-cylinder processes, especially heat transfer and mixing, was critical to achieving low emissions with high efficiency.

Reviewer 3:

The reviewer said that the project was very relevant to efficient and low-emission combustion.

Reviewer 4:

The reviewer indicated that clearly this type of work was required, to better our understanding and our tools. This person added that it needed to be kept in mind, too, that the real proof of success was improving the product.

Reviewer 5:

The reviewer claimed that it was important to understand the contributors to soot, since future Low Emission Vehicle (LEV)III/Tier3 regulations would be applied to medium-duty (MD) vehicles as well as light-duty (LD) vehicles.

Reviewer 6:

The reviewer summarized that the project considered fundamental research towards improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 7:

The reviewer noted that the project provided a fundamental experimental understanding of conventional and low-temperature combustion and spray process interactions in an engine.

Reviewer 8:

The reviewer voiced that the current work was providing a solid contribution to understanding injector dynamics and soot, but added that there was little on fuel consumption improvements.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that this was a significant program and seemed to be properly funded.

Reviewer 2:

The reviewer asserted that the resources appeared to be adequate and that the funding level had been consistent.

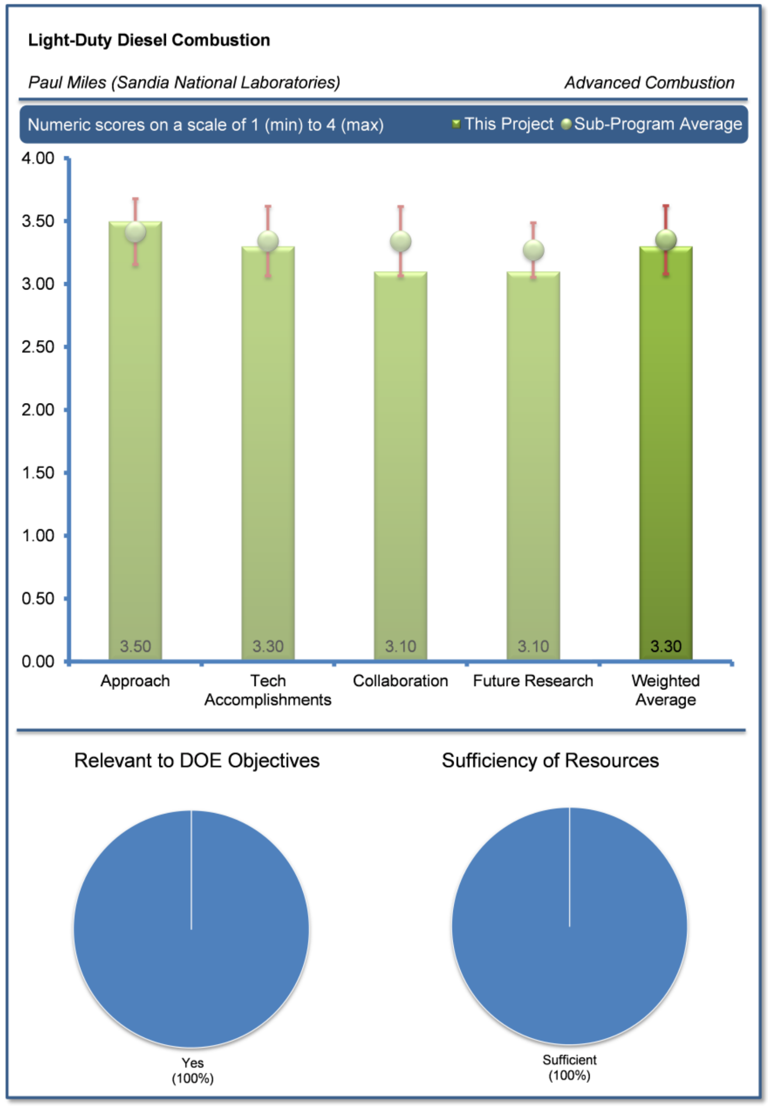
Reviewer 3:

The reviewer said very good progress was being made by the project, which suggested that the resources were sufficient.

Reviewer 4:

The reviewer suggested that the project team could involve more visibly industrial partners. These appeared to be involved (e.g., Cummins and Delphi), but there was no technical information shared. The reviewer felt this would have been beneficial and to some extent required for this project. The project could have provided selective metal engine data to compare with optical results/benchmark of the injector, while respecting confidentiality.

Light-Duty Diesel Combustion: Paul Miles (Sandia National Laboratories) - ace002



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this was a remarkably well-rounded program looking at most of the key aspects of light-duty diesel, making effective use of optical diagnostics and combustion CFD to further understanding. This person added that the newly updated injection rate measurement facility allowed detailed study of single and multiple injections on low-temperature and conventional diesel combustion. At the same time, the effects of temperature, oxygen concentration, pilot diesel mass, and injection pressure on the ignition quality of the fuel/air mixture were accomplished, and key factors were also identified. The reviewer indicated that the results provided a better understanding for diesel combustion. Computational modeling had also been improved and notably included both university research and commercial CFD tools. The predicted swirl ratio and pilot ignitability results showed a reasonable match with experiments. This reviewer noted that the disadvantages of the current modeling methods, which gave useful information for code development, were also established. Overall, the work was both fundamentally sound and very comprehensive.

Reviewer 2:

The reviewer said that there was a good combination of experimental work feeding information into the models and using the models to help understand the experimental results.

Reviewer 3:

The reviewer noted that the approach of coupling optical engine studies using a production engine configuration (General Motors Corporation [GM] 1.9 liter) with simulations was very useful.

Reviewer 4:

The reviewer stated even more emphasis by the project team on squish interactions would be of interest.

Reviewer 5:

The reviewer commented that it became clear that the intent of this study was to explore mixing/ignition processes for a close-coupled, pilot-main injection event. Initial research showed on a test bench that a dwell of (roughly) less than 0.3 ms led to an impact on the initial rate of injection of the main event. The reviewer added that the PI did not quantify the approach for studying close-coupled pilot injection mixing-ignition characteristics based on the presentation. This person added that it would have been helpful to know the game plan for systematically addressing the impact of dwell both experimentally and computationally based on a design of experiments that included variance in dwell times. Maybe it was hidden in the presentation, but it was not clear to the reviewer if this was the case.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated the project had very good progress in the pilot injections studies, as well as interesting results regarding the optimal fuel/air ratio.

Reviewer 2:

The reviewer reported that injection rate dependency on fuel type when using a pilot injection was an interesting result. This person added that more investigation on this topic to understand the root cause might identify important issues that needed to be included in the injector spray models.

Reviewer 3:

The reviewer commented that excellent progress had been made against the objectives of the program, addressing key factors that affected pilot ignition and methods to improve the diesel ignition process with pilot injection. The planar (LIF) measurements provided more information on equivalence ratio distribution and diesel ignition at different pilot mass fractions. The improved three-dimensional (3D) CFD study showed the benefits of doing full 360-degree mesh simulation compared to sector mesh simulation. The reviewer added that the indicated development of cold-start strategies and cold, in-cylinder emission control deserved more discussion, as it was of keen interest. Further, as the pilot ignition study was based on the heat release rate from experiment, the engine cycle-to-cycle variation should be addressed more fully. The reviewer noted that, as the averaged pressure and temperature near top dead center (TDC) were very important for the ignition study, more information on how pressure and temperature were controlled near TDC was also warranted.

Reviewer 4:

The reviewer stated that some initial results were shown concerning the impact of mass injected (via injection pressure) on the pilot heat release rate, but it was not clear how this behavior could be quantified in a real-world engine. It was not clear if the definition of robust ignition correlated with what was acceptable in a real-world engine. It would have been helpful if the study could better quantify the impact of any pilot dwell time research on the overall behavior of an engine.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted the project team had widespread collaborations, including a memorandum of understanding (MOU).

Reviewer 2:

The reviewer noted excellent team collaboration with a university, code vendor, and industrial partners, adding that perhaps more details were desirable regarding how Convergent Science was integrated into the project.

Reviewer 3:

The reviewer asserted there looked to be close collaboration with UW on some aspects of the project, adding that, with regard to industry collaboration, it was claimed that there was collaboration/information sharing with the OEMs.

Reviewer 4:

The reviewer explained that just about the entire presentation focused on the experimental aspects of this project, and thus little was shown from the partners. It was clear that the UW-ERC was supporting the project with CFD analysis, and that Convergent was also supporting the project. This reviewer added that showing more contributions from the partners would have been helpful in evaluating collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer confirmed that the project plans looked good and to continue the progress made.

Reviewer 2:
The reviewer indicated that the planned future work was a good extension of the research completed to date, adding that the planned study of close-coupled multi-injection (as well as piston geometry) would generate a greater impact on engine design applications. One suggestion this reviewer had was to also look at the effects of nozzle-geometry specifications (number of holes, spray angle, etc.) on mixture formation and ignition. This reviewer added that going to a full 360-degree simulation would enhance the ability to look at the jet-to-jet variations in this context.

Reviewer 3:
The reviewer stated that the future work needed more detail. It was not clear to this reviewer what close coupled meant or how the initial chosen pilot start of injection could affect both the low- and high-temperature heat release rates. This person asked if possibly varying start of injection would be helpful. The reviewer also asked how a close-coupled pilot strategy would compare to a more traditional pilot, long dwell, and then main injection strategy, where the latter could take place at lower injection pressure to compensate for over-mixing.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that elucidating the fundamentals of the combustion process should help to improve engine design, leading to higher efficiencies and lower fuel consumption, which in turn reduces petroleum-derived fuel consumption.

Reviewer 2:
The reviewer indicated that improved combustion understanding would help engine designers to develop improved, more efficient engines.

Reviewer 3:
The reviewer said, well, perhaps somewhat through the backdoor by increasing efficiency, and added that it might be interesting for the project team to expand the work in the future to include non-petroleum fuels to more directly address petroleum displacement.

Reviewer 4:
The reviewer commented that this research did support the further development of light load combustion strategies for direct-injection, compression-ignition engines that could reduce oxides of nitrogen (NO_x), PM, and carbon monoxide (CO)/HCs. This reviewer added that, nevertheless, future experiments should be more focused to address real-world engine applications as previously commented, such as better quantifying the experimental conditions and resulting conclusions versus other options.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

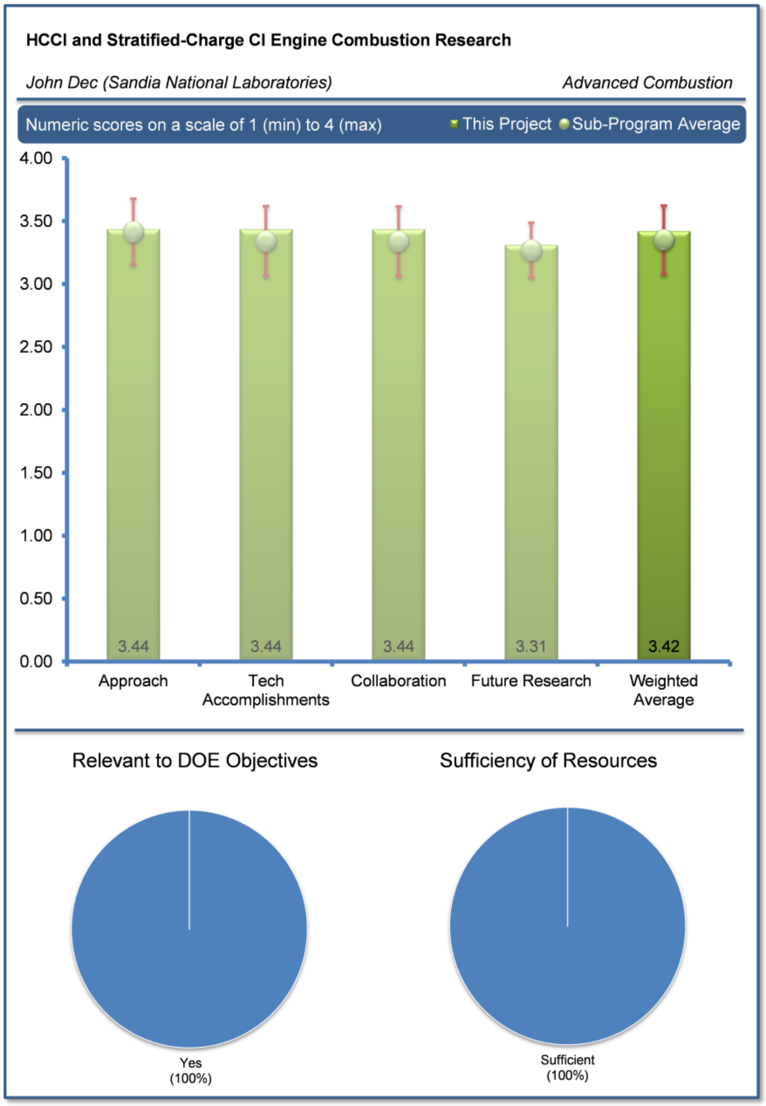
Reviewer 1:
The reviewer expressed that the resources seemed adequate, but added that the PI had scoped out quite a program, such that these resources would have to be used wisely and efficiently.

Reviewer 2:
The reviewer affirmed that good project progress was being made and that there were no indications that the resources were not sufficient.

Reviewer 3:

The reviewer observed a well-funded project for the work output.

HCCI and Stratified-Charge CI Engine Combustion Research: John Dec (Sandia National Laboratories) - ace004



Reviewer Sample Size

A total of eight reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach was excellent in that all pertinent tools were brought to bear on low-temperature gasoline combustion. This included metal engine experiments (to find the limits and effects of variables) and optical engine experiments (to probe key issues in a fundamental manner), and further provided understanding and data to improve models of low-temperature combustion (so that more detailed analysis could be performed with the validated models).

Reviewer 2:

The reviewer noted that the project showed a comprehensive approach with the contributions of metal and optical engine hardware, which were accompanied by collaborations with partners contributing to the computational modeling. The reviewer added that milestones were clearly identified including the status at which the project team found themselves.

Reviewer 3:

The reviewer remarked that the proposed research sought to demonstrate efficiency improvements for a low-temperature gasoline combustion system. The approach provided a strong integration of full metal and planned optical measurements. This person added that the PI indicated that the CFD contribution was planned to grow in the future.

Reviewer 4:

This reviewer commented that the fundamental learning objectives of this project were basically the same as the work reported by Dr. Ekoto, and added that both were addressing low-temperature gasoline combustion (LTGC). Both projects were also planning to explore augmented ignition. It seemed to this reviewer that the two research activities should be able to identify synergies common between them and the information that was being generated. This reviewer added that the PLIF measurements of the fuel stratification and correlation with LTGC should be very insightful data.

Reviewer 5:

The reviewer observed extremely interesting work on this topic. While this reviewer may have had some concern about “LTC” versus “dilute” combustion, this program was a very good way to address those questions with fundamental data and analyses.

Reviewer 6:

The reviewer said it would have been helpful to include an estimate of brake thermal efficiency (BTE) from the project team's indicated efficiency numbers. This reviewer was glad to have seen inclusion of the combustion noise metric, but did not see how it was applied to constrain the high load limits portion of the research.

Reviewer 7:

The reviewer asserted that the approach had demonstrated the indicated efficiency potential over a reasonable load range, but added that, without considering the tradeoffs necessary for turbo-machinery and transient operation, this potential might not easily translate into a practical combustion solution.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer affirmed good project progress this year.

Reviewer 2:

The reviewer noted encouraging technical progress in building upon past lessons learned with intermediate temperature heat release and expanding to look at partial fuel stratification (PFS). This reviewer asked if the PI would consider more injection events in the future. Additionally, this person felt the conclusions drawn regarding the interpretation of ringing intensity and combustion noise level were relevant and solid technical contributions.

Reviewer 3:

The reviewer stated that the overall accomplishments were useful toward demonstrating high gross indicated efficiency, and a better fundamental understanding of where HCCI/LTGC strategies might provide an efficiency advantage over other boosted GDI strategies (under the constraint of near-zero tailpipe emissions). This reviewer added that addressing exhaust gas availability transient control (i.e., achieving robust operation while controlling within a narrow range of phi and glomerular filtration rate [GFR]), as well as enabling boost and effective after-treatment, would help to speed the path to commercialization.

Reviewer 4:

The reviewer reported that a large amount of progress and technical accomplishments had been made, as shown in Slide 7. This reviewer was not sure if the analytical investigation of the Miller cycle had been taken to completion, in that a higher boost level needed to be investigated in conjunction with dropping the effective compression ratio to 14. This person noted that, because knock and combustion stability were challenging to analytically predict, Miller cycle investigations were sometimes best done experimentally.

This reviewer added that much more light had now been shed on the behavior and correlation between ringing intensity and combustion noise level, and how retarding CA50 affected it. Peak thermal efficiency numbers had been double checked after fixing some issues with fuel measurement and now there was increased confidence in the reported numbers. The reviewer noted that the increases in thermal efficiency observed with double injection were exciting, adding that the x-axis of the plots that showed injection timing should have indicated before (or after) TDC firing (or TDC breathing) so it was clearer.

Reviewer 5:

The reviewer reinforced that this was very nice work, adding that it would have been nice if the investigator could have framed the work and research plans in terms of how it would augment what had already been reported in the literature. For example, there was much literature on PFS and optimization efforts in terms of injection pressure, swirl, number and timing of injections, fuel splits between injections, etc. There was also literature on the ringing intensity index versus combustion noise measurements. This reviewer asked how this work was going to augment or overcome the deficiencies of what has already been done, adding that it would have been helpful to put the work in perspective with what else was going on in the field. This person also noted that the investigator responded well to last year's comments.

Reviewer 6:

The reviewer noted that the effort appeared to be a calibration optimization approach for a specific hardware set. The reviewer asked how the results could be generally applied.

Reviewer 7:

The reviewer voiced that the work extended the studies to the higher compression ratio of 16 from previous studies at 14. The latest results showed greater thermal efficiency but became limited at peak load. This reviewer added that it might have been helpful to assess what the targets were for the work (comparing these with the current state of technology). This person added that the latter results also required higher EGR, and asked what the implications of this would be in practice. The reviewer asked if the Miller cycle data were simulated. There was an extensive treatment of combustion noise and ringing. This reviewer added that the treatment is comprehensive, including its mitigation with factors such as combustion phasing.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted excellent project team collaboration with the relevant stakeholders.

Reviewer 2:

The reviewer felt that this project team was a good example of how collaboration should work.

Reviewer 3:

The reviewer remarked that collaboration with industry and other labs was very good; adding that closer connection with other LTGC efforts at Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL) would also be useful.

Reviewer 4:

The reviewer commented that the team assembled was very good, with the core team composed of GM, Cummins, Lawrence Livermore National Laboratory (LLNL), University of California (UC)–Berkeley, University of Melbourne, and Chevron. The reviewer added that the specific contributions of each of these members could have been better highlighted, and that more detail could have been provided from the simulation work done by UC–Berkeley and GM.

Reviewer 5:

The reviewer pointed out that the PI should leverage industry collaborators to project these results from an indicated metric to brake numbers. The PI mentioned this point during the presentation. This reviewer additionally asked what specific technical challenges the PI required for the CFD modeling. The reviewer asked if there would be some correlation between the CFD predictions and the experimental fuel distribution images.

Reviewer 6:

The reviewer felt that it was hard to determine the extent of the project's collaborations from the presentation.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the project team was continuing a great series of research plans.

Reviewer 2:

The reviewer was glad to see the project team's effort to predict BTE.

Reviewer 3:

The reviewer remarked the proposal to add realistic friction and turbocharger models to the single cylinder work was sensible in that it would allow an assessment of thermal efficiency on a net and brake basis. This reviewer noted that the addition of a spark plug to conduct spark-assisted low-temperature combustion was also a step in the practical direction, and added that the use of 300-bar injection pressure had the potential to modify partial-fuel stratification favorably and result in an increase in thermal efficiency.

Reviewer 4:

The reviewer commented that the proposed optical imaging of in-cylinder mixing would provide excellent insight and provide a relevant dataset for CFD model validation. This person asked, furthermore, if the PI planned to investigate more than two injection events.

Reviewer 5:

The reviewer acknowledged that a strong consideration of the compromises necessary for robust transient operation, efficient turbocharging, and effective after-treatment was critical to moving LTGC closer to commercialization. This reviewer added that combustion optimization should be a secondary goal after these primary constraints were applied, with thoughtful assessment of the anticipated technology limits.

Reviewer 6:

The reviewer noted that the PI knew what the ideal phi distribution was, and, in turn, asked if the ideal phi distribution was known, why not just determine the best solution analytically. Given the larger number of degrees of freedom at play, it would seem to be the more sensible approach.

Reviewer 7:

The reviewer pointed out that, in light of the discussion of the sensitivity of the results to uncertainties, it seemed that an uncertainty/error-propagation analysis should have been shown in the figures. This would have shown the total impact of the uncertainty of all measurements used in the work and facilitate the comparison to other results (whose investigators should also do the same).

Reviewer 8:

The reviewer said that the future work would focus on multi-hole injections with guidance from CFD modeling, which may need to be better explained and outlined. The project could have been more aggressive and innovative in showing new paths towards higher efficiency. The reviewer added that the very detailed studies were good and welcome, but new ideas on how to break the load and efficiency barriers were lacking.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer asserted that the project considered fundamental research towards improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 2:

The reviewer affirmed that the project developed a clear technical basis for future engine combustion regimes.

Reviewer 3:

The reviewer appreciated the comments on comparing the thermal efficiency of the LTGC technology with other combustion systems.

Reviewer 4:

The reviewer emphasized that very high indicated thermal efficiencies were being shown for LTGC on a single cylinder engine with somewhat ideal conditions. This person added that, while there was still a long way to go and many more barriers to be addressed, this work showed potential for OEMs to follow.

Reviewer 5:

The reviewer explained that LTGC was important as a long-term strategy for improving LD engine efficiency, but added that the project needed to move forward in a few critical areas to enhance the opportunity for commercial applications.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

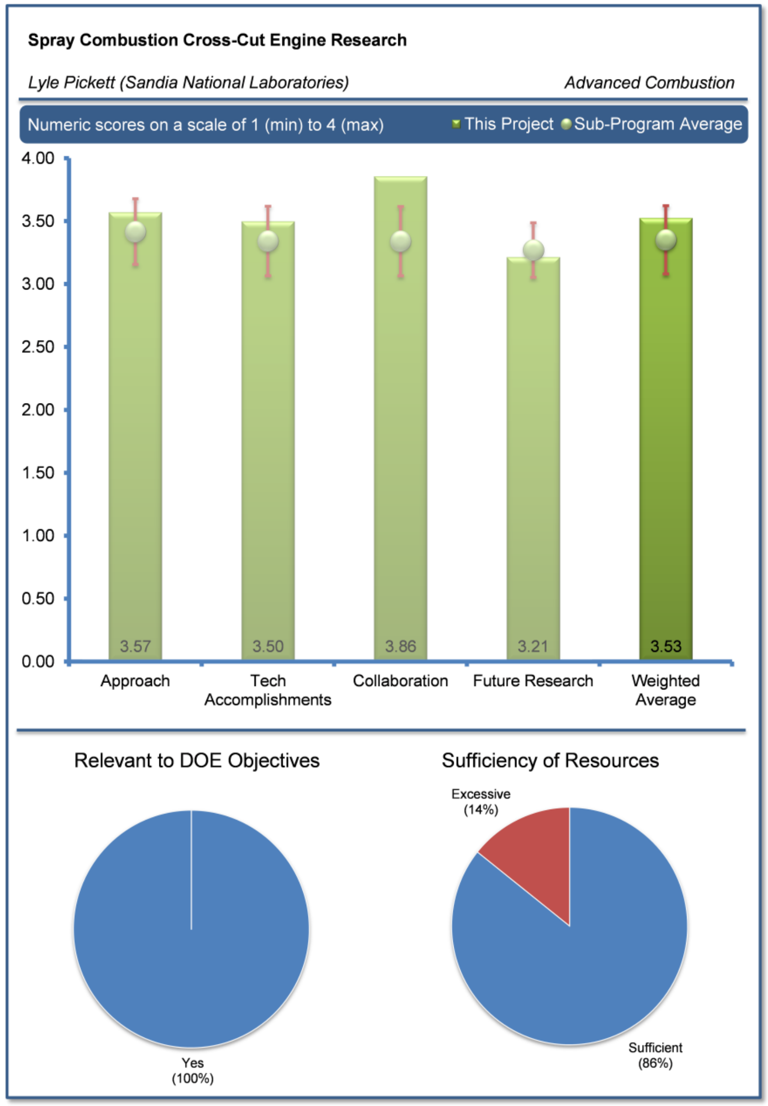
Reviewer 1:

The reviewer stated that the PI was using the supplied resources well.

Reviewer 2:

The reviewer said that there seemed to be an appropriate level of resource effort.

Spray Combustion Cross-Cut Engine Research: Lyle Pickett (Sandia National Laboratories) - ace005



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that outstanding methods were deployed to obtain experimental data to test and refine the CFD efforts.

Reviewer 2:

The reviewer highlighted that this was a well-organized project that encompassed many outside research organizations in a cohesive manner, as well as focused on maintaining experimental consistency among the various organizations. The reviewer exclaimed well done to the PI.

Reviewer 3:

The reviewer noted an excellent approach of establishing a network of national laboratory, university, and industry researchers studying fundamental injection and mixing phenomena using the same type of injectors and conditions, which enabled a basis for cross-comparison of results. This reviewer added that the project team also took advantage of the specialized equipment available at each lab.

Reviewer 4:

The reviewer remarked that the fundamental understanding of sprays was the key to advanced engine technologies, and added that the PI had undertaken a very collaboration-based effort in coordinating in-house measurements with experiments across the globe through the Engine Combustion Network (ECN). This person said it was good to see the study of gasoline sprays incorporated in the presentation and encouraged emphasis in this area.

Reviewer 5:

The reviewer commented that, overall, the technical barriers were well addressed and the experiments were well designed to investigate evaporating sprays in an engine-like environment, with most important factors from injection through combustion considered. The reviewer added that the experimental research efforts were directed to provide ample quantitative data on spray characteristics and combustion indicators, such that accurate numerical models could be developed and tested. Future work should consider addressing in more detail how applicable constant volume experimental results were to real engine conditions. This reviewer suggested that this could perhaps be done through comparative measurements in an optical bomb and optical engine.

Reviewer 6:
The reviewer said that it was very good to see inclusion of the gasoline injector, but would have liked more results. This person noted a novel approach to combining Schlieren and single-shot LIF to gain insight into spray/combustion behavior, and this reviewer looked forward to more results.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted excellent progress, including extending the spray injection work to GDI ("Spray G"), the development of quantitative soot data sets, and the quantification of the near-field liquid volume fraction for diesel spray "A."

Reviewer 2:
The reviewer felt that it was good to see a focus on challenges associated with predicting spray behavior based on nozzle geometry. The models needed to be improved in this area.

Reviewer 3:
The reviewer remarked that the ECN continued to produce useful measurements. One suggestion this person had was to consider exploring spray angle measurements over various density ratios and temperatures for a variety of high-pressure nozzles.

Reviewer 4:
The reviewer commented that extensive experimental work had been conducted from near the nozzle region to far downstream, which hooked up with the measurement of ignition delays and transient soot contours. The project team provided a rich source of information for improving predictive modeling capabilities, with promising modeling results also shown. This reviewer added that the work should continue to identify the sensitive factors influencing spray characteristics such as spreading angle and liquid core height, which could then aid CFD model development to reduce dependence on arbitrary tuning parameters.

Reviewer 5:
The reviewer acknowledged the effort to correlate in-house optical measurements with x-ray measurements regarding the liquid core detection. The reviewer asked if this approach could be expanded to provide quantitative metrics that could be used for CFD modelers in the development of primary atomization models. For example, this reviewer noted that modelers are moving towards exercising Eulerian spray approaches that transition to Lagrangian droplets. These models generally required transition criteria. The reviewer asked if any unique experiments were available to help with the transition criteria.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated the ECN was an ideal model for collaboration among various partners.

Reviewer 2:
The reviewer pointed out the project team's huge collaborative effort deployed to speed up data acquisition.

Reviewer 3:
The reviewer noted the project's outstanding network of collaborators, composed of industry, national laboratories, and universities, which further enabled procurement of field-relevant injectors from the industry partners.

Reviewer 4:
The reviewer commented that the coordination of the ECN network had been excellent and extremely relevant to the advancement of clean engine technology.

Reviewer 5:
The reviewer emphasized the broad collaborative effort across industry and researchers, and added that it was good to see even more researchers joining ECN.

Reviewer 6:
The reviewer acknowledged the ECN was perhaps the poster child for industry-university-government-lab cooperative research, and added that what was even more remarkable was that the collaborative, open-forum concept had actually worked in practice. The PI was to be congratulated for his ability to effectively coordinate the various efforts. The only downside that this reviewer noted was that the range of different spray modeling approaches being compared was somewhat limited. This reviewer said that some comparisons (undoubtedly in the works) with Eulerian-Lagrangian, Eulerian-Eulerian, or even volume-of-fluid methods for handling dense sprays near the injector would be particularly enlightening. Of course, this was potentially limited by the volunteer nature of the network.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer expressed that the project plans appeared to continue to build on the successes obtained to date.

Reviewer 2:
The reviewer stated that the project team’s Spray G plan was good and would help gasoline spray models.

Reviewer 3:
The reviewer’s only suggestion was to explore the possibility of correlating spray angle behavior for various high-pressure nozzles as a function of key parameters (such as density ratio, temperature, length-to-diameter ratios, etc.).

Reviewer 4:
The reviewer reported that the proposed work was fine, but that the project team should consider looking at internal injection flow coupling with downstream sprays (such as the effects of cavitation, hydro-machining, internal wave motion, needle motion on sprays, etc.). This might draw upon and build up collaboration with ANL and ORNL, given their diagnostics capabilities. This person added that, while it was good to see gasoline injection now being studied in addition to conventional diesel, it might have been useful to expand the family of fuels being considered to include biodiesels, E85, etc.

Reviewer 5:
The reviewer stated that the PI showed in the presentation slides the desire to visualize spray collapse for the gasoline spray. This person asked what separated this study from measurements already shown in the literature. The reviewer added that the PI was encouraged to consider different optical techniques, such as spray particle image velocimetry to quantify the entrainment field during spray collapse. Furthermore, this reviewer asked if there was any plan to study multiple injection events to compliment the PFS work of John Dec.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that spray characterization was a major pathway to efficient direct injection (DI) combustion systems and enabled improvements in fuel consumption.

Reviewer 2:
The reviewer commented that improving the understanding of fuel sprays was critically important to understanding and improving engine behavior, and noted that the experimental information provided by this project was crucial to improving fuel spray and engine models.

Reviewer 3:
The reviewer noted that the great fundamental spray research that would support various DI combustion approaches deemed necessary to reduce engine-out NO_x and soot in both compression and SI engines.

Reviewer 4:
The reviewer remarked that mixing analysis was critical to combustion simulation.

Reviewer 5:
The reviewer acknowledged that improved understanding of spray and mixing processes was important for improving the design of engines using direct fuel injection. This person added that this should lead to the development of more efficient engines, and thus lower fuel/petroleum consumption.

Reviewer 6:
The reviewer indicated that, as this research promoted improved tools and understanding that would ultimately improve engine efficiency, it generally supported the overall objectives. However, this reviewer added that the current program seemed limited by only considering conventional diesel and gasoline, and could more directly impact petroleum displacement through studies with non-petroleum fuels.

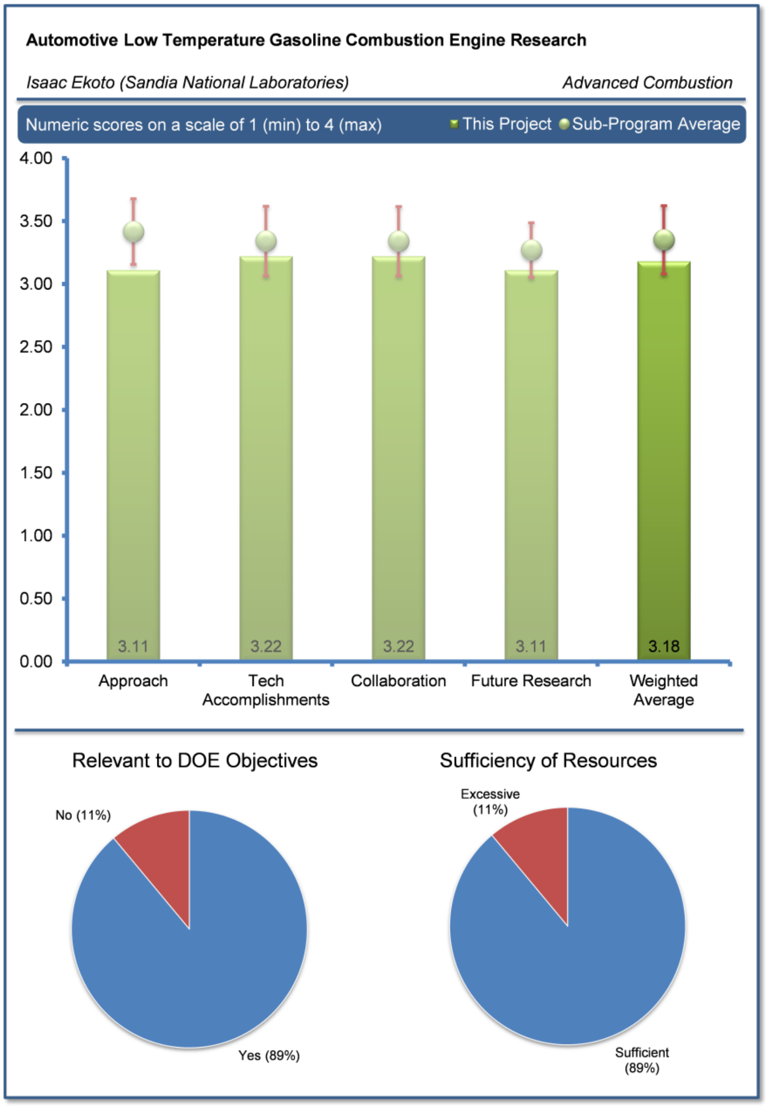
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer pointed out that, by utilizing collaborative assets under the ECN, this program had very effectively expanded its resources substantially for little expense other than the coordination needed to keep all the parts moving in the same general direction. The person added that this had to be one of the most cost-effective DOE projects out there.

Reviewer 2:
The reviewer stated that the project's allocated resources appeared sufficient for this work.

Reviewer 3:
The reviewer suggested that the project was possibly overfunded, and added that it would have been nice to have seen a budget breakout for this project. This reviewer felt the project was well-funded for the work output.

Automotive Low Temperature Gasoline Combustion Engine Research: Isaac Ekoto (Sandia National Laboratories) - ace006



Reviewer Sample Size

A total of nine reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the project showed a comprehensive approach with the contributions of optical engine hardware, in-cylinder measurements and diagnostics, and computational modeling. Milestones were identified to expand the fundamental understanding of LTGC, with specific focus on the negative valve overlap (NVO) fueling impact on the main combustion.

Reviewer 2:

The reviewer noted that the PI's approach to gas speciation was thoroughly undertaken, involving correlation of results across different test facilities. The PIs also used modeling tools to help explain their results, in addition to verifying their observed trends at ORNL.

Reviewer 3:

The reviewer acknowledged the project's good coupling of optical engine tests with computer models.

Reviewer 4:

The reviewer commented that the approach as listed by the PI was quite good, and was somewhat indicative of all projects at Sandia National Laboratories (SNL).

Reviewer 5:

The reviewer observed that this project used the unique capabilities at Sandia to study LTGC. This person added that fundamental questions regarding low temperature heat release were being studied, as well as the effects of temperature and/or species concentration.

Reviewer 6:

The reviewer observed that the approach offered unique insight into combustion species formation, but was not part of a critical path for commercialization of LTGC technology.

Reviewer 7:

To this reviewer, it seemed that the presentation concentrated more on what was being done, rather than why it was being done and what would be the benefit once the data was understood. It also seemed that the fundamental knowledge barriers being addressed in this work were the same as those being addressed in Dr. Dec's work. This reviewer added that, as such, and since the work was addressing fundamental knowledge gaps, this reviewer felt that there should be synergy between the two programs. The reviewer asked if there were synergisms and how what was learned in each program was helpful to the other. Alternatively, this reviewer inquired about whether results of this study could be presented so industry could do comparative analysis between the two approaches, so as to determine which approach held more promise technically, or what the tradeoffs of complexity of implementation versus benefits were that came into play.

Reviewer 8:

The reviewer mentioned that the presentation noted NVO was a promising approach for implementing LTC. This reviewer suggested that it would help to have some evidence for that.

Reviewer 9:

The reviewer noted a generally good approach, adding there seemed to be some fuzziness of what concept(s) were being researched. The reviewer wanted to know if this was compression ignition. The reviewer said to explain the logic of the ignition work, and added that it needed to be clear it was not just jerking from one thought to the next.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer mentioned good progress versus milestones, including the following: hydrocarbon speciation during high-O_2 NVO; confirmation that acetylene is the species primarily responsible for results with high-O_2 NVO; and determination that low-O_2 NVO might be a more viable approach for production engines than high-O_2 NVO.

Reviewer 2:

The reviewer asserted that the study focused on high-O_2 NVO experiments (raising the temperature of the charge for low load stability), cylinder sampling experiments (demonstrating the capability to speciate NVO products via the dump-valve and gas chromatograph apparatus), speciation of low-O_2 NVO products (providing fuel reforming at these lower O_2 concentration levels), vacuum ultraviolet (VUV) mass spectrometer experiments, and the development of new opportunities for advanced gasoline ignition. The reviewer added that model results from the high-O_2 NVO experiments confirmed the main combustion phasing chemical effect was mostly due to the improved charge reactivity from increased NVO acetylene production. This reviewer said the work showed that low-O_2 NVO could be a more controllable pathway to optimal HC intermediate production. This was well coordinated with the work of ORNL, and the operating conditions of the tests were well documented.

Reviewer 3:

The reviewer affirmed project team's nice work on a number of experiments.

Reviewer 4:

The reviewer emphasized that this year, an important accomplishment regarding the role of acetylene had been made, adding that it had been determined convincingly that acetylene production during the NVO heat release was the main reason for the enhancement of the main combustion heat release. This person added this conclusion came from the modeling part of the investigation, and low-O_2 NVO species sample measurements had also been performed and compared to ORNL data. This could potentially offer better control of the main combustion process, and the reviewer added that initial species measurements using the Lawrence Berkeley National Laboratory (LBNL) molecular beam mass spectrometer looked promising. These were compared to the gas chromatography measurements.

Reviewer 5:

The reviewer indicated the project team was doing a very nice job with the experiments and establishing nice leveraging with other groups. This person added that it seemed that a fundamental CFD analysis with comprehensive kinetics was needed, and that this could explain or verify the PI's conjectures on the acetylene formation and its importance. The reviewer asked if this would then feed useful information to the PFS activities.

Reviewer 6:

The reviewer noted good progress in measuring the exhaust components and determining the role of acetylene in changing the reactivity of the NVO gas and driving the main combustion. The reviewer asked if the PI was able to determine if the source of acetylene was from wall wetting on the piston, and if there was any evidence from inspection of the piston top. This reviewer added that the work on advanced mass spectroscopy at LBNL should be continued.

Reviewer 7:

The reviewer highlighted that the work relative to NVO was good for improving our fundamental understanding. This person would have liked to see this understanding translated into a "controls" approach that would ensure robust combustion along with high efficiency and low emissions over a range of speeds, loads, and environmental conditions. Similarly, this reviewer added that an assessment could be made as to the accuracy required for the different control parameters (injection timing, injection amount, valve timing, etc.). The SI accomplishments were somewhat limited, given this work was just getting off the ground. This reviewer added that the project team was seeking feedback from industry, and the resulting report was a very good start.

Reviewer 8:

The reviewer claimed that the latest findings did not seem to be moving the project substantially closer to a "leap forward" in LTGC strategy. This reviewer added that the insight on the role of simple HC species and acetylene was now a few years old, but little progress had been shown on fuel effects (for example) that could move this insight forward.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project team's collaboration appeared to be excellent.

Reviewer 2:

The reviewer noted that it looked like there were good collaborations with the auto companies, as well as with the other national laboratories.

Reviewer 3:

The reviewer noted that the project team was a part of the big group, and observed outstanding collaboration.

Reviewer 4:

The reviewer felt the team assembled was very good, with the core team composed of four national laboratories, two universities, and multiple OEMs. The reviewer added that the work such as the low-O_2 NVO was well coordinated with the work of ORNL, and suggested that there may be an opportunity for the OEM partners to provide more feedback and direction towards the viability of the concept here.

Reviewer 5:

The reviewer encouraged the collaboration with LBNL and ORNL in accurately characterizing exhaust components.

Reviewer 6:

The reviewer remarked that there was good collaboration with the other national laboratories on the NVO topic, and the ignition project was off to a good start as well. This reviewer would have challenged the PI to see if there were any other institutions doing ignition work that would add value and contribute to the project. The OEM involvement should continue as well.

Reviewer 7:

The reviewer stated that the pace of collaboration with the ignition system suppliers (e.g., USC) should be increased. If possible, suppliers of prototype Corona or Plasma ignition systems should be contacted to see if these suppliers would work with SNL.

Reviewer 8:

The reviewer observed very good collaboration to get the task done, but added that otherwise it was difficult to see cooperation with the other labs leading to a common objective.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the work needed to be performed to demonstrate the effects of oxygenated species (as, for example, in Fuels for Advanced Combustion Engines [FACE] fuels) on the NVO mechanisms being examined.

Reviewer 2:
The reviewer supported the future focus on advanced ignition systems as a means to support dilute combustion.

Reviewer 3:
The reviewer asserted that the project's planned research seemed reasonable.

Reviewer 4:
The reviewer asked if there was sensitivity to fuel properties, and added that fuel, even in a conventional SI engine, was still a significant source of noise (in a statistical sense).

Reviewer 5:
The reviewer highlighted that the project planned to continue post-processing data to speciate low-O_2 and high-O_2 NVO engine samples. This person added that the project would also perform scoping studies for advanced ignition technologies, although the directions to be taken were not too clear (thermal plasmas/lasers, pre-chamber).

Reviewer 6:
The reviewer said generally strong, but added that the project needed a clearer thinking-through of the concept(s). Perhaps this would be the natural fallout of the experimental data, but this reviewer asked for the PI to please clarify the plans and research directions as part of the big picture.

Reviewer 7:
The reviewer would have liked to see more project details on the future ignition system plan.

Reviewer 8:
The reviewer claimed that it would be good if the future work could have been stated more in terms of specific technical goals/challenges, as opposed to the current rather general activities. This would have allowed the audience to get a sense of why these activities were planned and what would be learned when they were successfully completed.

Reviewer 9:
The reviewer commented that it was not clear exactly what kind of combustion concept was going to be investigated. It was also not clear exactly how the ignition studies were going to relate to the combustion concept. This reviewer asked if using Reynolds-averaged Navier-Stokes (RANS) modeling was a valid approach in trying to predict cyclic variability in the combustion process, and suggested using a Large Eddy Simulation (LES) model.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that the project considered fundamental research towards improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 2:

The reviewer highlighted that SI engines still dominated in the light duty fleet, and other researchers had shown that more capable ignition systems could lead to improved engine efficiency. So this area of research was relevant. This reviewer added that accurate and predictive simulation of the ignition event was equally important and relevant.

Reviewer 3:

The reviewer voiced that exploring approaches such as NVO to improve engine efficiency was consistent with DOE goals.

Reviewer 4:

The reviewer summarized that the project sought to extend dilute operation of gasoline combustion for increased fuel efficiency.

Reviewer 5:

The reviewer stated that the research was relevant to several engine combustion schemes that were being developed.

Reviewer 6:

The reviewer noted that the work was relevant in that it presented an approach to alter the reactivity of the charge mixture without the inclusion of an additional fuel.

Reviewer 7:

The reviewer felt that it was unclear that this work, especially the specific operating conditions that were being considered, would lead to a tangible reduction in petroleum consumption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that there was no indication that the project’s resources were not sufficient.

Reviewer 2:

The reviewer observed sufficient resources for the project.

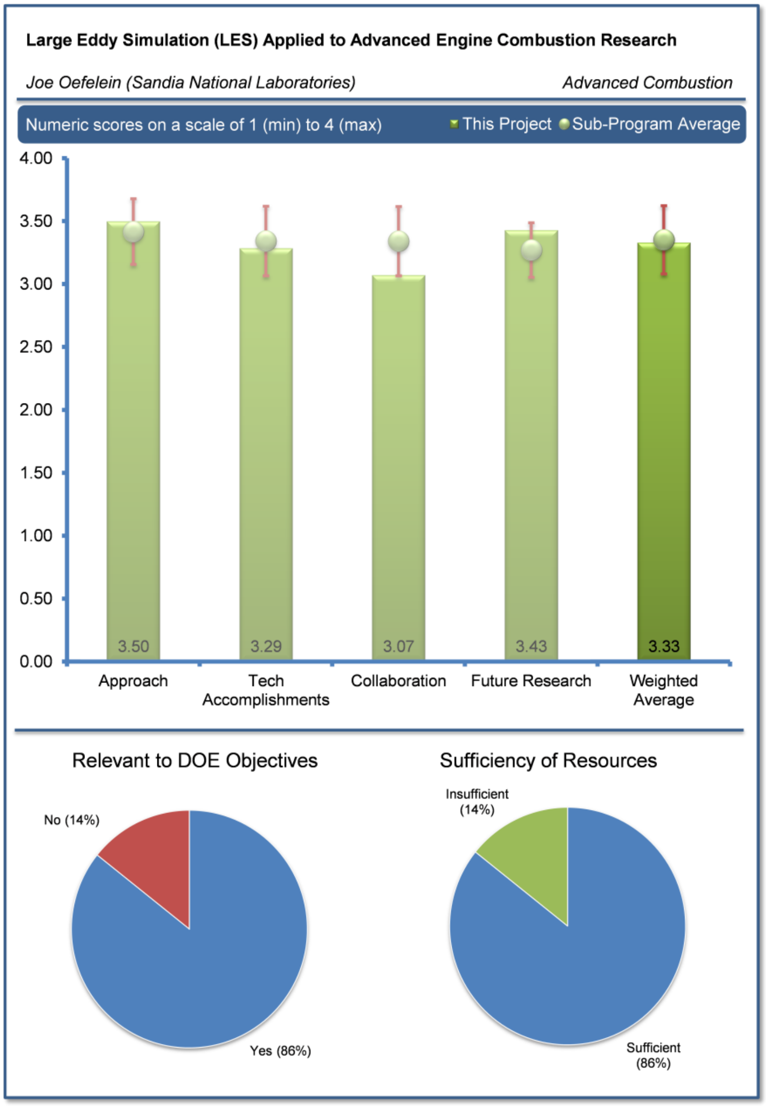
Reviewer 3:

The reviewer said the resources seemed to be at the appropriate funding level.

Reviewer 4:

The reviewer indicated that the resources appeared to be excessive for the perceived benefit.

Large Eddy Simulation (LES) Applied to Advanced Engine Combustion Research: Joe Oefelein (Sandia National Laboratories) - ace007



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer expressed that this is very important work to provide a benchmark to show the ultimate capability of simulations and models.

Reviewer 2:

The reviewer emphasized that the application of complex modeling tools such as LES is important for understanding and modeling fundamental fuel injection, mixing, and combustion processes. Also, the approach of first using complex techniques to get correct, accurate results and then determining how the computational approach can be simplified (thus reducing computational time/requirements) made a lot of sense.

Reviewer 3:

The reviewer explained that the project's approach sets to develop and exercise a high-fidelity simulation code to bridge the gap between basic science and applied research. This person felt that this was an endeavor that should be undertaken at the national laboratories, and added that the PI should clarify what the pathway was from this work to industry. This reviewer asked if industry would have access to the RAPTOR code.

Reviewer 4:

The reviewer indicated that the approach has been very methodological throughout the last few years, with the initial focus on more basic combustion applications such as simple flames. It appeared LES was slowly approaching a reasonable level of predictive simulation capability for direct injection engine combustion characteristics. This reviewer added that overall this project was making progress, though it would be great to see a real focus on assessing LES for practical engine applications (e.g., accelerating these latter efforts).

Reviewer 5:

The reviewer reported that, generally, the work on detailed turbulence modeling (and more recently, the addition of real fluids modeling) is great, but the project continues to struggle to show the direct connection to real-world engine modeling for the purposes of designing better engines. This person added that potential steps are seen in the plan, such as possible coordination with spray modeling work at ANL, but the real jump would be to coordinate and collaborate with commercial code vendors and industry to take this fundamental numerical analysis research and get it (obviously not directly, due to the computational costs, but in a derivative fashion) into commercial tools and into the hands of engine designers. This reviewer added that then the impact of this great research could be felt where it could do the most good—designing cleaner, more efficient IC engines.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer indicated great results showing detailed simulations that match experimental results, and added that this would provide insight into engine behavior.

Reviewer 2:
The reviewer noted very good project progress versus the planned milestones.

Reviewer 3:
The reviewer asked how the property evaluation from the PI's real fluid model compared with other property calculation routines, such as REFPROP from NIST. The PI shows a comparison of Raptor simulations with the ECN Spray A. This reviewer asked if there was a plan to compare model predictions with x-ray measurements for a more quantitative comparison of mass distribution. The reviewer asked if the PI had performed any assessment on the added benefit of this modeling approach over engineering LES simulations available in commercial codes like CONVERGE. The reviewer added that CFD modeling of sprays has been focused on better predictions in the dense spray region, and asked if the current modeling approach provides help to assist in the development of engineering-based Eulerian-Lagrangian transition models.

Reviewer 4:
The reviewer stated that, to date, progress had been made assessing LES against basic combustion problems, and that the project was slowly working toward a useful tool for assessing advanced combustion strategies in future direct injection engines. This person added that progress had been reasonable, though it needed to be accelerated for application to practical combustion devices.

Reviewer 5:
The reviewer stated that, again, while the technical accomplishments, themselves, are excellent, the project loses points appreciably in addressing its contributions to overcoming barriers. (For this reviewer, those being the barriers to applying the technology to designing better IC engine combustion systems.)

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted, historically, this project has leveraged combustion data from other sources to assess and develop the LES methodology, and that the project team has collaborated well with various experimentalists and modelers from a number of research organizations. This reviewer added that collaboration has been strong throughout the years.

Reviewer 2:
The reviewer felt that there was good collaboration with experimental groups to compare to the simulations, and added that it was a good idea to compare the project team's LES results to CONVERGE, which is used in industry.

Reviewer 3:
The reviewer felt that the collaborations were mostly with other national laboratories, adding that no industry collaboration was evident. But there may not be much opportunity at this stage and this level of computer simulation. This reviewer noted that, ultimately to be the most useful, this work would need to be related to the type of simulations the OEMs can run.

Reviewer 4:
The reviewer remarked there should be a continued and stronger linkage with the ECN. Additionally, this person asked what the collaboration pathway was to link the lessons learned from this project with other code development work being done at Los Alamos National Laboratory (LANL) and LLNL. The PI mentioned that the code was being refactored for Graphics Processing Unit (GPU) acceleration. This reviewer asked if it was possible to incorporate to this work some of the learning from LLNL on combustion modeling with GPUs.

Reviewer 5:
The reviewer asked why there was no industry collaboration by the project team and if there was a lack of interest or failure to reach out to industry.

Reviewer 6:
The reviewer explained that there was a great deal of collaboration with academia and national laboratories (particularly in the high performance computing [HPC] area) and even some with the aerospace industry (although again on a very basic research level). What this reviewer felt to be missing was collaboration with commercial software vendors to take this basic research and apply it to engineering tools, as well as (of course) collaboration with IC engine designers. This reviewer felt there was a real, perhaps even dire, need for better turbulence and spray modeling capabilities in the trenches, but added that this project was cruising above the fray at 50,000 feet.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said the project plans seemed reasonable.

Reviewer 2:
The reviewer said that it was a good idea to compare the research to commercial codes.

Reviewer 3:
The reviewer mentioned that the proposed effort was excellent. This reviewer's only suggestion was to focus more on ensuring the LES is truly capturing in-cylinder behavior that agrees with engine measurements and/or constant-volume combustion vessels.

Reviewer 4:
The reviewer asked if the modeling approach could simulate flash boiling and cavitation. The reviewer asked what the remaining technical challenges currently prohibiting engine simulations were. A priority should be put on demonstrating highly resolved, highly scalable in-cylinder flow calculations. This reviewer said to continue to demonstrate the comparison of the high-resolution codes with engineering models to show benefit (this will develop with increased involvement in the ECN). The reviewer then wanted to know if there was a plan to simulate the gasoline spray G test condition.

Reviewer 5:
The reviewer expressed that the project reviewers really did appreciate the work done here even though these reviewers had been grading it rather severely. What excited this reviewer most was the plan to perhaps take it to the next level and begin (if still somewhat tentatively, in this reviewer's opinion) to address the more practical problems associated with IC engine analysis and design. The proposed collaboration with ANL was a start, but diving deeper into the engine-modeling world is even more highly encouraged.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the application of complex modeling tools such as LES is important for understanding and modeling fundamental fuel injection, mixing, and combustion processes. This should enable the design of more efficient engines, leading to lower fuel consumption, which is consistent with DOE goals.

Reviewer 2:
The reviewer indicated that high-fidelity spray simulation is a pathway to model the cyclic variability commonly experienced in advanced combustion concepts.

Reviewer 3:

The reviewer asserted that the LES is still working in the potential phase of aiding in the development of future DI engines. This may eventually provide a tool for the development of advanced combustion strategies that could reduce engine-out NO_x and PM.

Reviewer 4:

The reviewer said the current and future work as described here is only tangentially applicable to meeting this objective. Down the road, as the program gets more engaged in real engine analysis and then starts looking at non-petroleum fuels (or even just starts getting directly applied to solve questions of increasing efficiency), it will have more direct relevance.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that it was good to see that the team is growing, and indicated there is a need to add more resources to figure out how to reduce the cost of LES calculations so that these techniques can be incorporated into the engine design and development time scale.

Reviewer 2:

The reviewer observed a modest project budget for this work effort.

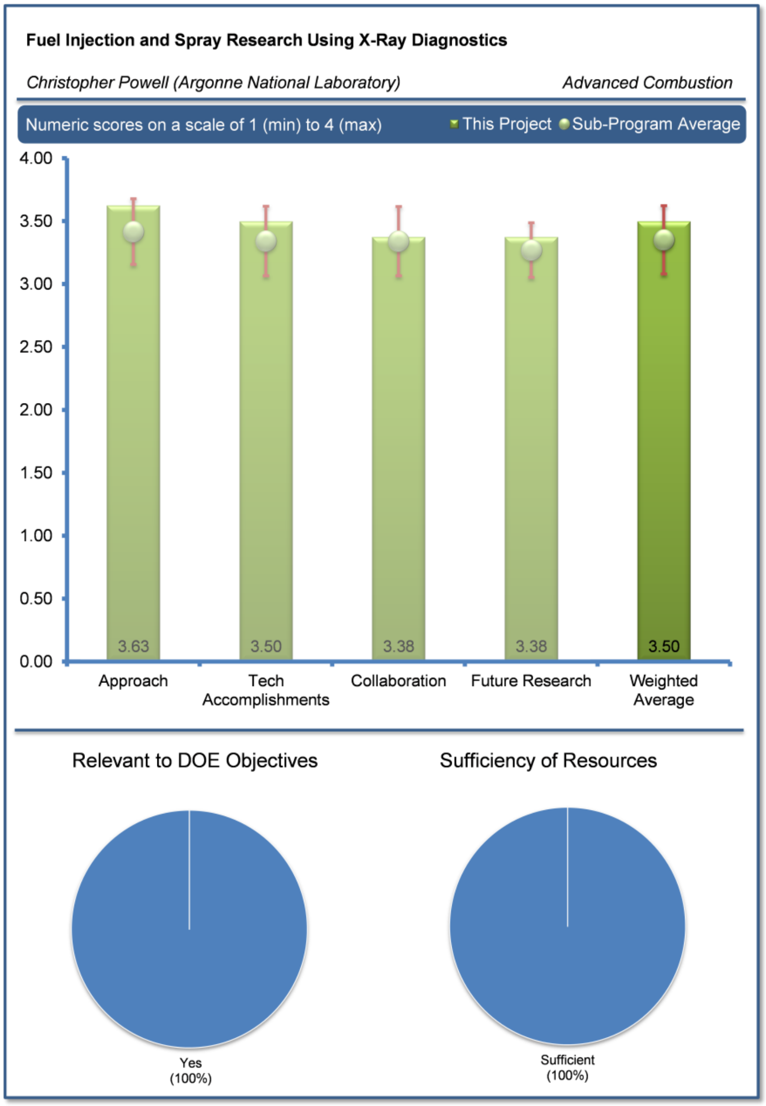
Reviewer 3:

The reviewer reported that the allocated resources were sufficient unless an additional head count is needed to accelerate engine simulations.

Reviewer 4:

The reviewer remarked that, for the stated milestones, the project’s resources appeared adequate.

Fuel Injection and Spray Research Using X-Ray Diagnostics: Christopher Powell (Argonne National Laboratory) - ace010



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted great use of a variety of measurement tools to get at different aspects of spray characterization.

Reviewer 2:

The reviewer asserted that the approach proposed by the PI was sound. This project was providing fundamental, state-of-the-art data to accelerate model development.

Reviewer 3:

The reviewer explained that x-ray diagnostics appeared to be a useful tool for investigating spray phenomena.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted very significant results from the project.

Reviewer 2:

The reviewer found the work visualizing needle dynamics and ingestion of gas into the nozzle hole very noteworthy.

Reviewer 3:

The reviewer indicated that it looked like good progress in measurements of multi-hole diesel nozzles for the ECN. This person added that the project team appeared to be trying to address previous reviewer concerns about this being an ensemble-average technique rather than enabling investigation of shot-to-shot variations.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commended the PI’s participation in the ECN. In addition, the experiments were helping to improve CFD models, as shown through the collaboration with University of Massachusetts.

Reviewer 2:

The reviewer noted that the investigators appeared to have attempted to address previous reviewers' concerns about limited collaborations by increased interactions with the ECN and establishing private projects with Delphi Diesel and Caterpillar.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer voiced that the proposed work seemed reasonable for continuing progress and improving the capabilities of the technique.

Reviewer 2:

The reviewer said that the project team should focus on cause/effect leading to improvement opportunities.

Reviewer 3:

The reviewer stated that the x-ray measurements provide a quantitative metric that can be directly compared with CFD computations. Many CFD modelers are now investigating the using of Eulerian-to-Lagrangian transition formulations to predict primary atomization. The reviewer encouraged the PI to work with the ANL team of Som to potentially, through measurement, determine a proper transition between both approaches. This reviewer also encouraged the PI to migrate towards gasoline sprays as indicated in the presentation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that fuel injection was critical to combustion efficiency and control.

Reviewer 2:

The reviewer remarked that a better fundamental understanding of spray phenomena should aid development of improved fuel injection systems, leading to higher-efficiency, lower-emissions engines.

Reviewer 3:

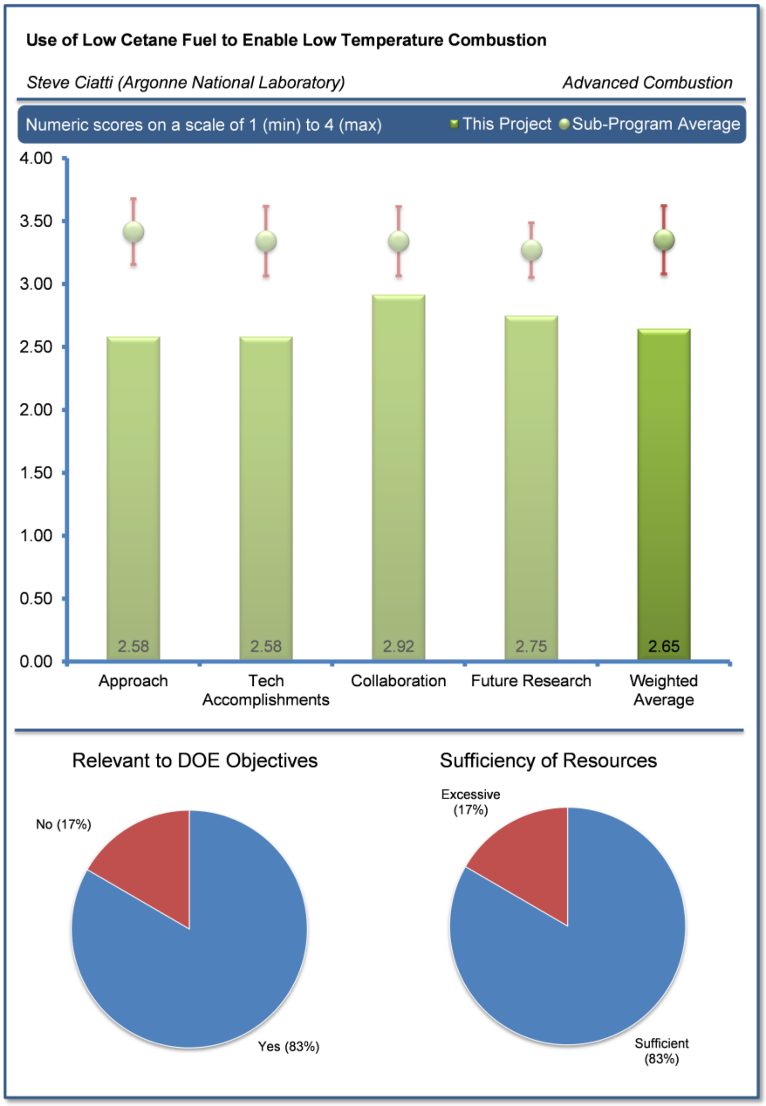
The reviewer indicated that the measurements offered quantitative information in the dense spray region, which was a problem for the CFD modeling community.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer supported the project team's proposed upgrades to the x-ray beamline.

Use of Low Cetane Fuel to Enable Low Temperature Combustion: Steve Ciatti (Argonne National Laboratory) - ace011



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer pointed out that the approach uses a diesel-type engine with a compression ratio of 17.8 to study various gasoline low-temperature combustion phenomena of interest. This approach provides a relevant physical platform, but because of the high compression ratio, a concern is the management of high-load combustion noise and pressure-rise rate issues. This reviewer added that the approach of using regular pump gasoline increased the chances of the concept making it into production.

Reviewer 2:

The reviewer said it still appears to be a “process of discovery” or calibration optimization approach, rather than seeking to understand the fundamentals or mechanisms behind the responses seen in the experiments.

Reviewer 3:

The reviewer pointed out that the use of 2-ethylhexyl nitrate (EHN) to alter the reactivity (and thus expand the speed-load range of 87 Anti Knock Index [AKI] gasoline) was relevant. It will be interesting to compare the results to those of others who have also been working with cetane improvers to expand speed-load range. This reviewer added that a key driver for trying to improve the feasibility of using 87 AKI gasoline is to enable the use of “pump gasoline.” However, the 87 AKI gasoline used in the current work is E0 (i.e., contains no ethanol). This is not representative of the majority of gasoline in the United States, which contains about 10% ethanol (i.e., E10). This reviewer concluded that it was not clear whether the results and trends found for E0 would apply to E10.

Reviewer 4:

The reviewer indicated the project seems to expand the operating range of a multi-cylinder gasoline LTC engine to lower loads on 87 AKI gasoline (expanding from previous results at 5 bar brake mean effective pressure [BMEP]). The work used 0.4% EHN cetane enhancer. The project seeks to reduce PM and NO_x emissions compared to conventional diesel combustion. This reviewer added that the project also seeks to better understand the effects of fuel/air mixture preparation, fuel reactivity, and intake conditions on low load ignition propensity and combustion stability. The authors use 3D CFD to simulate the changes in fuel/air mixture conditions and combustion. This reviewer added that the roadmap, including targets and specific milestones, might be better organized. There is a sense that the project is improvising as it moves ahead. Examples of this may be the proposed use and this year’s testing of low-pressure exhaust gas recirculation (EGR), narrow spray angle, hot EGR, and so forth.

Reviewer 5:

The reviewer commented that this was interesting work, but some of the program assumptions created serious limits. The diesel engine geometry and single injection limit the range of mixing that can be generated, and the mixing is shown to be critical. Perhaps there are opportunities if spark ignition could be used at some conditions. This reviewer added that this program needed to spend more time thinking about the approach (e.g., what the knowledge of kinetics and in-cylinder flow developed by other DOE projects indicates about the ideal approach to in-cylinder processes, and how can that relate to this program). In addition, the reviewer asked if there is still a possible system (adding ignition, cetane additive controls, etc.) if one is not fully successful at low speed load. This reviewer noted that cold-start was a very big issue for emissions, and asked if this engine could even start on gasoline without a spark plug. While the totality of these issues may be beyond the scope of the project, the project team has to address how these issues can be contained to avoid the risk of doing a lot of work on a system that fundamentally cannot work.

Reviewer 6:

The reviewer cautioned that the project has relatively little general applicability for achieving success with LTGC in a practical, commercial application. The person added that the work had relatively little coordination with other LTGC efforts, and that the metrics for combustion performance did not appear to be well defined or consistent with other works.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said progress was being made on the extension of low-temperature combustion to lighter loads. It had been determined that richening the combustion zone with a combination of a narrower spray angle and lower rail pressure extends the minimum load to lower levels. This reviewer noted that the addition of EHN, a cetane enhancer, had also helped in lowering the load limit. This had been achieved at soot and NO_x levels lower than a comparable conventional diesel combustion engine.

Reviewer 2:

The reviewer said basically good results, but needed more on how calibrations and strategies were developed. This reviewer asked if important opportunities had been missed by using single injection.

Reviewer 3:

The reviewer noted some interesting results, but, as previously mentioned, it was not clear whether results obtained from E0 would be applicable to E10, which is the “pump gasoline” across the majority of the United States.

Reviewer 4:

The reviewer explained that the project was able to attain stable Low Load/Speed Operation Investigations with 87 AKI gasoline. This person added that the accomplishment counted on a brief experiment using EHN to study low-load operation using a single injection, uncooled EGR (this latter effort did not give the expected results), and narrow angle injector. The brake-specific fuel consumption (BSFC) results are better than typical port fuel injection (PFI) SI engines but are 10% worse than the diesel benchmark for this engine (an older calibration).

Reviewer 5:

The reviewer indicated that there was a need to address the UHC emissions during a cold start scenario, and the NO_x and PM emissions during steady state operation. The barriers here should be identified and quantified as soon as possible. The reviewer added that this may direct a change in the research focus, and noted that LEVIII/Tier3 emissions standards by 2025 will be at 30 mg/mile HC+NO_x and 3 mg/mile PM emissions for ALL light-duty vehicles. This reviewer emphasized that this was a significant challenge.

Reviewer 6:

The reviewer warned that the accomplishments seemed to be measured against ill-defined performance baselines. The comparison against Euro IV emissions and efficiency was really disappointing, as it had no relevance to North America. This person added that the test points and objectives are poorly defined, and even the constraints on performance (e.g., combustion noise) seem to have no foundation in general principles.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated the team is very capable, including GM for engine hardware, technical guidance, and engineering support; University of Wisconsin for KIVA 3D simulation support; British Petroleum for fuel sourcing; Driven for engine controller and algorithm support/modification; and UC–Berkeley for E10 HCCI ignition information.

Reviewer 2:
The reviewer noted that good CFD modeling support from UW (KIVA) and ANL (Converge) existed. Links to other relevant work like SNL are being explored. This reviewer added that the support for hardware came from GM.

Reviewer 3:
The reviewer highlighted that the introduction of simulations to help understand the results is very important and being done. This person added that it might be necessary to modify the engine hardware (e.g., bowl geometry, injector, and etc.).

Reviewer 4:
The reviewer said some collaborators were mentioned, while some seemed to just be providing supplies.

Reviewer 5:
The reviewer summarized that collaboration seemed to exist, but stronger engagement with industry was needed to focus the test program and establish realistic objectives and bring the project into relevance.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer specified that the project proposes to continue to expand the engine operating map (low load at idle speed), pursuing an injection strategy of lower injection pressure (similar to GDI). The project will continue to reduce NO_x and PM emissions to achieve LTC behavior across the entire map. This reviewer added the authors propose to migrate to low-pressure EGR to provide reduced O_2 concentration and additional premixing at higher loads.

Reviewer 2:
The reviewer stated that the planned future work was right on track to address the remaining barriers of conflicting requirements between combustion and ignition control over the load range. Low-pressure EGR, the use of a supercharger, and the continued push to reduce engine-out NO_x and PM were good measures for pursuing these goals. This reviewer added that, going forward, HC emissions would also need to be lowered compared to the baseline diesel combustion engine.

Reviewer 3:
The reviewer noted that the project plans seemed reasonable, provided that the fuel focus is shifted to E10 instead of E0.

Reviewer 4:
The reviewer felt that the future work appeared to incorporate important features of advanced LTGC engines, but that the test program objectives were unclear. This reviewer inquired about the efficiency and emissions objectives and how the modeling efforts would enhance the probability of success of the experimental work. Conversely, the reviewer queried how the experimental work would contribute to improved modeling of LTGC.

Reviewer 5:

The reviewer remarked that it would help to have a more organized plan of optimizing the combustion system. This reviewer suggested using simulations and logic to decide what needed to be done, and to move in that direction.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that this project seeks to advance the limits and controllability of LTGC, which has the potential for significant fuel consumption savings.

Reviewer 2:

The reviewer noted that finding feasible ways to expand the speed-load range of advanced low-temperature combustion strategies was important to improving the commercial viability of those engines.

Reviewer 3:

The reviewer observed that the project promoted improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 4:

The reviewer noted some relevance, although the general area of HCCI seemed to be reducing in industrial interest and the likelihood of a future all-HCCI seemed low.

Reviewer 5:

The reviewer mentioned that LTGC was an important combustion technology for reducing petroleum consumption, but that the present work was not of sufficient relevance to commercial development of this technology.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

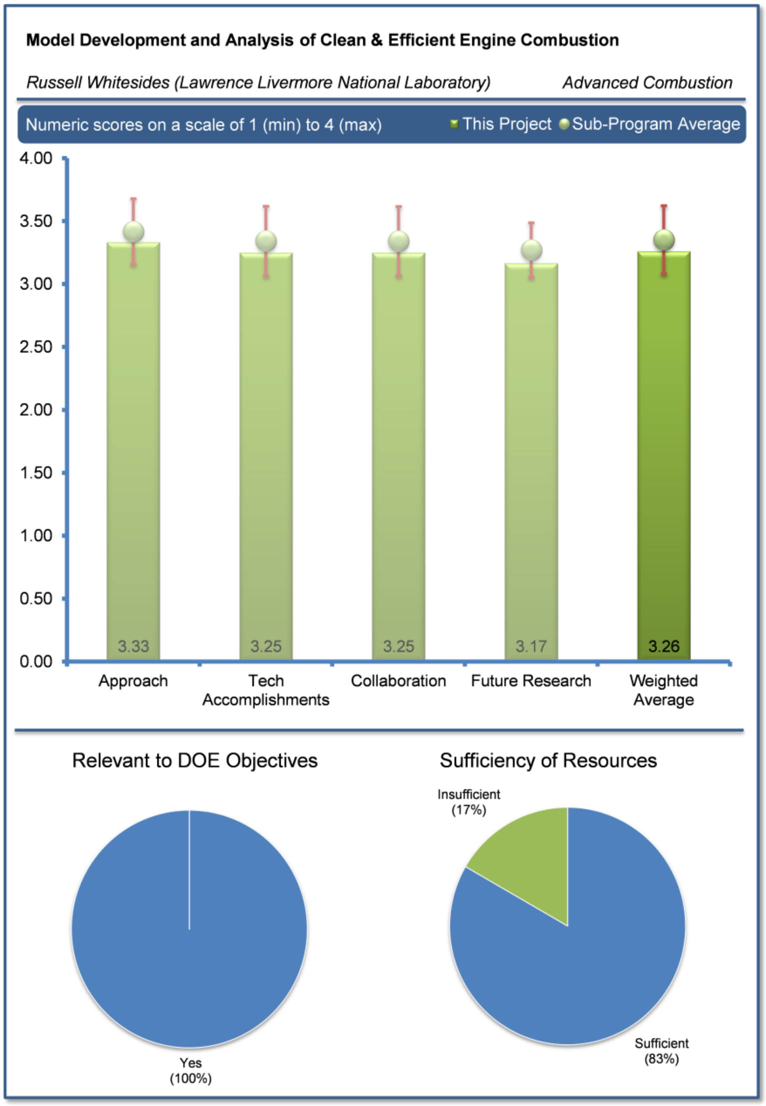
Reviewer 1:

The reviewer said the project scope should be reduced to focus on the experimental work alone until it can be better defined.

Reviewer 2:

The reviewer felt the resources seemed sufficient, assuming there was suitable collaboration with other computational programs to support the CFD, etc.

Model Development and Analysis of Clean & Efficient Engine Combustion: Russell Whitesides (Lawrence Livermore National Laboratory) - ace012



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer voiced that the approach of using numerical simulations and experiments to gain more insight into high efficiency clean combustion (HECC) regimes, and developing tools for desktop computers that combine fluid dynamics with chemical kinetics, was very good.

Reviewer 2:

The reviewer stated that the work of the PI was striving to improve the computational efficiency of combustion calculations to support predictions over a variety of combustion regimes.

Reviewer 3:

The reviewer felt that this project had been well designed throughout the years, though it was disappointing that there still existed little validation of developed tools for combustion predictive capabilities in real-world environments.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted significant speedup in computation time was achieved, and added that it was good to see the efforts with SNL to validate models against experimental work.

Reviewer 2:

The reviewer noted impressive gains in computational speed by the project.

Reviewer 3:

The reviewer commented that implementation of the GPU solver was a key accomplishment, and that integration into CONVERGE would make it available in a timely manner to engine developers.

Reviewer 4:

The reviewer indicated that the key accomplishment during the past year appeared to be the computational speedup time using GPUs versus central processing units (CPUs). To the reviewer, although the summary side stated that the project was providing industry and researchers with accurate and efficient combustion modeling tools, there was still a lack of validation in real-world engine environments, such as matching the heat release rate over a reasonable operating range or in predicting certain species. This reviewer added it was recognized that this project developed tools for others and that validation was also a community issue, but more effort should be spent addressing validation given the claim of "accurate" combustion modeling tools.

Reviewer 5:

The reviewer stated that the PIs were developing algorithms for faster chemistry. However, this reviewer added that the sub-grid scale was still assumed to be compositionally well mixed. The reviewer asked if the PIs planned to investigate turbulence chemistry interaction. The reviewer would like to see stronger application of the combustion approach to engine validation cases in the future. For example, the reviewer wanted to know if the current approach could capture the intermediate temperature heat release that is key for Dec's engine to achieve higher loads.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated the collaborations mentioned included one OEM, two hardware/software developers, several universities, and one other national laboratory. This reviewer felt it was good to see efforts with SNL to validate models against experimental work.

Reviewer 2:

The reviewer commented that it was great to get NVIDIA involved to better implement the GPU solver.

Reviewer 3:

The reviewer reflected that the project has definitely included partners from various organizations throughout the years. One complaint that this reviewer had is that this collaboration has not led to a better validation process.

Reviewer 4:

The reviewer said that working with a software supplier is a very direct way to impact the industry. The PI referenced a new licensing framework with Convergent Science (Slide 7). However, this reviewer noted that the PI also showed a chart in Slide 12 showing the linkage of the advanced chemistry algorithms with commercial and open-source codes. The reviewer asked if the PI could explain the following: how the license agreement works; how this interplays with linking the combustion algorithms with other codes; if this capability was being shared with ANL because they investigate high mesh resolutions for their applications; if plans exist to validate test cases from the ECN database; and the contributions from the partner universities towards the project accomplishments.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that the plans for future work seemed reasonable and should continue the progress in this project.

Reviewer 2:

The reviewer stated that continuing with the engine validation cases shown in the presentation was encouraged. One of the current trends in the industry is the proliferation of downsized boosted gasoline engines that rely heavily on flame propagation within a highly dilute environment. Additionally, this reviewer added that spark assisted compression ignition had been studied as a low temperature combustion mode. The reviewer asked if the PI was planning to validate these types of combustion systems with the advanced kinetics.

Reviewer 3:

The reviewer commented that the proposed research was reasonable, though it really needed to include some level of sufficient validation of the combustion predictive capability in a real-world scenario. This reviewer asked if a partner could possibly help with this task.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer indicated that improving chemistry solvers was very useful to industry where CFD and chemistry calculations were used in the engine design process. This person added that speeding up the solvers and improving accuracy were important tools to design more efficient engines. This work had a direct impact on industry by improving the simulation tools that were used to develop new, efficient engines.

Reviewer 2:

The reviewer mentioned that development of better fluid mechanics/kinetic model solvers that can be used on personal computers should greatly enhance the ability to design advanced combustion engine systems.

Reviewer 3:

The reviewer observed that combustion CFD remained expensive and inaccurate for low-temperature combustion, and that this project was showing good progress in addressing this.

Reviewer 4:

The reviewer stated that the project provided a pathway to studying advanced combustion, particularly low-temperature combustion concepts.

Reviewer 5:

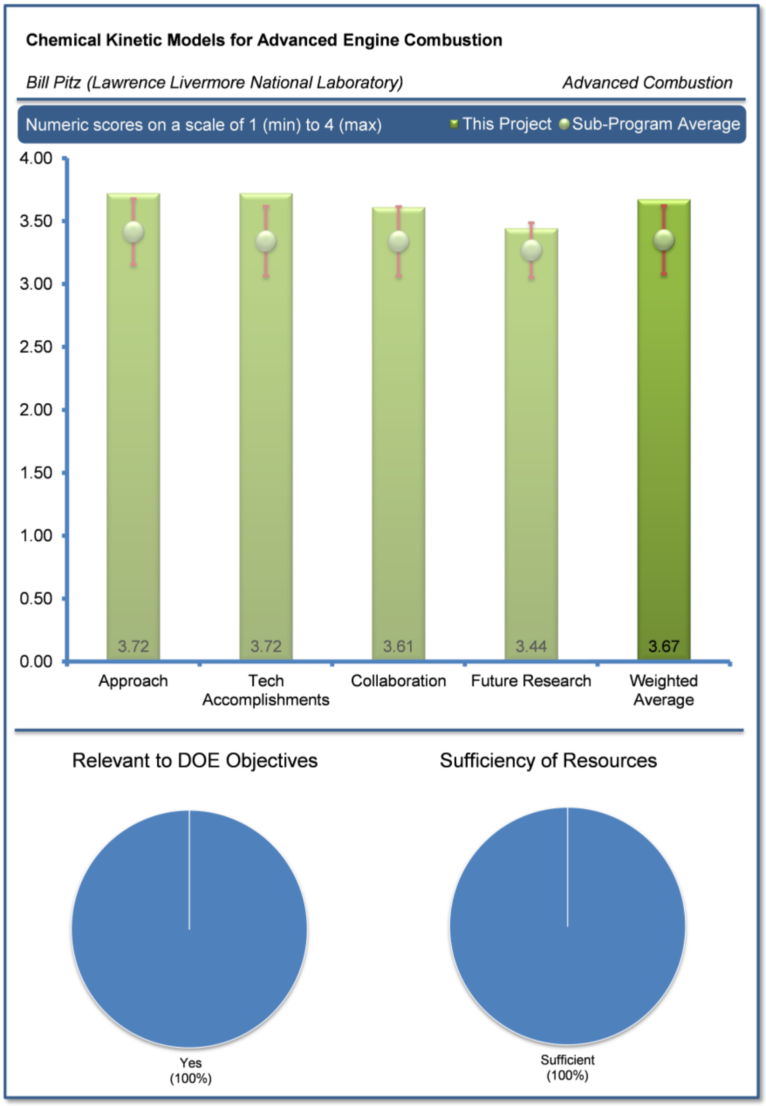
The reviewer affirmed that this work provides tools to researchers exploring advanced combustion strategies for meeting future engine fuel economy and emission standards. This person added it is relevant though currently upstream of other concurrent projects.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented additional resources should be applied to the project in order to accelerate the progress toward the goal of reducing computation time.

Chemical Kinetic Models for Advanced Engine Combustion: Bill Pitz (Lawrence Livermore National Laboratory) - ace013



Reviewer Sample Size

A total of nine reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this is very good fundamental work of the sort that really moves technology forward over time. The fundamentals of chemical kinetics underlie all combustion.

Reviewer 2:

The reviewer said great and necessary work, and continues to build on past foundation.

Reviewer 3:

The reviewer indicated development of chemical kinetic mechanisms for fuel components by the PI and co-workers was critical to advancing engine simulation/modeling.

Reviewer 4:

The reviewer stated that the work in developing FACE fuels and the associated kinetic models was critical toward unifying research in this area.

Reviewer 5:

The reviewer noted that the objectives and approach were well aligned to industry needs.

Reviewer 6:

The reviewer commented that the validation of highly resolved kinetics schemes was extremely challenging. The PI and his team were doing a thorough job with the available measured data.

Reviewer 7:

The reviewer stated that the approach has a strong fundamental basis and an outstanding team of investigators. Having an understanding and modeling capability for the complex chemistry occurring during combustion is a critical component of the advanced modeling efforts that are necessary to the realization of the highest possible efficiency and lowest possible emissions. This reviewer added that the work on surrogates is a good basis for establishing the base kinetic models for real fuels from which more simplified kinetic routines can be derived.

Reviewer 8:

The reviewer remarked that the approach was sound in that fundamental chemical kinetic models were generated for surrogate fuels for gasoline and diesel. The reviewer added these models were validated by comparison to fundamental experimental data. Such models have become more important in recent years with the growing interest in LTC.

Reviewer 9:

The reviewer said that the project seeks to develop predictive chemical kinetic models for gasoline, diesel, and next-generation fuels to facilitate simulations and overcome technical barriers for improved engine efficiency and reductions in pollutant emissions. The chemical kinetic reaction models for individual fuel components are important to accurately model fuel surrogates for gasoline, diesel, and next-generation fuels. This reviewer added that the work was accompanied by reduced mechanisms for use in CFD software tools.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the progress with gasoline fuels had been remarkable. Continued work in defining mechanisms for fuels containing higher aromatics concentrations of C12–C14 will be critical for understanding PM formation mechanisms.

Reviewer 2:

The reviewer noted good progress in adding to the diesel and gasoline palette and exceptional work in the validation models by comparing to experiments. This reviewer was impressed that the prediction for Dec's engine correlated to experiment to the degree it did.

Reviewer 3:

The reviewer mentioned excellent progress with application to real-world challenges, like engine auto-ignition and flame lift-off lengths, with varying fuel composition.

Reviewer 4:

The reviewer indicated excellent progress in meeting milestones. The accomplishments include the development of kinetic models for three out of four of the remaining components in Coordinating Research Council (CRC) FACE diesel fuels (n-butylcyclohexane, trimethylbenzene, and tetralin), development of chemical kinetic models for surrogates of the CRC FACE gasolines, and modeling of Sandia HCCI engine tests of gasolines with and without ethanol (including the intermediate heat release).

Reviewer 5:

The reviewer stated that the project keeps whittling away at the need for high-quality simulation of realistic fuels. This person also noted nice progress in the last year.

Reviewer 6:

The reviewer reflected that the project selected components from the CRC Advanced Vehicle/Fuel/Lubricants (AVFL)-18 Diesel Surrogate palette. The team developed models for n-butyl-cyclohexane, tri-methyl benzene, and tetralin. The project members modeled gasoline fuels by a 10-component surrogate palette to match properties of FACE gasoline fuels. Finally, this reviewer noted that the investigators modeled Sandia HCCI engine experiments with gasoline surrogate models, including ethanol. The authors had made a very disciplined effort to have the models validated with experimental data across a range of facilities. This reviewer concluded that the effort had also begun work on a preliminary model for large PAH as soot precursor.

Reviewer 7:

The reviewer mentioned that several worthy accomplishments were presented (Slides 6–17).

Reviewer 8:

The reviewer observed progressing towards completion of diesel surrogate palette.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted excellent collaborations, and added that the kinetic models developed were being rapidly disseminated to the combustion community at large. The project team's work was serving as the basis for much of the kinetic routine development and subsequent predictions that were taking place in many combustion laboratories worldwide. New kinetic routines were made available on the web in a very timely manner. This reviewer added that the project team was responding well to last year's comments.

Reviewer 2:
The reviewer stated that the project was well connected to leading researchers in the fuels area from around the world. This reviewer added that there was a good balance of simulation, bench, and engine experiments.

Reviewer 3:
The reviewer indicated that this project was very well connected with contributors and potential users—the way it should be done.

Reviewer 4:
The reviewer mentioned a significant amount of collaboration with industry (through CRC projects and the AEC), other national laboratories, and universities. In addition, the reviewer noted that the developed chemical kinetic mechanisms were posted on the LLNL website for others to use.

Reviewer 5:
The reviewer remarked the collaborations appeared to be keeping the research aligned with experimentation and simulation requirements.

Reviewer 6:
The reviewer noted that the main PI collaborated to model the two-component diesel surrogate model developed for CFD engine applications, n-dodecane, and m-xylene, in collaboration with ANL and the University of Connecticut (UConn). UConn collaborated further with the reduced models of the surrogate models. This reviewer added that the ranges of temperatures and pressures were very applicable to engine conditions. ANL performed CFD simulations under engine conditions to reproduce the experimental data taken at SNL. This reviewer stated this included ignition delay and lift-off length measurements. The modeling of gasoline fuels was performed in collaboration with KAUST, UConn, and Rensselaer Polytechnic Institute (RPI).

Reviewer 7:
The reviewer said that the mechanism development at LLNL was world-class and is referenced by researchers around the globe. A plan to strengthen the link to industry is encouraged, especially in a pathway to reduce the mechanisms schemes for engine CFD simulations.

Reviewer 8:
The reviewer suggested greater coordination with industry would be useful to broaden the reach of this work.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated the future research is spot-on relevant with future technology trends and anticipated fuel effects.

Reviewer 2:
The reviewer observed well designed plans to build on the accomplishments made to date.

Reviewer 3:
The reviewer noted a well laid out program for meeting future objectives.

Reviewer 4:
The reviewer stated that the project team would continue to finish the nine-component surrogate mechanism for diesel. The project will continue to develop surrogates models for three remaining FACE gasoline fuels and new gasoline certification. This reviewer added that the models would continue to be benchmarked with experimental tests.

Reviewer 5:
The reviewer observed that the plan for the next year is excellent, and added that it may be time to start thinking about how much more depth is needed once reasonable diesel and gasoline surrogates have been modeled. The reviewer asked at what point was more detail no longer needed for the level of simulation needed to do tasks of engineering and research, and if it was getting near to that point. The reviewer concluded that this should perhaps be addressed in the next year.

Reviewer 6:
The reviewer stated that the work of gasoline should continue to be accelerated, including the effect of EGR and more equivalence ratios, pressures, and temperatures.

Reviewer 7:
The reviewer remarked that it is understood the full mechanism needed to exist before it could be reduced; however, to be practical to industry, accurate and fast (e.g., reduced) mechanisms were required. This reviewer added that it would be good to see experimental validation, at the engine level, to evaluate the accuracy of the reduced mechanisms. This person agreed with the direction to improve the capability in predicting soot; it is needed, for both diesel and gasoline.

Reviewer 8:
The reviewer asked if there were any plans to work on the chemistry for advanced ignition systems (such as plasma). This work would align with the projects undertaken at ANL and SNL. The reviewer wanted to know if the kinetics schemes currently available to capture the effect of acetylene on NVO combustion that Ekoto and Steeper at SNL were measuring, and if there was a plan to develop models for soot particle size distributions in the future. This reviewer further asked if the PI was confident that the mechanisms developed were able to capture both flame and auto-ignition in spark assisted HCCI (spark assisted compression ignition [SACI]) downsized boosted gasoline engines. Slides 3 and 4 showed a focus on soot modeling; however, this reviewer noted it was unclear where this work was planned in Slide 22.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that this is extremely relevant, and that engine simulation and optimization cannot occur without it.

Reviewer 2:
The reviewer observed directly relevance to DOE’s combustion and fuel tasks.

Reviewer 3:
The reviewer voiced that the development of chemical kinetic mechanisms is critical to the development of models and simulators for advanced high-efficiency, clean-combustion engines.

Reviewer 4:
The reviewer reflected that the project promoted improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 5:
The reviewer noted very important chemical kinetic mechanisms, which are needed for LTC development, result from this project.

Reviewer 6:
The reviewer mentioned detailed kinetics modeling was a pathway for predicting advanced combustion concepts.

Reviewer 7:

The reviewer indicated that the work related indirectly to DOE's objectives for greater fuel efficiency, but was critical to achieving higher efficiency with low pollutant emissions.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

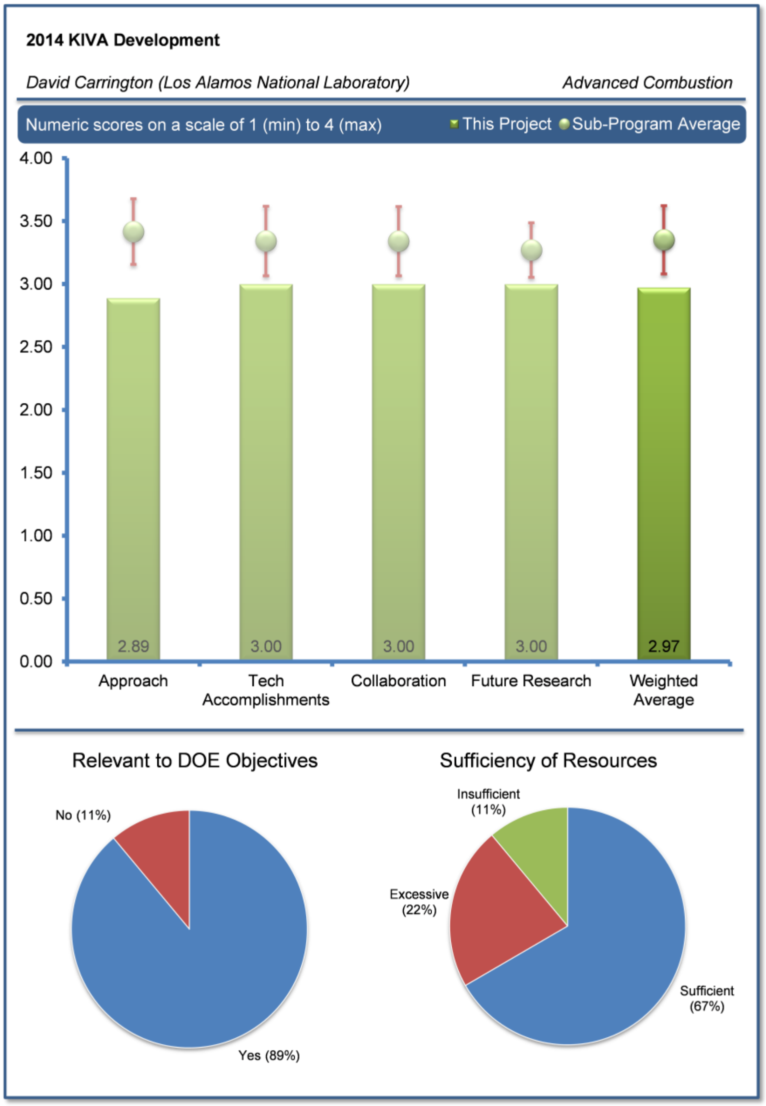
Reviewer 1:

The reviewer noted no express request was made for more funding. This reviewer asked what additional work more funding would allow if it were available.

Reviewer 2:

The reviewer said the resources seemed sufficient to do the high-quality work shown here.

2014 KIVA Development: David Carrington (Los Alamos National Laboratory) - ace014



Reviewer Sample Size

A total of nine reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated keeping KIVA relevant was critical for academic institutions performing fundamental work on internal combustion engines.

Reviewer 2:

The reviewer rated this as good to excellent. This person added that this was very important work and, if successfully completed, it would facilitate the independent work of many researchers developing more sophisticated aspects of combustion and spray modeling, with the net result being more robust and accurate CFD predictions. This reviewer was not sufficiently knowledgeable to critically evaluate the details of the work, thus the reason for the moderate rating of the project.

Reviewer 3:

The reviewer indicated the project seemed like a very solid continuation of a long-time program that was very valuable.

Reviewer 4:

The reviewer remarked that continuing to improve KIVA is worthwhile.

Reviewer 5:

The reviewer noted that the project seeks to provide improved tools for more accurate prediction of engine processes, including fuel injection, fuel-air mixing, and emissions prediction. The effort targeted a wide range of combustion regimes. This reviewer also mentioned that the project focused on new, more efficient algorithms and grid generation.

Reviewer 6:

The reviewer asked if this code competed or complemented commercially available code.

Reviewer 7:

The reviewer felt that the approach was not clearly articulated in the presentation.

Reviewer 8:

The reviewer mentioned that the current approach seeks to improve the backbone numerical algorithms and structure of the KIVA code to address many of its current shortcomings. Based on the current milestones (Slide 4) and timeline (Slide 2), it is a bit unclear to the reviewer how the current improvements to KIVA will compare to capabilities in popular commercial codes. This reviewer asked if KIVA would hold a strategic advantage. Additionally, many academic institutions are beginning to evaluate OpenFOAM as CFD software. This person noted that OpenFOAM has modularity and parallelization that is an objective of this project, and asked what the reason was to not begin with OpenFOAM as the base platform and focus on updating the physical submodels.

Reviewer 9:
The reviewer voiced that KIVA-3 and KIVA-4 are seeing less and less use within industry. KIVA has become more of a free resource to universities that want an open-source type format so they can do physical modeling. But even there, this reviewer added, other competitors like OpenFOAM are taking over the market share. A serious evaluation of the business model needed to be made. This reviewer added that it would really be healthy to continue to have KIVA as a competitor to other commercial codes, and asked what could be done to hasten the development and deployment of KIVA within industry.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer emphasized that the addition of spray and advanced turbulence models were critically important, as were pre-processing and solver improvements.

Reviewer 2:
The reviewer noted good progress on meeting milestones.

Reviewer 3:
The reviewer was not an expert in this area, but the results seemed solid.

Reviewer 4:
The reviewer stated the emphasis of focusing on a sound numeric approach in KIVA is a good direction and should be pursued. Several test cases were presented to demonstrate the new capabilities of KIVA. This reviewer asked if there is a reason the PI did not invest in using newer databases, such as ECN spray measurements and engine data currently being taken at other national labs. This reviewer noted the project timeline ends in September 2015, and asked if the code would be mature and capable enough to simulate many of the low-temperature DI combustion problems being studied by other AEC projects.

Reviewer 5:
The reviewer mentioned that the accomplishments seek to update the original KIVA model, and span a range of methods and models, including spray models (with evaporation, breakup, and droplet transport), easier and quicker grid development, and parallel solution schemes. It appeared that the project made good progress, though it was hard to evaluate this. This person added that it would be most optimum it would be optimal to have the authors make a proof-of-concept when applied to a real engine scenario and compare this with other modeling tools and experimental data. Some of this was done with simple examples (such as in the grid generation).

Reviewer 6:
The reviewer felt that it was difficult to resolve what accomplishments were completed in the last calendar year.

Reviewer 7:
The reviewer indicated that it was not clear how all of the improvements made in KIVA compared to features currently available in commercial codes. This reviewer asked if KIVA was leading or lagging the commercial codes, and added that, as KIVA is maintained by a national laboratory, it should be leading.

Reviewer 8:
The reviewer emphasized the technical accomplishment appears to be excellent. However, it is a concern to this reviewer to not see the broad-based user community, universities, other national laboratories, and industry showing much excitement about this program.

Reviewer 9:

The reviewer noted plenty of work had been done and numerous test cases were shown. However, overall technical progress over the last few years on KIVA-4 has been very slow. The reviewer added that the key issue now was whether industry was really interested in KIVA-4, and asked why it was not. It is a free code, yet industry prefers to use other commercial codes. The reviewer opined that there was something wrong with this picture. This reviewer asked what could be done to make the usefulness and deployment of KIVA-4 within industry faster.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted collaboration was mostly with academic institutions, which seemed to be appropriate for KIVA.

Reviewer 2:

The reviewer said KIVA is a widely used tool with many collaborators actively involved.

Reviewer 3:

The reviewer noted that the team assembled includes the University of New Mexico, Purdue University Calumet, and University of Nevada–Las Vegas. This reviewer added that the presentation showed how the work was being split.

Reviewer 4:

The reviewer emphasized the collaborations cited were mostly with universities.

Reviewer 5:

The reviewer felt the collaborations that exist appear to be good, but added there was no mention of interface with “heavy” academic, research laboratory, or industry users to get feedback or their impressions of the program or to exercise it.

Reviewer 6:

The reviewer commented that the development goals of the project appeared very aggressive, with the logical progression of new models being somewhat fragmented. The reviewer encouraged the PI to solicit industry input as beta testers to provide feedback during the development process. It appeared that other national laboratories were entrenched into using their own in-house or commercial codes like CONVERGE and OpenFOAM. This reviewer asked what the business model was to proliferate KIVA to the wider technical community outside of the academic partners involved in the project.

Reviewer 7:

The reviewer remarked it was good to see a few universities involved, but felt it was interesting to see that Wisconsin was not among the project team. This reviewer stated that an additional collaborator should be SNL’s ECN. It is a chance to simulate and compare simulation to measurement. This person asked if the spray model could be “tuned” to one experimental condition, then be accurate (and predictive) for other conditions. If KIVA was leading the industry, this would be a way to showcase it—by showing how good the KIVA prediction was compared to commercial codes. This reviewer would like to see this in next year’s review.

Reviewer 8:

The reviewer suggested that perhaps a new business model that increases the chances of KIVA not fading away in the next few years would demand different types of collaborations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the plan to complete the remaining objectives is good.

Reviewer 2:
The reviewer indicated that this seemed to be the correct direction. This reviewer looked forward to a tool that could handle turbulence and wall interactions more directly.

Reviewer 3:
The reviewer commented that the future work was appropriate, but should consider flame kernel models in the context of dilute combustion.

Reviewer 4:
The reviewer noted that, with the validation being done on numerical schemes, it would be good if this group could suggest good, fundamental test cases that others in the community could use to benchmark the numerical accuracy of their own codes or commercial codes. One could envision a distribution of tutorial test cases within the KIVA package. The reviewer noted that this group is in a unique position to help industry understand the limitations of using lower-order treatments on boundaries (such as cut-call, as mentioned in the presentation) and drive the larger engine CFD community to more numerical accuracy.

Reviewer 5:
The reviewer said the project would continue to pursue spray and combustion systems modeling, solvers, and grid generation, but added that the closure of the effort was not too clear.

Reviewer 6:
The reviewer felt that there needed to be faster progress on getting the remaining work done.

Reviewer 7:
The reviewer indicated, similar to previous comments on accomplishments, it was hard to judge if the proposed work was on target or not. There was no justification for any of the improvements. This person asked if the improvements were driven by gaps in current commercial codes that KIVA could fill. The reviewer further asked if they are general improvements, where they came from, and how they were prioritized. The reviewer noted Convergent Science's CONVERGE code was quite prevalent in many of the other presentations, while KIVA got little (or no) mention. The reviewer continued to ask if the KIVA resources would be better utilized by using the national laboratory capability to develop open “sub-models” that can be incorporated into commercial codes. If this is not doable today, the reviewer wanted to know what enablers were required to make this happen. This reviewer suggested this might be the better use of the resources.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the project promotes improved modeling tools that will help in the overall fuel efficiency roadmap.

Reviewer 2:
The reviewer felt that KIVA modeling is invaluable to the academic research in the field of advanced ICEs.

Reviewer 3:
The reviewer indicated that KIVA is a basic tool for many levels of simulation necessary to DOE’s mission.

Reviewer 4:
The reviewer summarized that improved modeling/simulation of fluid injection, mixing, combustion, and emissions formation is important to the design of higher-efficiency, lower-emissions engines—which is consistent with DOE goals.

Reviewer 5:
The reviewer noted that accurate CFD codes were a pathway to predictive simulations for advanced engine concepts, and added that demonstration of this code to compute these concepts needed to be faster.

Reviewer 6:

The reviewer said it was clear that an open-source 3D CFD code had a place. This reviewer added that, given the current direction shown, it is not clear that KIVA is relevant—but it can and should be. This reviewer asked what the unique strength is of LANL and KIVA, and how it can best be leveraged to lead the industry. Similarly, the reviewer asked what the gaps/needs in current commercial codes were, and how KIVA could address them. This reviewer noted there needs to be time and thought put into this, and a plan clearly communicated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

To this reviewer, having an open-source advanced CFD program that allows the technical community to work on sub-model development for higher precision and fidelity in the modeling of the various phenomena occurring in the engines—and then evaluating these sub-models in a predictive program and presenting results for peer evaluation—has been key to the rapid advancement that has occurred in CFD analysis over the past several decades. This reviewer added that providing such a program is an appropriate role for DOE, and DOE should be proud of the progress in engine understanding and development that has occurred though the KIVA program. However, this reviewer noted that KIVA-3 seems to approaching the end of its useful life and that an upgrade is needed. That is the objective of this program. The reviewer concluded that, to this end and relative to the importance of having a timely update introduced (which is of use to the CFD community), the program seems underfunded.

Reviewer 2:

The reviewer asked if, to get work done faster, the funding needed to increase or if the funding model needed to change.

Reviewer 3:

The reviewer said that the funding level seemed to be appropriate, and added that it sounded like much of the funding went to universities under subcontracts. This reviewer asked if there were enough core personnel at the laboratory.

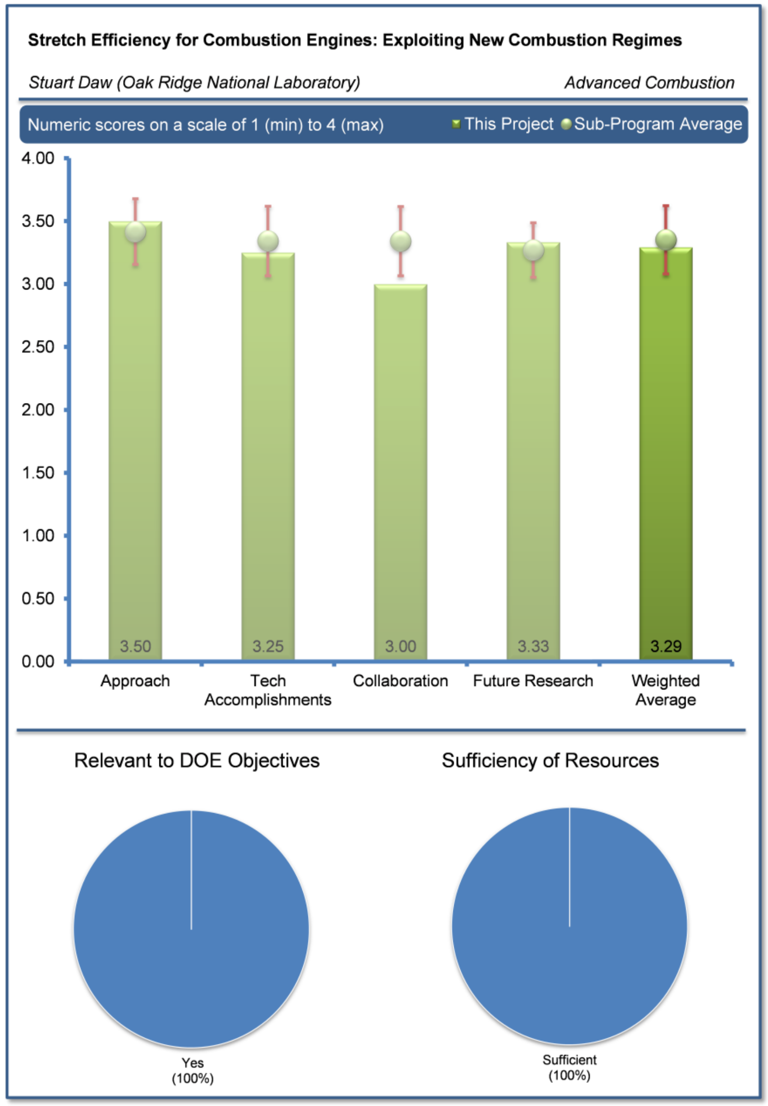
Reviewer 4:

The reviewer remarked that, in the future, the PI should more clearly credit in the presentation material on what contributions/sub-models were being made by LANL and the universities.

Reviewer 5:

The reviewer observed excessive funding for the current direction.

Stretch Efficiency for Combustion Engines: Exploiting New Combustion Regimes: Stuart Daw (Oak Ridge National Laboratory) - ace015



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this work was an excellent look at the fundamental thermodynamics of efficiency improvement in SI engines, with a very innovative approach to improving efficiency through thermochemical recuperation (TCR). This reviewer added that building a flexible engine platform to look at competing concepts was a great idea for both providing a common basis of comparison and reducing costs of duplicate hardware, etc.

Reviewer 2:

The reviewer noted that the project included some creative and unique ideas, as well as adaptations of other's ideas to improve engine efficiency. This reviewer looked forward to the results of in-cylinder reforming to see the net benefit considering the friction penalty of a non-firing cylinder. The reviewer summarized that this was a high-risk project with a potentially high reward.

Reviewer 3:

The reviewer believed that this type of study should be conducted through DOE funding. The reviewer agreed with the PI's concept of 'evolutionary versus revolutionary' technology investigation.

Reviewer 4:

The reviewer remarked that clearly this was high risk but may be promising. This reviewer added such programs were needed if we are to achieve breakthrough engine efficiencies.

Reviewer 5:

The reviewer stated that this proposed approach of reformate-assisted dilute combustion through thermochemical recuperation is high-risk, high-potential work that merits scoping funding from DOE. This person added that it was unclear how beneficial it would be to dedicate one of the four cylinders to reforming.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated great work on showing what could be accomplished and what barriers must be overcome.

Reviewer 2:
The reviewer emphasized good progress on assembling the engine system and starting to evaluate the two approaches of in-cylinder reforming and catalytic EGR loop reformer.

Reviewer 3:
The reviewer noted that results were shown at one operating condition, and added that it would be interesting to see a sensitivity study on operating conditions to see what conditions are best to do reforming to maximize efficiency (as exhaust temperature and gas compositions vary depending upon operating condition).

Reviewer 4:
The reviewer stated that ORNL is uniquely able to study the catalytic EGR reformer chemistry. This person asked if the PIs had knocking issues with the introduction of 'reformed' EGR in the power cylinders, and if the PIs believed this technology to be synergistic with lean-burn engine concepts.

Reviewer 5:
The reviewer observed good progress in getting the engine put together, but was hoping to see some engine test results this year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted excellent collaboration with universities, other government laboratories, and industry.

Reviewer 2:
The reviewer asked if there was any plan to incorporate CFD modeling of the in-cylinder reforming/combustion process. This person indicated this data could provide a good benchmark to drive future kinetics development.

Reviewer 3:
The reviewer mentioned some collaboration with other national laboratories and universities, and added that there appeared to be limited collaboration with industry.

Reviewer 4:
The reviewer felt that it appeared there could be more collaboration opportunities.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer asked if the PI would show comparisons between different EGR reforming approaches in the future.

Reviewer 2:
The reviewer suggested that it would be good to estimate the improvement in efficiency (possibly via numerical/analytical modeling) before proceeding too much on the experimental side of choosing which catalyst and approach to use. This reviewer was not sure if there were better catalysts than rhodium.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer emphasized that this work could provide breakthrough results to improve engine efficiency and reduce petroleum usage.

Reviewer 2:
The reviewer noted that improving efficiency would aid petroleum displacement, and added that presumably this technology would work just as well with non-petroleum fuels.

Reviewer 3:
The reviewer summarized that the project focuses on a concept that has the potential for higher engine efficiency.

Reviewer 4:
The reviewer commented that this technology provided a pathway for dilute SI combustion to improve fuel economy with standard after-treatment technology.

Reviewer 5:
The reviewer stated that TCR is one avenue for exceeding the limits imposed by the Carnot cycle.

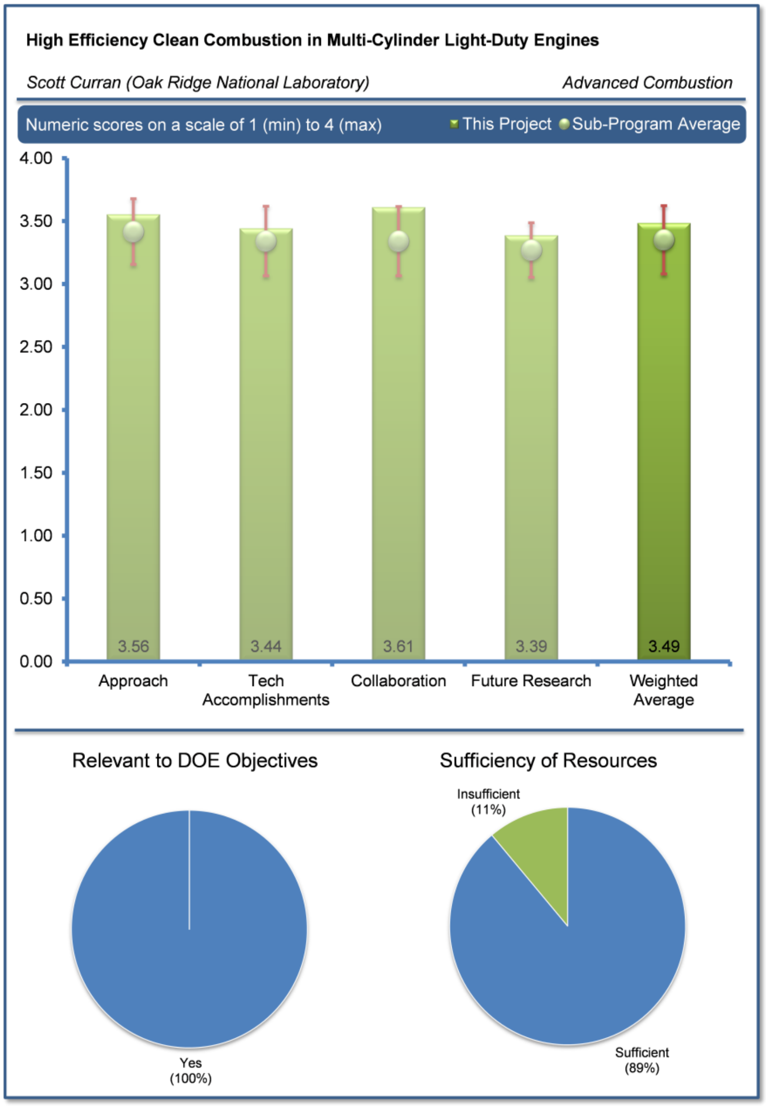
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer felt that this project needed additional resources to accelerate progress.

Reviewer 2:
The reviewer noted good use of resources and expertise.

Reviewer 3:
The reviewer indicated that the resources appeared to be adequate for the planned program.

High Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines: Scott Curran (Oak Ridge National Laboratory) - ace016



Reviewer Sample Size

A total of nine reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach was excellent in that it seeks to be as relevant to real-world application as possible, using multi-cylinder engines, calibrating it over the test cycle, and using the map in vehicle simulations to assess benefits.

Reviewer 2:

The reviewer emphasized that the PI has a solid approach that combines experimentation and modeling, including characterization of emissions.

Reviewer 3:

The reviewer felt that it was very useful to see RCCI tested in real conditions, and added that the approach seemed solid.

Reviewer 4:

The reviewer indicated that the development of the technology is considered in the proper context for demonstrating its commercialization potential. This person noted efficiency is considered in the context of the application to conventional and hybrid powertrains, with realistic fuels, and with due consideration of the exhaust-aftertreatment challenges.

Reviewer 5:

The reviewer mentioned that a system-level approach was needed for evaluating vehicle-level emissions and efficiency benefits.

Reviewer 6:

The reviewer explained that the project seeks to overcome the lack of fundamental knowledge about advanced combustion regimes, the lack of effective engine controls for LTC, and the lack of actual emissions data on future engines. The effort seeks to assess the potential of advanced combustion concepts, such as RCCI, on multi-cylinder engines for improved efficiency and emissions along with advanced emission-control technologies. This person added that the approach includes the characterization of emissions from advanced combustion modes, and it defines synergies and incompatibilities with aftertreatment systems. The reviewer noted that the study also considers the operation in both conventional and advanced combustion modes, including mode switching.

Reviewer 7:

The reviewer mentioned this was a good approach, but should include the fuel economy impact of after-treatment in the vehicle simulation.

Reviewer 8:

The reviewer asserted that the effort to expand the assessment of the advanced combustion strategies to vehicle system and transient operation was an important component of performing realistic evaluation of the potential for these combustion technologies to move toward production. This reviewer added that the work should also identify important areas of system control, as well as emission challenges that would need to be addressed for these advanced combustion strategies to make the next step towards implementation.

Reviewer 9:

The reviewer said that the assessment of the RCCI concept in multi-cylinder light-duty, hybrid light-duty, and heavy-duty engines is extremely important to assessing the potential of this approach. This person's only criticism of the work is that E30 was used instead of E10, and added that, since E10 is commercially available, it is important to assess the RCCI capabilities with this fuel.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the project was demonstrating excellent progress toward meeting realistic, well-defined objectives for the technology. This person added that extending the load range would be an important next step, so that the efficiency gains may be realized with equivalent acceleration performance.

Reviewer 2:

The reviewer noted excellent progress in assessing the performance of RCCI in various engine/vehicle platforms.

Reviewer 3:

The reviewer noted very nice work. This reviewer viewed what has been accomplished as setting the stage for the really important work that lies ahead, namely, the evaluation of the actual transient performance for both fuel consumption and emissions.

Reviewer 4:

The reviewer stated lots of good data, but added that data with E10 would be important.

Reviewer 5:

The reviewer asked how the RCCI fuel economy targets compared with a modern DI baseline engine (such as GM's LNF or Ford's EcoBoost).

Reviewer 6:

The reviewer remarked the accomplishments included demonstration of cylinder balancing control for RCCI operation, and establishing control authority on an HD engine for future RCCI operation. The RCCI mapping focused on efficiency and load extension. This person noted that the limited load range required mode switching to cover full drive cycles, and that the present work appeared to be limited to modeling; therefore, the implementation to actual hardware should be the focus now. This reviewer felt that this would be the high value added by the project, as steady state data was available from other programs and platforms. Also, this person felt that the use and reason for selecting E30 with diesel might need to be explained.

Reviewer 7:

The reviewer voiced that the benefits of RCCI combustion over various drive cycles were now better understood, and added that the fuel economy benefits of RCCI have now been compared to relevant PFI gasoline and diesel baseline engines. The RCCI region of the drive cycle needed to be expanded further to get more benefits. This reviewer added that the character of particulate matter from RCCI combustion was being better understood.

Reviewer 8:

The reviewer noted good progress towards vehicle-level estimates of emissions, but noted a need to consider cold start and catalyst light-off periods.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer emphasized excellent collaboration with industry, universities, and other national laboratories. This reviewer especially wanted to compliment the PI on Slide 16 regarding the project's collaborations, which clearly elucidates their types of collaboration with the various organizations—distinguishing between info exchange, equipment supply, and robust collaboration. This was the only presentation this reviewer had seen where those distinctions were made. In presentations by others, this reviewer often wondered whether what is characterized as collaboration consists only of a presentation once or twice a year.

Reviewer 2:

The reviewer noted excellent interaction with the relevant groups, and stated that a good level of collaboration had been achieved.

Reviewer 3:

The reviewer indicated that the PI has leveraged an extensive network of collaborators, providing good synergy and feedback towards the project.

Reviewer 4:

The reviewer said that the collaboration was well designed for progress on multiple fronts in the technology (e.g., efficiency, emissions, and technology demonstration).

Reviewer 5:

The reviewer noted that the team leveraged resources and expertise across industry, national laboratories, and universities.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer observed that the plans were well designed to build on the progress to date and met program objectives.

Reviewer 2:

The reviewer encouraged the future work that focuses on engine transients.

Reviewer 3:

The reviewer stated that it was good to see the after-treatment integration into the vehicle simulation is planned for next year. This reviewer noted the transient work is also critical, to make sure the vehicle results predicted from modeling will be realizable in the vehicle.

Reviewer 4:

The reviewer commented that the future work was well laid out for the closing of fiscal year (FY) 2014 and for 2015. The program will continue to develop experimental RCCI maps suitable for standard drive cycles, and it will continue to try to demonstrate a 25% increase in the modeled fuel economy with RCCI over LD drive cycles. This reviewer added the selection of a low-temperature catalyst will be pursued, and that the project will also seek to demonstrate heavy-duty RCCI on a multi-cylinder engine.

Reviewer 5:

The reviewer said that the challenge is to not let the size of the RCCI regime diminish when relevant transient controls and transient calibration are done. This reviewer added that the after-treatment challenges with regards to CO and HC emissions, as well as low exhaust temperature, were also critical remaining barriers.

Reviewer 6:
The reviewer noted a solid plan to get the data, and added that it may be useful to collaborate with Bosch, which had done a lot of work and analyses on HCCI multimode controls. This reviewer added that much of what the project team had found might inform this work, and reminded the project team to be sure to use properly aged catalysts in this work.

Reviewer 7:
The reviewer indicated that the proposed future research had realistic yet ambitious goals, and was extremely relevant to efforts to commercialize the technology. However, this reviewer noted further transient performance objectives should also include more aggressive US06 cycles, or that the application should be restricted to hybrids or perhaps even medium-duty trucks (with higher displacement). The reviewer added that finding a means for reducing the ethanol requirements by addressing octane sensitivity might be useful.

Reviewer 8:
The reviewer emphasized that it would be critical to incorporate appropriate systems-level controls (model-based controllers would be ideal) to control RCCI through transient operation. Otherwise, this reviewer thought it was likely that the advantages of this mode of combustion would be lost in practical application.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer offered that bridging the gap from single-cylinder engine studies—and determining the capabilities/feasibilities of advanced combustion concepts, such as RCCI in multi-cylinder engines—greatly advanced the assessment and development of the most promising of the high-efficiency, clean-combustion technologies.

Reviewer 2:
The reviewer indicated HECC was an important high-risk, high-reward technology for LDVs, and that this project was addressing all the appropriate areas.

Reviewer 3:
The reviewer noted that low-temperature combustion technologies are a means to improve engine fuel economy.

Reviewer 4:
The reviewer said the work was very relevant to the research on future systems.

Reviewer 5:
The reviewer voiced that RCCI has demonstrated high brake thermal efficiencies with ultra-low NO_x and soot emissions in steady state. However, this reviewer noted that the benefits and challenges of RCCI over federal driving cycles were still not well understood. The reviewer added that this effort would bridge this gap, and that the project promoted improved tools that would help in the overall fuel efficiency roadmap.

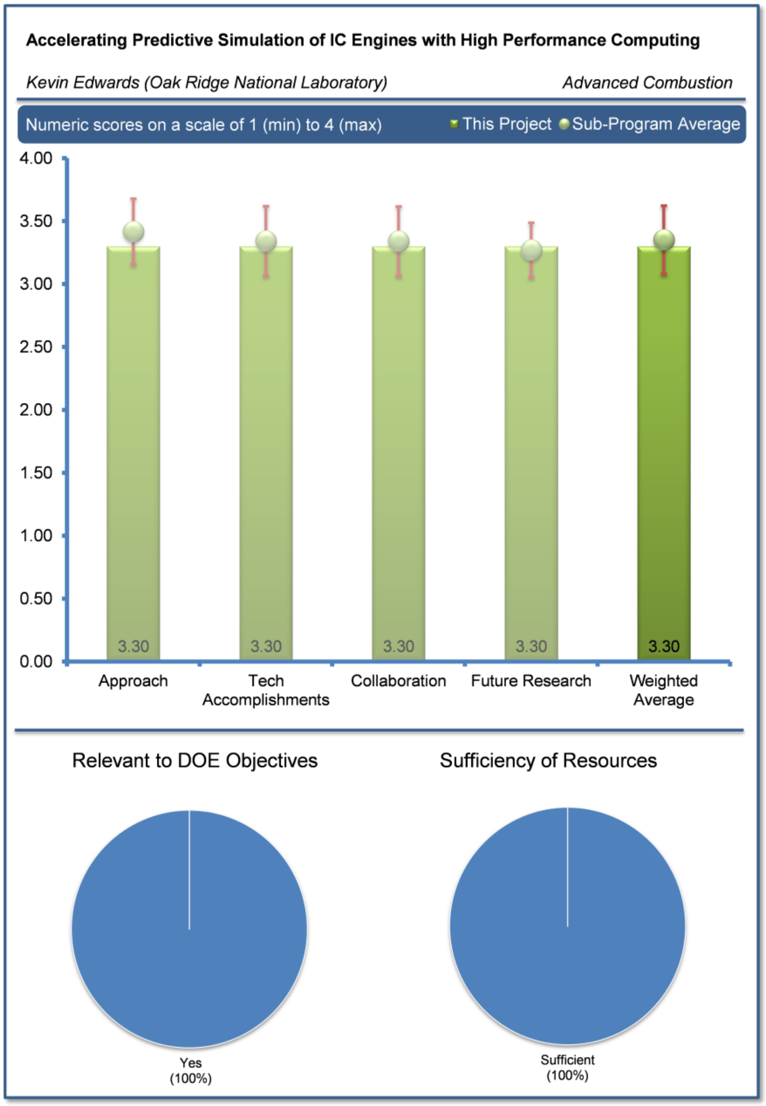
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that the presenter did not complain of insufficient funds.

Reviewer 2:
The reviewer suggested that expanding the collaboration to address some of the critical challenges of the technology would be useful to making progress toward the needed LD efficiency improvements.

Reviewer 3:
The reviewer felt that the funding level seemed appropriate.

Accelerating Predictive Simulation of IC Engines with High Performance Computing: Kevin Edwards (Oak Ridge National Laboratory) - ace017



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this was important work to help industry leverage the capabilities of large-scale computing.

Reviewer 2:

The reviewer felt it was good to see a complete, iterative design/model/optimization scheme.

Reviewer 3:

The reviewer indicated the approach of developing and applying innovative uses of HPC and predictive simulation to accelerating internal combustion engine (ICE) development was of value.

Reviewer 4:

The reviewer stated that the project provided a “package deal” of HPC computing and support for industrial partners to tackle specific large-scale engineering problems relating to IC engine design. While this can be a very useful way of promoting and conducting basic research, the “open” nature of the research limits its ability to impact the actual design process, or to even tackle very specific technical issues faced by industry. This reviewer said a better balance is needed between the project’s “openness” criteria for maximum engagement of these resources (of course, this is just a reflection of higher-level policy) with the needs of industry to keep at least some aspects of the work proprietary. This reviewer’s organization has formed partnerships with other laboratories and universities, which better meet these needs while also meeting their needs for publications, and etc. So, while one could argue the “technical barriers” are being addressed, the issue is with the “integration” of these resources within the needs of industry. The reviewer added that if the latter could be given more flexibility, then this would be an excellent or even outstanding effort.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the project had completed the development and deployment of the computer framework for launching parallel ICE simulations on ORNL’s HPC resources. This person added that most of the other work for 2014 seemed to be still in progress but on track to meet milestones.

Reviewer 2:

The reviewer observed very interesting simulation results and suggested continuing to pursue experimental verification whenever feasible.

Reviewer 3:

The reviewer felt that the progress on the reported collaborations appears to be excellent, and added that it might have been interesting to include some comments and feedback from the customers on these three projects in terms of the timelines and utility of results, key assistance provided by ORNL, etc. The reviewer added that, as this appears to be a very customer-driven project, having the customers' feedback on the highs and lows of the interaction would be useful and perhaps (assuming things are being done right) lead other potential collaborators to step up to be included.

Reviewer 4:

The reviewer remarked that the techniques and solutions developed to run CONVERGE on the Titan supercomputer will help other projects that could use large-scale computing.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted good collaboration with a software supplier and industrial partners.

Reviewer 2:

The reviewer mentioned that collaborations were established with several industry partners (including Ford, General Electric, GM, and Convergent Science).

Reviewer 3:

The reviewer commented that the project appears to have three main collaborators to date, and added that, if the goal is true outreach and facilitation with industry, there is a long way to go to impact the industry as a whole. This person stated the question of balance between "openness" on the laboratory side and the proprietary aspects of potential projects from possible industrial partners needs to be more effectively resolved.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said plans seem reasonable.

Reviewer 2:

The reviewer indicated that the concept of a low-order "meta-model," which greatly reduces the computational cost, is a very interesting idea. Besides the meta-model mentioned, phase-invariant proper orthogonal decomposition (POD) also provides a good basis (modes) to construct low-dimensional turbulence/combustion models. The reviewer added that these POD modes offer the potential for rapid analysis and prediction of in-cylinder flows/combustion that might eventually be used for real-time control. Also, these base functions (modes) for the low-order models could be derived either from experiments or simulation. This person suggested that the authors could refer to the following references for more details: Holmes P, Lumley J L and Berkooz G, 1996, Turbulence, Coherent Structures, Dynamical Systems and Symmetry (New York: Cambridge University Press); and K. Liu, D. C. Haworth, X. Yang and V. Gopalakrishnan, "Large-eddy simulation of motored flow in a two-valve piston engine: POD analysis and cycle-to-cycle variations," Flow, Turbulence & Combustion. Vol. 91, pp. 373-403, 2013.

Also, this reviewer noted that to study the combustion stability, the SI ignition model development is very important. The flame kernel initialization and early development are essential stages for the cycle-to-cycle variations. This reviewer concluded that this subject could be an interesting topic.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said accelerating the development of high-efficiency, low-emissions engines by applying innovative uses of HPC and predictive simulation supports DOE goals.

Reviewer 2:

The reviewer commented that leveraging supercomputer resources to address engine combustion problems could help design more efficient engines.

Reviewer 3:

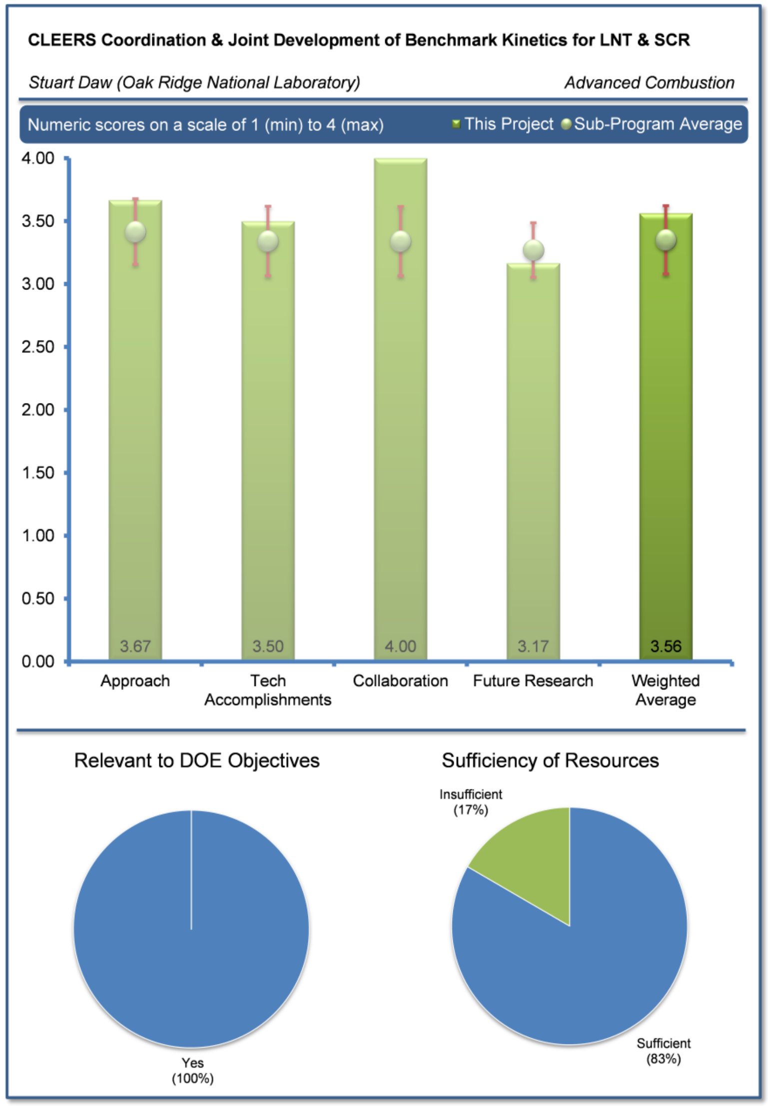
The reviewer indicated that, of course, this point is highly dependent on the projects that the collaborators want to bring in and which the project then chooses to support. This person added that the basic assisted HPC approach is neutral, but, by seeking out the right projects, it can then indeed promote the larger DOE objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer did not think one could ever have too many computing resources, and added that better capitalizing on the GPU capabilities of Titan would add even more capability.

CLEERS Coordination & Joint Development of Benchmark Kinetics for LNT & SCR: Stuart Daw (Oak Ridge National Laboratory) - ace022



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that the overall approach of the CLEERS program reaches out very well to the appropriate people.

Reviewer 2:

The reviewer indicated that expanded and enhanced database activities for kinetics and modeling activities within the catalysis community are very important to continue and support. This material can be used by OEMs to tune and improve their control strategies for aftertreatment development without expending internal resources and funds. This reviewer added the inclusion of the industry OEMs, universities, and suppliers through the Cross-Cut Lean Exhaust Emission Reduction Simulation (CLEERS) conference, telecoms, public database, and feedback surveys is important for the development and characterization of future aftertreatment systems.

Reviewer 3:

The reviewer mentioned that CLEERS provides a valuable coordination of pre-competitive aftertreatment efforts by different companies, universities, and labs that are shared with the CLEERS participants. This person added the regular CLEERS audios and the annual workshop are extremely valuable.

Reviewer 4:

The reviewer noted CLEERS uses a good approach in dealing with experts, issues, challenges, modeling, coordination, and dissemination of proper, relevant information. The project team is using the right tools, such as a website, an annual workshop, and monthly teleconferences, as well as the best experts, a nearly all-inclusive policy, and a focus on developing strong relationships. CLEERS' charter has grown from a mere after-treatment modeling circle to one now including engines as well (gasoline, diesel, and natural gas), plus testing, and has stayed reasonably well connected with industry needs and outlook.

Reviewer 5:

The reviewer stated CLEERS coordination has been the main hub for connecting all the activities and communications among the after-treatment community, and noted it is so important to keep up with industry needs and the trend of state-of-the-art emission control strategies. This reviewer added that, overall, ORNL's effort has been very well focused in that regard. However, this reviewer saw there still are some opportunities of improvement. For example, this person would encourage the project to coordinate communications with the Environmental Protection Agency (EPA) or California Air Resources Board (CARB). In the area of model development, it is not clear how ORNL will approach competing with or implementing homegrown models with other models being used in industry.

Reviewer 6:

The reviewer felt that the experimental work is great, and added that the one weakness in this project is the need to leverage outside partners who are working on the project under their own funding. This reviewer indicated that, consequently, the ability of the project to reach their stated goals is dependent on the willingness of the partners. This reviewer believed the majority of the kinetic analysis comes from the Institute of Chemical Technology, Prague (ICT) and Politecnico di Milano and uses neither Chemkin nor Autonomie. The reviewer asked if this is a significant crack that has the capacity to severely limit the goals of the project. The person further asked if there is a well-defined mechanism and parameter transfer from ICT and Politecnico di Milano. The reviewer noted that Slide 13 showed the modeling to be custom codes, Chemkin and Autonomie. This reviewer further thought that most of the component modeling at ORNL is Matlab-/Simulink-based, which are included as add-ons to Autonomie. Although Automomie is supported, this reviewer did not believe the add-ons in Matlab are supported or generally disseminated.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted highly valued activities within CLEERS to support aftertreatment characterization, including the following: enhanced and accessible databases; telecommunications; Advanced Combustion and Emissions Control (ACEC) low temperature aftertreatment support for protocol development; and the CLEERS annual conference. This reviewer further said lean NO_x trap (LNT)–N_2O generation is important for LNT technologies and lean systems (thereby very appropriate), and the project is looking to reduce N_2O generation using modeling and reaction characterization at low temperature. Emerging LNT/NO_x storage catalyst (NSC) technologies would argue against diminishing the effort to understand these materials. This reviewer added NH_3 storage is a strongly supported activity. Characterizing NH_3 storage as a function of temperature and aging is required for proper NH_3 dosing and conservation. This reviewer mentioned using isotherms to determine the number of NH_3 storage sites is an easy, effective way to demonstrate this.

Reviewer 2:

The reviewer commented on the very good progress on NH_3 storage capacities in selective catalytic reduction (SCR) catalysts, which will be useful for maximizing NO_x conversions and minimizing NH_3 slip. The results on N2O production from LNTs during regeneration were interesting.

Reviewer 3:

The reviewer emphasized that CLEERS is a government-sponsored program with its own benchmark, and added that it has grown from a small circle to one having industry-wide impact, even outside the United States. CLEERS' monthly teleconferences are highly educational and stimulating, and its annual workshops have become one of the best interaction opportunities in the 'development' circles. This reviewer noted CLEERS' focus has expanded to include discussions on various combustion and emission types. Its topics diversity (relevance) is adequate. This person said congratulations to ORNL (the PI and his team) for having created such a stimulating circle of open information exchange. This reviewer noted that in one area, however, CLEERS has been somewhat slow in shifting its focus from LNT to SCR, to accommodate the diesel industry needs and trends. It did, however, integrate properly and timely modern gasoline engine developments in its focal discussion areas.

Reviewer 4:

This reviewer described technical accomplishments and progress as excellent, and suggested that even more modeling results available to researchers would be better.

Reviewer 5:

The reviewer indicated that the adsorption isotherms were quite interesting, and added that the Temkin isotherm was used for the adsorption mechanism for a commercial modeling code. This work that shows the two-site Langmuir was very interesting. It validated the more commonly used two-site kinetic codes. This reviewer was disturbed at the conclusion that previous approaches could be wrong or chaotic (Slide 17). Differences in zeolite and metal ion exchange can cause significant differences in the kinetic description. Much of this could just be substrate differences. FY 2013 ORNL showed that NO–NO_2 oxidation was not important, and then indicated a new mechanism for NO oxidation—a bit mysterious. This reviewer felt perhaps a bit more clarity for the Annual Merit Review (AMR) would have been helpful.

Reviewer 6:

The reviewer saw that the project team had clearly made big efforts in improving existing models, with additional features in both LNT and SCR technologies. However, this person felt the deliverables and timing for each year were not well-defined.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that CLEERS had done an outstanding job in helping develop proper collaborations with industry, academia, and national laboratories. This person added that it had indeed gone above and beyond its initial charter, brought added value to the industry, and had made a positive, irreversible impact.

Reviewer 2:

The reviewer observed that collaboration is inherent in this project and is handled well.

Reviewer 3:

The reviewer noted that the project had broad inclusion of the catalyst community as well as highly respected research teams throughout the country.

Reviewer 4:

The reviewer indicated good collaborations with ICT on N2O generation from LNTs, as well as with Politecnico di Milano and Pacific Northwest National Laboratory (PNNL) on SCR mechanisms.

Reviewer 5:

The reviewer mentioned that the collaborations with ICT and Politecnico di Milano were outstanding and provided substantial value-added benefit to the project. This reviewer also noted that the collaboration with PNNL was good, but a bit disconnected due to the personnel changes at PNNL. This reviewer further added the regular visits of students from ICT and Politecnico di Milano was a great collaboration tool.

Reviewer 6:

The reviewer stated this project has demonstrated excellent collaborations for many years. However, the collaboration or interaction with combustion groups working on the advanced combustion area is relatively low. This reviewer recommended the project team update their engine-out emissions more frequently for harmonizing activities.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that increasing the focus on low temperature after-treatment activities is important to align with the advanced combustion strategies investigated by U.S. Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability (U.S. DRIVE). This reviewer added that the integrity of the data present in the database must be policed better and standardized to better utilize the information.

Reviewer 2:

The reviewer remarked that the coordination of the planning, focus group, workshop, and website is great, and added that low temperature after-treatment and kinetics model improvements are important. However, this reviewer recommended providing more specific and measurable deliverables for next year in the future plan.

Reviewer 3:

The reviewer stated that the project needed more specific action plans for low temperature catalyst work and support.

Reviewer 4:

The reviewer felt that in general cross-cut lean exhaust emissions reduction simulations (CLEERS) research work in after-treatment had done a fair job staying in sync with industry activities, although some of the other key industry challenges had not been regarded. This reviewer's examples included relatively high failure (warranty) rate in HD diesel emission systems and algorithm development (such as urea injection).

Reviewer 5:

The reviewer noted that N_2O formation during LNT regeneration was getting a lot of attention, and asked if it was certain this deserved this much attention, given that there was not yet a regulation and Tier 3 was already out. This reviewer wondered if the oxygen storage and NO_x reduction synergy in LNTs might need more attention, especially under highly transient conditions. This reviewer added more work on the ammonia formation over the LNT might be helpful, and that enhancing platinum-group metals (PGM) dispersion and aging resistance has a lot of utility for LNT devices. The isotherm work on SCR systems was quite interesting, but some information on the dynamics of return to equilibrium during transients might be very important.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reiterated that this project was one of most important programs funded by DOE in the emission control area. This reviewer added the focal point of this research portfolio was to develop enabling technologies for improving fuel efficiencies in cost-effective future powertrains.

Reviewer 2:

The reviewer noted the models that CLEERS develops will help maximize the fuel economy and minimize the emissions from future engines.

Reviewer 3:

This person asserted that research strongly supports this goal.

Reviewer 4:

The reviewer commented that CLEERS has properly integrated industry discussions on GDI and other high-efficiency gasoline engines—and many varied discussions on diesel combustion and emission control—assisting DOE's goal.

Reviewer 5:

The reviewer felt the work was well coupled with combustion strategies that would be used to meet future fuel economy and emissions standards. This reviewer noted modeling of after-treatment components enabled these strategies, and accurate models were needed.

Reviewer 6:

The reviewer acknowledged that there seems to be steady and perhaps growing resistance to LNT in larger displacement vehicles, and asked if there should be a strong continuation of LNT mechanism research. Both active and passive SCR are getting a significant amount of industrial attention. This person suggested perhaps a higher fraction of this activity should focus on the mechanisms for those systems, especially the dynamic response of the passive SCR system.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated overall progress was not as expected probably because of the diluted effort on both modeling and experiments. This person added that more resources for this project would help facilitate all the existing activities in this direction.

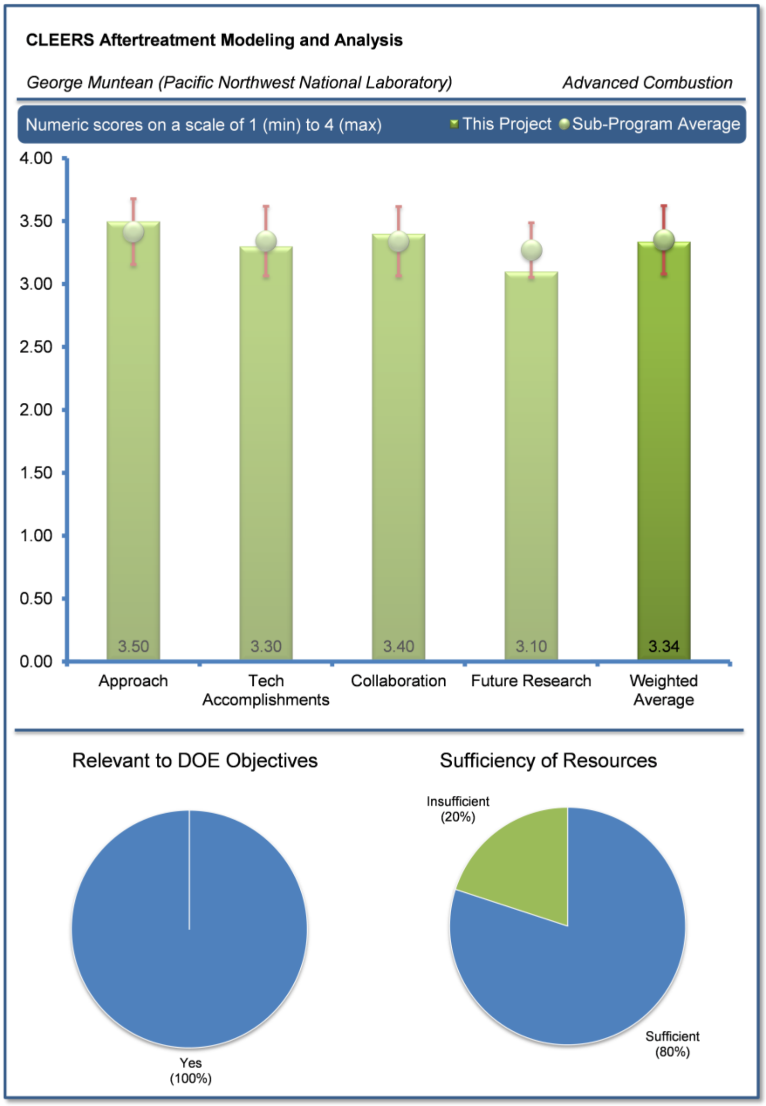
Reviewer 2:
The reviewer said sufficient, but just barely. As previously noted, if either of the international modeling partners terminates the collaboration, then there does not seem to be sufficient funding to take up the slack. This person believed a backup plan needed to be considered.

Reviewer 3:
The reviewer commented that CLEERS had integrated all it could to maximize its impact, and specified the following: the website; teleconferences; workshops; collaborative tasks; continuous communication (email); and a citation reference archive. This reviewer added it had also expanded its focus from mere modeling (its initial charter) into wider types of emission activities.

Reviewer 4:
The reviewer observed appropriate funding.

Reviewer 5:
The reviewer noted that the funding allowed for CLEERS coordination and for kinetic development was consistent with the progress that was shown.

CLEERS Aftertreatment Modeling and Analysis: George Muntean (Pacific Northwest National Laboratory) - ace023



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that inter-laboratory and industry relationships have been properly integrated into its mission to achieve objectives.

Reviewer 2:

The reviewer noted PNNL applied a very scientific approach to analyzing SCR and LNT and diesel particular filter (DPF) catalysts.

Reviewer 3:

The reviewer felt PNNL was well structured to execute fundamental approaches for solutions to real-world problems. This person indicated their combined efforts via the Cooperative Research and Development Agreement (CRADA) would have provided more specific challenges from industries in understanding as well as implementing new technologies. This reviewer added that it would be interesting to see how their contribution under the DOE/National Science Foundation (NSF) joint program would turn out in the broad aspect.

Reviewer 4:

The reviewer remarked there continued to be a good approach, and base funding provides consistency, strategic direction, and repository. This person added that, for excellence, the project could add an industry survey (such as from the United States Council for Automotive Research [USCAR] or 21st Century Truck Partnership partners) to confirm/identify needs and interests.

Reviewer 5:

The reviewer mentioned that phasing out research in the area of LNT/NSC might be premature. This person noted that focusing on the low-temperature activity of catalysts that are durable to high temperatures is very appropriate and consistent with the ACEC roadmaps. This reviewer also indicated switching to NO_x adsorption (passive) from LNT catalysts.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer explained CLEERS had developed strong relationships with proper outlets (such as the University of Milan, ICT, Chalmers, and etc.) and alike to develop proper kinetics models for LNT and SCR. This reviewer added that the work on various SCR performance attributes was noteworthy.

Reviewer 2:
The reviewer noted great progress in understanding the dip in activity at 350° C from SAPO SCR catalysts (the seagull effect). This person also said interesting analysis on the filters, particularly with the modeled flow results.

Reviewer 3:
The reviewer saw good progress on many relevant topics, which could be excellent if the project directly addressed industry and expert assessments of open-domain needs. This reviewer added the project presents and confirms challenges in the "open" domain.

Reviewer 4:
The reviewer felt that there was in general a very good foundation for this direction of research activities. With respect to SCR, identifying the source of the seagull profile of NO_x conversion is crucial to developing an understanding of reactions occurring in the zeolite, but this reviewer asked if Cu loading has been investigated as a possible source of this behavior. With regard to NSR, looking at low-temperature NO_x adsorbers as the primary focus is appropriate. However, this reviewer added that investigating deactivation pathways earlier in the project (to minimize effort spent on materials that will not perform) is recommended.

This reviewer asked where the catalyst material is deposited with respect to DPFs. Results showed that catalyst material appears fairly uniform through the wall, but this reviewer asked what the effect was on back pressure and flow velocity dynamics. Novel washcoat application may be a good solution for minimizing diffusion restrictions as well as soot-cake formation on the front face. The reviewer also noted that SPLAT was used successfully to characterize particle size for soot from a lean GDI engine.

Reviewer 5:
The reviewer stated that this project had made very good progress in SCR, and added that PNNL pioneered in exploring many features of new Cu-based zeolite catalysts. However, the high temperature NO_x storage/reduction (NSR) tasks did not seem to be well focused. Although the micro computed tomography (CT) capability was fascinating, without a doubt it will be a very unique and strong tool for particulate filter technology. However, this reviewer felt it was not clear how the information from the CT results could be utilized for the filter technology, and added that the scope needed to be a little clearer.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer highlighted that overall PNNL has good coordination in partnering with industries and other national laboratories. Also, the addition of academic partners such as Purdue University, Notre Dame, and Washington State University (WSU) will provide even further positive outcomes.

Reviewer 2:
The reviewer indicated the project work with the ACEC Low Temperature After-treatment team on test protocols for material discovery and characterization is a high priority within the after-treatment community and very appropriate.

Reviewer 3:
The reviewer confirmed that the project team has developed proper relationships with other national laboratories as well as with USCAR, 21st Century Truck Partnership, WSU, Cummins, and Notre Dame.

Reviewer 4:
The reviewer explained that the university, national laboratory, and (to some extent) industry collaboration is very good, but added that stronger industry presence from Tier 1 and OEM carmakers could improve. This reviewer also mentioned to possibly embellish "tech team" approach for common issues.

Reviewer 5:
It was not clear to this reviewer how PNNL interacted with its partner organizations (e.g., CLEERS, cross-cut team, ACEC, and ORNL). The reviewer had the impression that CLEERS, cross-cut, and ACEC are more like "customers" rather than collaborators, in that they receive the results of the work, but do not contribute to the actual work or accomplishments. This reviewer added that some collaborative work with ORNL, ANL, Purdue, and Notre Dame was mentioned.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said the project team was continuing on a successful path.

Reviewer 2:
The reviewer mentioned that the plan to assess low-temperature NO_x adsorbers is good, and added that it is good the work on the high-temperature NO_x adsorbers is being curtailed.

Reviewer 3:
The reviewer asserted that standard deactivation pathways should be investigated on new materials early in the discovery process to expedite the process of new material discovery. This person said the work in the other areas is quite substantial and important to continue.

Reviewer 4:
The reviewer explained the future activities on SCR were pretty clear, although it would be nice to add more efforts on the mechanistic approach on aged or deactivated SCR. Also, for low-temperature LNT (or NSR, or cold start concept (CSC)) it is recommended the project team interact with suppliers to understand what the level of performance is from the state-of-the-art low-temperature NOx trap technology.

Reviewer 5:
The reviewer noted PNNL's key strength is in catalysis fundamentals. As such, the project team has done a good job capitalizing on this strength properly. This reviewer added that the project team has focused on DPF, SCR, and NSR, but not on diesel oxidation catalysts (DOCs). DOC is, however, the most important diesel after-treatment device, and a poor performing DOC will render the entire system dysfunctional. This reviewer felt it was therefore somewhat surprising that DOC is not represented in CLEERS' catalysis-related investigative work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer reported that the scope of work presented was very relevant research. This work supported an industry/government effort to uncover novel materials that would enable low-temperature after-treatment to meet future emission-control requirements.

Reviewer 2:
The reviewer indicated that, with the existing, proper focus on diesel emission efficiency, the relevance of the CLEERS project to DOE's goal was properly demonstrated.

Reviewer 3:

The reviewer felt that the effort on the fundamental understanding of the after-treatment catalysis would ultimately help develop new advanced catalysts that will enable the emission-compliant, fuel-efficient vehicle technology.

Reviewer 4:

The reviewer affirmed that the insights into catalyst performance and deactivation will allow researchers to design better after-treatment systems for lean-burn vehicles, which will help decrease fuel usage relative to stoichiometric applications.

Reviewer 5:

The reviewer remarked that after-treatment would always be a significant cost and challenge for combustion-powered vehicles. Lean after-treatment is an enabler for significant gains in fuel economy, and the current systems are prohibitively expensive. This reviewer said modeling and collaboration were the foundational basis for breakthroughs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

It did not appear to the reviewer that there were enough resources to answer many of the different questions related to mechanistic studies and characterization of both LNT and SCR catalysts.

Reviewer 2:

The reviewer said PNNL–CLEERS had made good use of PNNL's great catalysis research resources (in expertise and instrumentations).

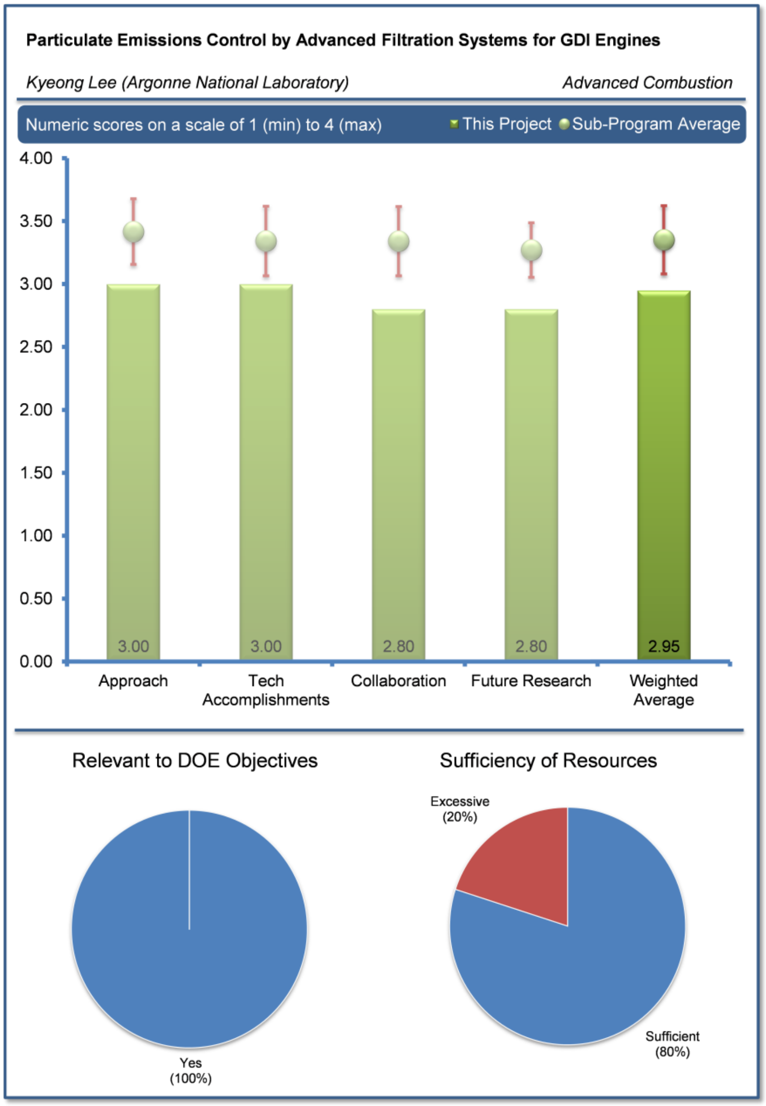
Reviewer 3:

The reviewer felt that the resources seemed to be sufficient. It was hard to make a judgment, as how much of the work being done under CLEERS or CRADA needed more clarification.

Reviewer 4:

The reviewer asserted that the funding level seemed appropriate for the large amount of work being performed at PNNL.

Particulate Emissions Control by Advanced Filtration Systems for GDI Engines: Kyeong Lee (Argonne National Laboratory) - ace024



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted a good approach to studying gasoline particulate filter (GPF) performance using a GDI engine, and added that measuring both PM and particulate number (PN) is important.

Reviewer 2:

The reviewer indicated this ANL team has a very unique capability and approach in particulate research. The approach includes filtration and regeneration via particle measurement, bench-scale imaging, microscopy, and bulk x-ray analysis on both particulate and filter substrates. Their environmental scanning electron microscope (SEM) provided some in-situ observation of soot-cake morphology during the regeneration.

Reviewer 3:

The reviewer mentioned the excellent approach to addressing key issues and quantifying particle size, count, and composition of engine-out and tailpipe emissions on a vehicle. This person said the approach addressed industry acknowledgement of the insufficient information about the properties of GDI PM emissions, the need for understanding filtration and regeneration mechanisms to support meeting the upcoming PM regulations (U.S. Tier3, Euro6), and the sensitivity of gasoline engines to increased back pressures associated with GPF.

Reviewer 4:

The reviewer had just one comment on Slide 3. The general belief at present was that the majority of the particulate emissions from GDI engines occurred during transients, not primarily on cold start (the reviewer highlighted the following two references). This reviewer added that most of the literature data is on the NEDC cycle, not U.S. test procedures and referenced the following: Happonen M, Matilainen P, Kanniainen K, Kinnunen T, Karjalainen P, Heikkilä J, Ronkko T, Keskinen J, Lähde T, and Malinen A. 2013. The Effect of a Particle Oxidation Catalyst (POC< sup>®) on Particle Emissions of a GDI Car during Transient Engine Operation. SAE Technical Paper; Liang B, Ge Y, Tan J, Han X, Gao L, Hao L, Ye W, and Dai P. 2013. Comparison of PM emissions from a gasoline direct injected (GDI) vehicle and a port fuel injected (PFI) vehicle measured by electrical low pressure impactor (ELPI) with two fuels: Gasoline and M15 methanol gasoline. Journal of Aerosol Science 57:22-31.

This reviewer also might object to the statement “no extreme heat release” in the GPF. Once light-off occurs there seems to be appreciable heat release. This person referenced the Emissions 2014 presentation by Corning. In this reviewer’s view, the background in this project is a bit weak, but the reviewer agreed with the approach for the GPF work.

Reviewer 5:
The reviewer said that the approach and methodology were too empirical, and that the work and conclusions were not adequately backed up by fundamentals. This reviewer added that there was room for a more scrutinizing approach to the nature of the problem at hand.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted that a thorough characterization of GDI PM source, quantity, and chemistry was identified. The research clearly and credibly quantified particulate count, size, and chemistry to dial in the level of the problem and the possible root causes. Also identified in the work were engine and operational mechanisms (cold operation and spray impingement), which generate particles and help to understand the characteristics of GDI particulate matter engine-out (Ca, Na, P, and Zn) and tailpipe (Mg, Al, and Cu), including a material analysis for source tracing to engine and engine oil, and, at the tailpipe, some catalyst materials. This reviewer added that, in addition to the particle formation methods and probable sources, the project team modeled behavior with good experimental fit in GDI oxidation mechanisms and kinetic correlations.

Reviewer 2:
The reviewer said good job in assessing the effects of various parameters such as injection timing and space velocity on the performance of the GPF. The reviewer also noted good characterization of the particulate, including the analysis of the ash. This reviewer recommended that the project team might want to obtain more data before claiming that the ash doubles the rate of soot oxidation.

Reviewer 3:
The reviewer was glad to see that this project had finally come to the right track. This person added that, compared to the previous year's progress, there were lots of interesting observations via a number of characterization results. This reviewer noted some of their results were still very vague, and was a little concerned about the conclusions given the limited information; some were not convincing.

Reviewer 4:
The reviewer indicated the project had produced good results, and added that it appeared to follow the literature properly. The relationship to ash was noteworthy, but some of the claims were too big and not sufficiently backed up using fundamentals.

Reviewer 5:
The reviewer made comments on individual slides. For Slide 8, this result seemed to be at odds with the literature, with no explanation given. This reviewer did agree with the conclusion of more particulates with transient versus steady state. This reviewer wished that the authors would reference the literature and explain the differences. For Slide 9, this had been discussed in detail in the literature (the reviewer noted previously supplied references), and asked what was new here. This reviewer really liked Slide 10, indicating that this was useful information. For Slide 11, this person was not sure about the result, but it was extremely interesting if consistent over a range of filters. For Slide 12, having the three-way catalyst (TWC) ahead of the filter probably eliminated the possibility that the soluble organic fraction enhanced soot oxidation. This reviewer asked if all the experiments had this configuration, as that answer makes a HUGE difference in the results. For Slide 13, the authors are going to have to work way harder to convince this reviewer that there is causality in this result. This reviewer was just not yet convinced that ash caused soot oxidation. For Slide 14, the reviewer asked why there were no precious metals, especially if the ash was based on a decomposition of the TWC coating. For Slide 15, this reviewer was really upset about the scales of the micrographs. It was hard to convince this reviewer of the crystallinity if the authors were playing with the micrograph scale. This reviewer was not impressed by Slides 16–18. The soot had already gone through a TWC. The reviewer asked how much of the organics had been oxidized there, and how much of the soot had changed morphology in the TWC. For Slide 19, the reviewer wanted to know how much of this was the TWC flaking, and where the TWC came from. Additionally, this reviewer did not see the relevance of Slide 20.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the PI leveraged prior work and activities from universities, as well as suppliers of GPF and particle-measurement equipment. This reviewer added the PI had published several papers on this topic in 2014 (and 2013), including at the CLEERS workshop, the Society of Automotive Engineers (SAE), and the Fiesta World automotive conference.

Reviewer 2:

The reviewer noted good collaboration with Corning and Hyundai.

Reviewer 3:

The reviewer felt that the collaboration with Tokyo seemed pretty superficial, but added that the UW collaboration did seem fairly strong. This reviewer noted that hosting a workshop was not really a research collaboration; basically, it was just information sharing.

Reviewer 4:

The reviewer said the project team listed a number of collaboration partners; however, all the results shown in the presentation seemed to be from ANL. Also, this reviewer added that it was still not clear who did what on this project. This person noted the contribution from the industry partners (Corning and Hyundai) was well described.

Reviewer 5:

The reviewer remarked that gasoline PM control was a new area, and as such it included many new questions that required investigation to find proper answers. The coordination in this project included exchanges only with the Tokyo Institute of Technology and some PM investigation work with UW. This reviewer added that, to quantify the measured data (which is all about soot properties, filtration, oxidation, and kinetics), the project should have included integration of kinetics expertise. This appeared to be a major gap in the project, currently also resulting in the simplistic models and lack of proper explanation for some of the observations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that the future work was very well defined. This reviewer added that, with the big improvement from the previous year, the project was expected to keep the momentum. The reviewer was looking forward to the next year's progress.

Reviewer 2:

The reviewer said there were good plans to continue characterizing soot, and added that it will be important to investigate the effects of aging on the GPF performance.

Reviewer 3:

The reviewer noted the good plan to evaluate GDI PM exhaust mitigation strategies by analyzing GPF loading and unloading mechanisms further to minimize pressure drop. This reviewer added that—as PM generation periods are limited, cold start, cold transient, warm restart, or with poor injector timing/targeting—it would make the research outstanding to consider the root cause and possible mitigation methods for the formation of PM on GDI applications. This reviewer further noted that future work that proposed action regarding lubrication material considerations, injector or combustion parameters, or other actions to reduce or eliminate GDI PM at the source would be excellent.

Reviewer 4:

The reviewer commented it was good to see that the effects of ethanol mixes had been previously included. The reviewer said that the team should focus now on diversification of the focus (such as on variations from one engine to another, and the role of combustion specifics such as cylinder pressure or injection strategies), as well as further PM and ash characterization, and especially their oxidation kinetics. This reviewer added that integration of an entity with proper kinetics expertise (such as BASF or experts such as Dr. Koltsakis) might be appropriate.

Reviewer 5:

The reviewer noted that, regarding oxidation behaviors of ash-contacted soot, a lot of work was needed to prove the statement that ash catalyzed soot oxidation. Regarding the interactions between soot, ash, and catalyst, there seemed to be no real clear goal here. Ash sintering effects were probably only interesting for possible pore blockage. This reviewer added that, regarding the evaluation of filtration efficiencies, this reviewer was not sure that filtration efficiency was a priority. Regarding different filter substrate models, the reviewer asked what would actually be done. The evaluation of regeneration efficiencies was very vague. The different filter substrate models did not have much clarity here. Regarding the catalyzed filters, the reviewer commented that everybody was doing that, and asked the project team to be more specific. To this reviewer, the evaluation of aged GPF in terms of filtration/regeneration efficiencies seemed perhaps very premature.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer indicated that GDI engines produced fuel economy and, as such, that this project provided synergy with DOE’s goals.

Reviewer 2:

The reviewer noted GDI soot filtration was not yet required in the United States, and that GPFs have been implemented on European GDI vehicles. This reviewer added that it would not be outside the realm of possibility that this device would be needed on U.S. light-duty vehicles in the foreseeable future. In addition, coating a GPF with a TWC coating appeared to this reviewer, to be a very space-efficient and perhaps synergistic technology that might be very valuable for future production GDI engines. So, overall, this reviewer liked the direction that the work was attempting to go.

Reviewer 3:

The reviewer said GDI engines improved fuel economy, and GPF would be needed to satisfy the low PM standards from such GDI engines.

Reviewer 4:

The reviewer expressed that this was one of the very few particulate-related projects in the DOE’s programs. This reviewer added that, with the ANL team’s expertise and unique capability, the project will answer many known questions that the industry will have to deal with regarding gasoline particulates.

Reviewer 5:

The reviewer stated that GDI is an enabling technology for reducing fuel consumption through downsizing and boosting to provide better power density, and added that PM emissions from GDI may pose a health issue and therefore will soon be regulated.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer felt that an increased scope to address the root causes of PM production could warrant additional funding.

Reviewer 2:

The reviewer said the project team seemed to have enough resources to carry out the proposed research.

Reviewer 3:

The reviewer noted a lot of work had been performed in this project, improving the understanding of GPF operation. This reviewer observed a good balance of resources and funding level.

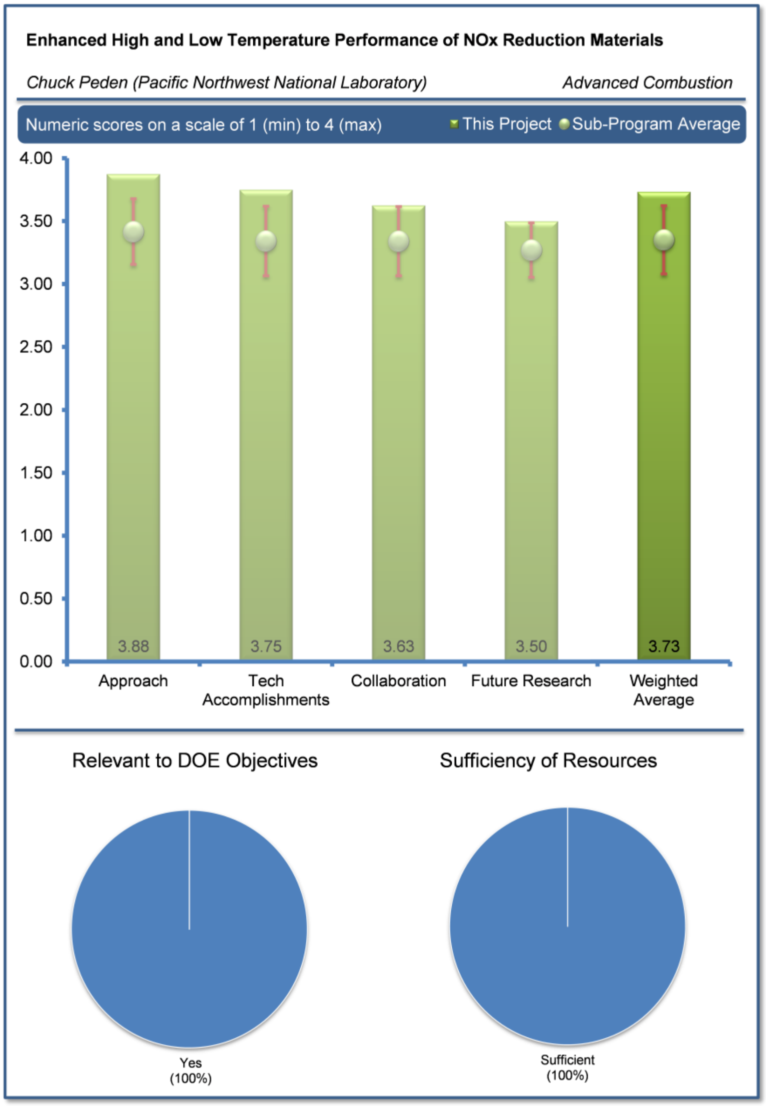
Reviewer 4:

The reviewer commented that, at the present time, the resources were proper for experimental investigations. However, this reviewer added that, to properly generalize the results and impact the field and relevant industry, the team needed to consider integrating kinetics expertise into the project to better explain the observations (i.e., models, theories, and etc.). This person noted that the inclusion of further insights into the kinetics, and integration of proper kinetics expertise, was highly warranted.

Reviewer 5:

The reviewer did not believe that the industrial sponsors of this work were getting a useful product.

Enhanced High and Low Temperature Performance of NOx Reduction Materials: Chuck Peden (Pacific Northwest National Laboratory) - ace026



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer felt that the project was well thought-out and used state-of-the-art samples/techniques.

Reviewer 2:

The reviewer commented that the U.S. DRIVE-sponsored workshop and CRADA industry involvement was an exceptional approach to clearly identify the R&D needs of the industry and continuously redirect priorities for an optimized result. The reviewer noted that the cross-cut workshop accurately captured the top R&D barriers of low/high-temperature performance, natural gas, and cost, and added that the low exhaust temperatures of future engines were a challenge for exhaust after-treatment technologies. This reviewer further noted that NO_x reduction systems would require improved high-temperature performance and stability for NO_x removal during high-temperature system maintenance events, including DPF regeneration. Additionally, NO_x treatment for natural gas engines would also require higher temperature performance. The reviewer also referenced an after-treatment system costs reduction, with a focus on PGM loading with improved performance.

Reviewer 3:

The reviewer indicated the work was of very high quality and directly supported DOE goals. This reviewer noted that the initial focus on high temperature reactivity had shifted towards lower temperature performance. The project team presented interesting results on Cu and Fe-zeolite catalysts, with new promising low-temperature catalyst formulations identified yet not disclosed pending current invention disclosure (i.e., a NO_x conversion percentage in the 90-100% range at low temperatures).

Reviewer 4:

The reviewer mentioned that the industry was moving toward lower temperature operation, and added that much of this LNT work seemed to be directed to higher temperature, and from the future plans this was being discontinued. This reviewer added that the chabazite work was very appropriate and has the capability of impacting the industry.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated the project's list of deliverables displayed outstanding results via well-designed research strategy.

Reviewer 2:

The reviewer noted that the readily adaptable dry method for the synthesis of Cu/chabazite catalysts was a significant accomplishment considering its performance was comparable or superior to other methods. The identification of SCR catalyst materials with significantly lower "light-off" temperatures than Cu-SSZ-13 was great progress. The reviewer noted the project achieving over 80% conversions at 150ºC on Fe/chabazite catalysts at optimum NO_2/NO_x ratios of 0.5 (i.e., "fast SCR") was an especially promising result. This person added that new low-temperature catalyst formulations identified light-off temperatures (T50) between 151°C and 193°C, as well as multiple T80 light-off formulations below 170°C to 200°C, showing the depth of work.

Reviewer 3:

The reviewer noted significant progress was made with a focus on low- and high-temperature performance and the stability of aged catalysts. This reviewer mentioned interesting results on Fe and Cu-based SCR catalysts, with Fe-based catalysts showing excellent performance at low temperatures.

Reviewer 4:

The reviewer felt that, regarding Slide 12, having a non-proprietary source of chabazites is very important to moving forward academic and national laboratory research. Regarding Slide 14, it was clear from the historic ZSM-5 experience that different methods of ion exchange do give different activities. This reviewer added that the dry exchange work on the chabazites is very helpful. Regarding Slide 17, there was very nice demonstration of the nitrate formation. The reviewer stated that Slide 18 was pretty much a confirmation of standard zeolite behavior, and asked if Slide 19 was proprietary information.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that having three legs to the stool was excellent for success and stability. This reviewer reported that the project had the following: a national laboratory for basic R&D; Tier1 industry partnering for requirements, testing, manufacturing considerations, as well as further research on promising alternatives; and OEM collaboration to support further the R&D cost and system integration perspective. This reviewer added that the sense of urgency was outstanding, with high frequency status updates and participation.

Reviewer 2:

The reviewer observed typically solid collaborations from PNNL.

Reviewer 3:

The reviewer summarized two industrial partners (Cummins and JMI) are involved. No noticeable miss-coordination or collaboration issues were observed.

Reviewer 4:

The reviewer acknowledged significant collaboration with Cummins, JMI, and universities. It was not entirely clear to this reviewer what Cummins was doing in support of the program, and what JMI did other than provide catalyst samples for reference/baseline characterization. This reviewer noted that perhaps this was covered in earlier presentations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the PI shared a clear vision on what to do (and not to do) next, such as continued work on Cu-chabazite materials.

Reviewer 2:
The reviewer commented that the current focus was on improving the fundamental understanding of Fe- and Cu-based catalysts, understanding why Fe has better low-temperature reactivity, the effect of zeolite acidity, and the effect of sulfur on low-temperature behavior. This reviewer added that an improved understanding of the fundamental mechanisms that are important for improving the low-temperature performance of catalysts (as highlighted on Slide 19) should be a focus.

Reviewer 3:
The reviewer said appropriate barriers were on the list such as deactivation mechanisms for new formulations. This person felt cost consideration or advantage would be a great plus for discussion.

Reviewer 4:
The reviewer indicated that bringing down the focus to the zeolite work was the right choice, and all the planned directions with chabazites were fine. This reviewer sure would have preferred more detail, especially since Slide 19 had very little helpful information.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer expressed that, like most other after-treatment catalyst technologies R&D, results from this work could indeed help support the DOE's energy policies.

Reviewer 2:
The reviewer said the work was clearly relevant to NO_x reduction under extended operating limits.

Reviewer 3:
The reviewer mentioned after-treatment requirements were changing to support the use of new higher-efficiency combustion regimes, which result in lower temperature combustion and lower normal exhaust operational temperatures. This reviewer added that cost and PGM considerations for after-treatment are continuously on the radar for OEMs.

Reviewer 4:
The reviewer reported that SCR seemed to be the future direction for both light and heavy duty, and added that LNTs do not seem to be in the future industrial plans much.

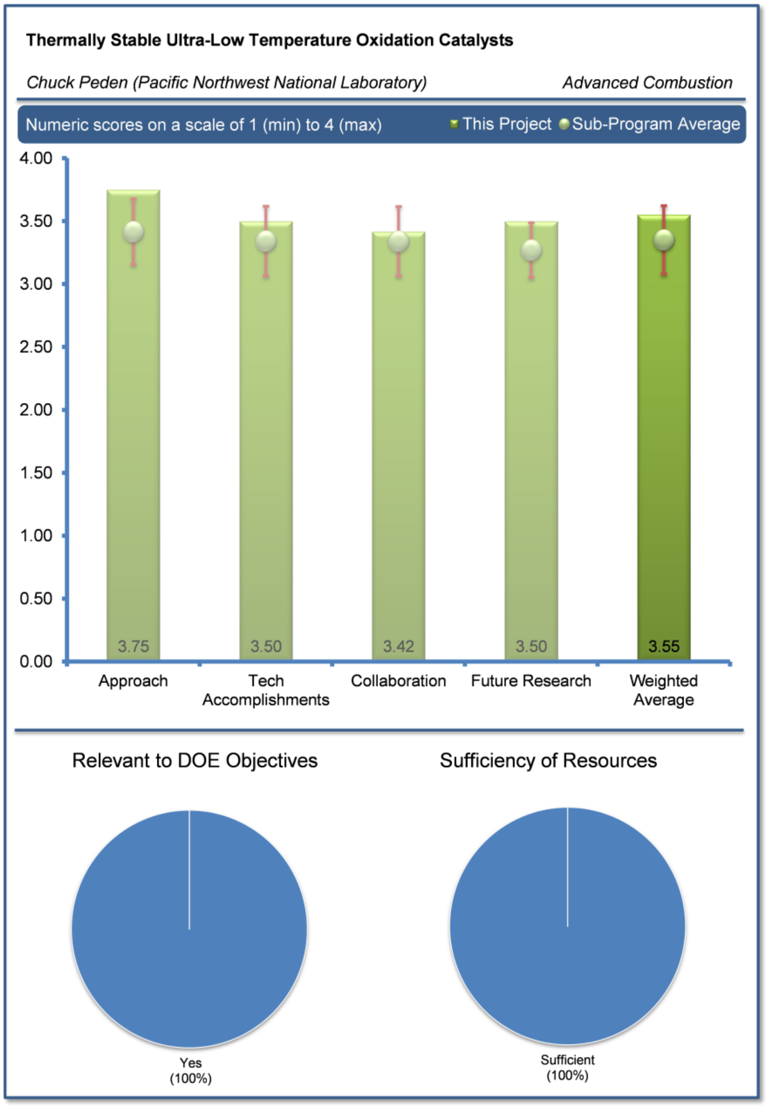
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that leveraging the in-house instrumentation at PNNL made the funding stretch very far.

Reviewer 2:
The reviewer indicated that the funding seemed acceptable, and noted the project was also leveraging other funding sources.

Reviewer 3:
The reviewer commented that the project seemed to have used proper expertise (PNNL's Institute for Integrated Catalysis) and instrumentation (Mossbauer spectroscopy and others) for this project.

Thermally Stable Ultra-Low Temperature Oxidation Catalysts: Chuck Peden (Pacific Northwest National Laboratory) - ace027



Reviewer Sample Size

A total of six reviewers evaluated this project

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said the PI's approach to fundamentals was invaluable. His approach was just as good as it could be (regarding spectroscopy, x-ray diffraction, Brunauer–Emmett–Teller analysis, transmission radiation detector (TRD), the role of low and high temperatures, etc.). This reviewer added it was hard to think of a better way of pursuing this project.

Reviewer 2:

The reviewer asserted that the range of methods is impressive.

Reviewer 3:

The reviewer remarked this was a very novel and promising technology that was consistent with low temperature after-treatment initiatives to meet future emissions standards. The person added that the program participants had considered and demonstrated that barriers related to deactivation from other combustion species had not impacted the CO oxidation performance of the Cu-based catalysts.

Reviewer 4:

The reviewer noted the synthesis and characterization leading to improved understanding and performance of low-temperature non-precious-metal catalysts.

Reviewer 5:

The reviewer observed a U.S. DRIVE-sponsored workshop, with input from a cross section of industry experts and laboratory staff (i.e., Chrysler, GM, Ford, PNNL, and DOE). The reviewer said one clear goal of high-efficiency 150°C operation was established, and added that the low exhaust temperatures of future engines was a challenge for exhaust after-treatment technologies. The reviewer added that the critical barriers and a plan to identify opportunities were presented with a focused plan for R&D and metrics. The sintering of active metal sites is a major barrier to catalyst stability over durability life, and improvements in stability can enable lower temperature performance for light-off. This reviewer noted the metric of T50 for CO and hydrocarbon oxidation of around 150ºC, and stable performance after 750ºC for 72 hours under 10% H_2O/air aging (approximately 120 kilo miles). This person noted a determination of the reaction mechanisms and catalyst structure/function at low temperature is needed for current and developing after-treatment technologies to identify and prioritize opportunities. This reviewer added that the cost-sensitive focus on non-PGM catalyst materials was excellent.

Reviewer 6:

The reviewer agreed that the approach shows promise, and includes starting with GM and other catalysts, analyzing performance and degradation, and then evolving further into extensions or new systems. This reviewer added that the tools and skills of the team are world-class, and the approach will significantly advance the understanding. This reviewer suggested that, before going too far on Cu-based systems, the project team should make sure that dioxin toxicity issues were not going to kill this later.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer described the understanding developed as excellent.

Reviewer 2:

The reviewer noted a very impressive start in identifying the active species in the catalyst-oxide system. The isotopic oxygen work was quite illuminating and this reviewer was very anxious to see the progress. The results to date raised more questions than answers, but this was very promising and set the groundwork for a valuable program.

Reviewer 3:

The reviewer summarized that the project team developed and tested material combinations to achieve T50 CO conversion efficiency at 150°C. This reviewer also noted the use of a commercial ceria-zirconia (CZ)-supported Cu catalyst (Cu/GMR6), which, after hydrothermal aging, was as active as the fresh CZ-Cu catalyst.

Reviewer 4:

The reviewer remarked that sintering of active metal sites had been identified as a major barrier. This person noted the analysis of commercial CeZrOx supported the demonstrated major structural stabilization benefit of additives. This reviewer added that it was early in the project lifecycle (about 17% complete), so the results were largely preliminary.

Reviewer 5:

The reviewer noted very good progress in characterizing the CO oxidation behavior of the catalyst and showing that there were no negative effects related to HCs or nitric oxide (NO). However, HC oxidation activity under various conditions was only mentioned, but not presented in the slides. The aging conditions used may not be challenging enough for after-treatment applications where high-load conditions may produce higher temperatures. The reviewer noted that other fuel-related poisons, such as sulfur, were under investigation and should be determined early to evaluate the viability of this catalyst.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated effective collaboration between GM R&D and PNNL that takes advantage of each organization's complementary strengths. The kickoff meeting was held at PNNL on November 1st, 2013, and conference calls were held 5–7 times a year to discuss results. This reviewer noted that an annual face-to-face meeting would be scheduled for later this year.

Reviewer 2:

The reviewer mentioned excellent collaboration in the requirements definition from the entire industry, and a detailed scope and division of cost/labor between the OEM partner and PNNL.

Reviewer 3:

The reviewer noted there was a well-designed group to address this new technology, and the researcher and participant organizations were well matched to this task.

Reviewer 4:

The reviewer noted impressive signs of collaboration that used GM catalysts as a starting point, but added that there were not a lot of signs yet on GM's inputs and work on the analytical methods. However, the reviewer added that this role might not be needed given the capabilities of the PNNL researchers. GM's role here needed to be directional, especially on the aging protocols and Cu toxicity in making dioxins.

Reviewer 5:

The reviewer stated that, apart from focusing the work performed via its industrial partner (GM), no major display of resource appeared to be planned outside of the PNNL–GM circle. Synergizing with resources outside of PNNL and GM was an open area, and could only enrich the approach. (The reviewer was cognizant that there would be intellectual property issues to be tackled then.) This reviewer added that one should note that the bulk of the funding was from DOE (i.e., public), hence a larger partnership emphasizing a more enriched investigative team would be desirable.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer emphasized that the project team should keep going. The future approaches seemed very reasonable and would deliver much better understanding. This reviewer added that it seemed important to also test mixed CO-HC systems as the understanding evolves, perhaps sooner rather than later.

Reviewer 2:

The reviewer noted continuity with future work (and synergizing with industrial partner) is properly integrated into the "future work."

Reviewer 3:

The reviewer mentioned that completing Cu/CZ studies to further document and share the results was excellent, and noted characterization, comparison with model materials, and kinetic studies of CO oxidation on fresh and aged catalysts (focusing on mechanisms and limitations for low-temperature performance, while providing CLEERS low-temperature oxidation protocol). The reviewer indicated that the project team was studying materials with the potential for a high value proposition and was on task for its goals, baseline mechanistic studies, and the performance and aging of ceria-supported and mesoporous Cu/ceria.

Reviewer 4:

The reviewer acknowledged the research consortium had a well-considered plan to address the oxidation capabilities of this technology. This person indicated that future research, however, should migrate toward HC feed species and aging schedules that will be proposed by the USCAR organization.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer indicated that low temperature catalyst performance could substantially help with fuel economy enhancements in engines, and hence help further meet DOE's goal.

Reviewer 2:

The reviewer commented that this was relevant work and very consistent with USCAR/U.S. DRIVE initiatives to develop these low-temperature after-treatment catalysts for future powertrains.

Reviewer 3:

The reviewer stated that this temperature range is where improvements are needed.

Reviewer 4:

The reviewer stated that this work could lead to lower-cost catalysts that were more effective at the lower exhaust temperatures that are experienced by more efficient engines (as well as after cold start).

Reviewer 5:

The reviewer mentioned that low-temperature DOC performance was beginning to limit the potential for low-temperature combustion engines. The reviewer added that these combustion strategies were very efficient, but generated a substantial amount of HCs and CO and have chronically low exhaust temperatures. This person said developing low-temperature oxidation catalysts was certainly needed to move these developments forward.

Reviewer 6:

The reviewer noted that after-treatment requirements were changing to support the use of new higher efficiency combustion regimes, which result in lower temperature combustion and lower normal exhaust operational temperatures. This reviewer emphasized that the cost and PGM considerations for after-treatment were continuously on the radar for OEMs.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer felt that $250,000 per year seemed appropriate at this stage, but added that it might be a little low as the program advances. Given the importance and the early promising results, it would seem that more resources might be needed in the out year(s). This reviewer added that this was such an important and fundamental program that DOE should not shy away from providing more funding if promising results are reported.

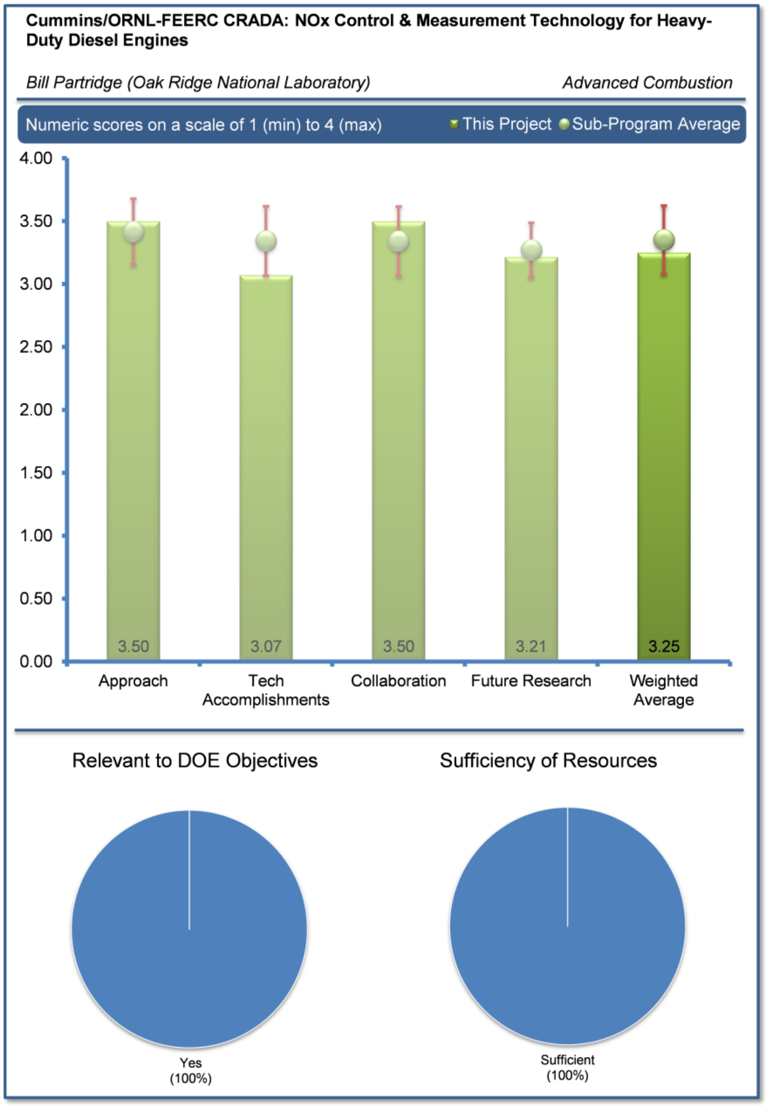
Reviewer 2:

The reviewer stated that this project was appropriately staffed and funded.

Reviewer 3:

The reviewer noted this was a fundamental catalyst project. PNNL has integrated state-of-the-art instruments for this project, and the resources were proper.

Cummins/ORNL-FEERC CRADA: NOx Control & Measurement Technology for Heavy-Duty Diesel Engines: Bill Partridge (Oak Ridge National Laboratory) - ace032



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated this was a refinement of both the spacims instrumentation and an evaluation on spatial composition within a catalyst channel of aging. The reviewer noted that either was a good project. This reviewer added that together the project garnered an excellent rating.

Reviewer 2:

The reviewer noted that further refinement and defining of this technique to characterize SCR catalysts as well as other catalyst technologies is essential to obtaining consistent results across many users. However, the use of this technology to answer specific questions related to performance and operating conditions will necessitate the use of different probe characteristics.

Reviewer 3:

This approach is fairly unique, even with other groups doing more SPACI work. This reviewer added that analysis of capillary impact is very interesting, because it comments directly on recent work in Europe claiming an impact using modeling, mainly.

Reviewer 4:

The reviewer stated that the approach seemed rather straightforward (i.e., thermally age catalysts and analyze the impact with the best tools). Understanding the mechanistics is fundamental to this. TU Milano can be very useful here. Understanding the axial profiles of NO_x reduction and NH3 storage and how aging affects these is important base information.

Reviewer 5:

The reviewer stated that ORNL's unique capability, SPACIMS, was a unique tool in developing kinetic models for the monolith based catalyst. The reviewer noted it allowed very comprehensive information under various conditions and added that the PI was one of the pioneers in this approach.

Reviewer 6:

The reviewer observed a thought-out approach; however, challenges remain.

Reviewer 7:
The reviewer felt that characterizing the spatial deactivation of SCR catalysts was interesting. It was not clear to the reviewer how this could be used on a vehicle to improve engine efficiency,

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer said good work characterizing the various functions of the SCR catalyst (NOx conversion, ammonia (NH_3) oxidation, etc) as a function of length, both fresh and aged. The reviewer described the effects of the size of the Spaci probe on the measured catalyst activity as interesting.

Reviewer 2:
The analysis of Aging effects is very interesting. It should be possible to separate the effects of ammonia oxidation versus SCR in the formation of N_2. Ways of selectively separating two aging paths should be possible with S or some special aging pathway.

Reviewer 3:
The reviewer stated that the SCR aging data seemed fairly incremental to the current understanding. The reviewer expressed that it was difficult to project how this information would meet the objectives. The reviewer asked what was new and exciting, and how could this be practically used. The reviewer suggested that the team needed to develop models or other methods that could lead to the actual use of these results in practice. Results on SpeciMS invasiveness was very important and has been a major concern out there. The reviewer stated this is an import tool and your results can help ensure results from others are pertinent.

Reviewer 4:
The reviewer noted that last year, the team had accomplished with a good correlation between SCR kinetic models and experimental data over fresh catalysts, and it was planned to move on to the field-aged parts. The reviewer stated however, it seemed that the field aged parts were not available over the last period of the project. The reviewer noted that instead, the team investigated hydrothermally aged parts, which had been done by many other groups previously.

Reviewer 5:
The reviewer noted that there appeared to be some differences of opinion in how to use this probe technique that were application dependent. The reviewer stated however, this work clearly supported catalyst characterization efforts to improve models for optimizing catalyst utilization.

Reviewer 6:
The reviewer noted that technical accomplishments were noteworthy qualitatively, but not quantitatively. The reviewer added that looking at the Accomplishments (Slide 15) the results were insufficient given that the project started in 2012.

Reviewer 7:
The reviewer asked regarding Slide 8, if there was enough information there to tune a mechanism. Regarding Slide 9, the reviewer said asked if the aging was done in a slow flow muffle furnace or a reactor. It seemed to the reviewer as if the front-end aging was characteristic of a reactor aging. If so, the reviewer wanted to know what made it front end aged. This accomplishment does not have enough detail for a reviewer to determine the value of the result. Regarding Slide 10, the reviewer observed no explanation for the aging effect on the parasitic ammonia oxidation, which seemed to occur mostly at the front and the conversion is made up for later in the catalyst. With regards to Slide 11, the reviewer said it was very helpful.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that it was extremely difficult to determine from this presentation how much was contributed from each partner. In addition, this reviewer queried whether the ORNL investigator went to Cummins and brought his instrumentation there, or if some of

the measurement work was done at ORNL. The reviewer added that an outstanding collaboration should be seamless, but the reviewer could not easily review collaboration without knowing what each partner contributed. The reviewer said to repeat last year's comment; please show at least one slide summarizing what the other partners did.

Reviewer 2:
The reviewer stated that this project has a good balance between experimentalists and spectroscopists. The reviewer added that participant organizations and researchers were well matched to this task.

Reviewer 3:
The reviewer noted excellent partner collaboration on this project. The reviewed noted clear evidence in course of project of the interactions here.

Reviewer 4:
The reviewer noted that the project was missing a catalyzer or others with fundamental catalyst understanding - PNNL, universities, etc. The reviewer suggested that the team has good understanding but someone who does basic research to help guide breakthroughs may help. The reviewer asked do you have this in the informal relationships.

Reviewer 5:
The reviewer stated that the ORNL team had an excellent group of collaboration partners including industries, universities, and national laboratories.

Reviewer 6:
The reviewer noted outstanding collaboration that included the integration of Cummins, CLEERS, Professor Luis Olsson (Chalmers University), Professor Tronconi (Politecnico di Milano), Institute of Chemical Technology at Prague, etc. The reviewer stated that a more interactive involvement of the university partners could help boost synergistic capabilities, as opposed to the existing 'informal' interaction set-up observed.

Reviewer 7:
The reviewer noted good collaboration between ORNL and Cummins was demonstrated as well as good collaboration with Chalmers and P. di Milano.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer agreed with characterizing the distributed impact of aging on SCR-catalyst functions and performance, as well as resolving NH_3 capacity distributions via transient analysis.

Reviewer 2:
The reviewer stated that much of this work had already been addressed through other activities.

Reviewer 3:
The reviewer noted that the proposed future work was certainly of interest. Better characterization of axial changes in NH_3 storage is important. The reviewer stated that the development of and comparisons to aging models was important. The reviewer agreed that in the end though, one would not have a SpaciMS, so there has to be some way to take exit sensor data and imply aging stage. The reviewer added that transients and pulsed diagnoses might help develop this. This was the role of fundamental work like this. The reviewer asked if it could be done.

Reviewer 4:
The reviewer hopes the field-aged part will be available this year so that the team can accomplish the original goal.

Reviewer 5:
The reviewer reported that a clear roadmap on what is next will be done (i.e., university collaboration, laboratory aging, and trying various temperatures).

Reviewer 6:
The reviewer stated that looking at field-aged catalysts will be very important to the project. The reviewer said the project team needs to think about how such information could be used on a vehicle to improve fuel economy. It might require some new sensors and possibly several sensors along the length of the catalyst, as catalysts can be deactivated (either temporarily or permanently) in a variety of ways. The reviewer offered that often times the front of the catalyst is aged more than the back of the catalyst, but sometimes the back of the catalyst can be deactivated more (such as from high-speed misfires). The reviewer stated that to account for all the possible deactivation mechanisms, we would need to actively monitor the performance of the catalyst along its length.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that $DeNO_x$ meant low fuel consumption in HD diesel. The reviewer suggested that the main limitation now is SCR catalyst durability. By knowing the state of the catalyst aging, the engine can be calibrated to balance emissions and fuel consumption. The reviewer stated that the OBD is a major challenge for all emissions systems, and this work can shed light on this.

Reviewer 2:
The reviewer stated that this was a very important project in harmonizing the kinetic model development for real-world diesel after-treatment application that enables the large deployment of fuel efficient vehicles.

Reviewer 3:
The reviewer said yes, as a NOx after-treatment solution, this project would help reduce fuel consumption.

Reviewer 4:
The reviewer noted that if the results of this project allowed the engine to operate at its peak efficiency point, it will meet the DOE goals of reducing petroleum use.

Reviewer 5:
The reviewer noted that this supported both the heavy-duty and the light-duty U.S. applications. The reviewer stated pretty much on target.

Reviewer 6:
The reviewer noted that the use of invasive techniques to characterize the performance of after-treatment components under bench conditions was essential in the development of future technologies. The reviewer stated however, that adapting these techniques to in-use after-treatment systems is not necessarily appropriate or practical.

Reviewer 7:
This reviewer opined that improvements lead in that direction.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that funding seemed adequate. The reviewer affirmed that it was not clear how much was internally contributed from Cummins. Cummins benefited greatly from this work and the reviewer hoped that their financial contribution reflected that.

Reviewer 2:
The reviewer observed that this project uses appropriate spectroscopists and experimentalists to derive the required information. The reviewer suggested that the level of funding was correct.

Reviewer 3:

The reviewer noted that the resources seemed reasonable to complete the work proposed. Adding the pulsing work might stretch the resources, but it seemed to fit.

Reviewer 4:

The reviewer stated it seems sufficient.

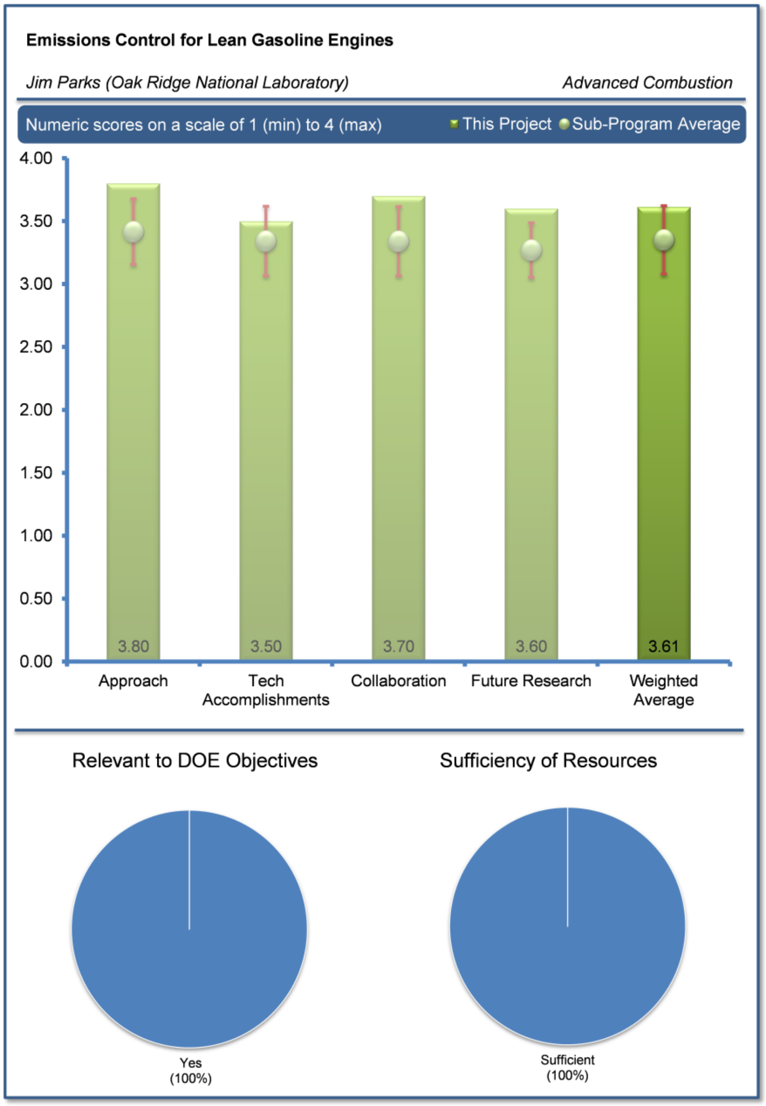
Reviewer 5:

The reviewer noted proper resource planning.

Reviewer 6:

The reviewer stated that the resources seemed to be adequate for the project.

Emissions Control for Lean Gasoline Engines: Jim Parks (Oak Ridge National Laboratory) - ace033



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer suggested that the project approach of investigating alternatives to urea injection for passive NO_x control was highly appropriate. The reviewer added that the low temperature limitations of urea based systems are a well-established barrier. Therefore, in order to meet the newly adopted low temperature after-treatment initiatives, the proposed architectures are worthy of investigation. The reviewer added that in addition, the low temperature NO_x reduction activity of newer, novel SCR and LNT materials would require passive NH_3 generation to be able to function under cold portions of the FTP cycle.

Reviewer 2:

This reviewer observed an excellent combination.

Reviewer 3:

The reviewer commented on the nice evolution of understanding and following adjustment of approach: determining and then optimizing ammonia generation; matching with NO_x and temperature effects; and then looking at system configuration. Matching FC with NO_x and system is comprehensive; however, one major lever is missing. The reviewer stated that using EGR and other engine means to adjust NO_x and potential H_2 and/or NH_3 production is needed. The reviewer stated that building one's knowledge on the capability of the after-treatment system to help guide the engine calibrations seemed like a nice progression.

Reviewer 4:

The reviewer stated that Jim Parks, his team and collaborators have done a thorough job in defining the right targets, setting a strong, collaborative team and devising a strong framework for the project.

Reviewer 5:

The reviewer commented that the combination of lab reactor and vehicle work is a good two-pronged approach for optimizing the system. The vehicle work will be particularly important for understanding the HC emissions during lean/rich cycling, as it is difficult to accurately simulate the HC on lab reactors due to the wide variety of hydrocarbons emitted from engines. The reviewer affirmed that the vehicle work will also be important for characterizing the PM emissions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted that the project had produced an excellent outcome and worthwhile results, providing some foundations on pros and cons of how various emission reduction strategies could meet next generation lean gasoline engines' after-treatment needs.

Reviewer 2:
This reviewer described the level of ammonia production as very impressive.

Reviewer 3:
The reviewer stated that the large amount of fundamental data displayed here was quite impressive. The baseline information would help guide practitioners in the field. The reviewer offered that the focus on NH_3 generation and storage, along with fundamental system architecture was valuable. The data appeared robust, but more may be needed in the regard (e.g., repeatability, aging, poisoning effects, etc.) if only a peak in the box can be done.

Reviewer 4:
The reviewer noted a good analysis on NH_3 production versus air-to-fuel ratio and temperature. The reviewer expressed a need to investigate novel purge strategies to limit CO production during the rich purges. The reviewer suggested that the idea of adding NO_x storage materials to the TWC was good, but the TWC needed to be hot to minimize the HC slip during purges, and that would prevent the TWC from storing NO_x as shown on Slide 23. Placing a LNT in front of the SCR in the underfloor position is a better way to go to provide some lean NO_x storage, although the impact on N_2O production will need to be investigated. The reviewer noted good correlation between laboratory results and vehicle results on Slide 17.

Reviewer 5:
The reviewer noted that in order for passive NH_3 NO_x control to be seen as a viable way of meeting future emissions standards, the fuel penalty associated with $DeNO_x$ events was not the only negative element to consider early on. The reviewer stated that optimizing these events along with $DeSO_x$ strategies were critical to enabling this technology to proceed, and should be considered early in the program. In addition, the effect of SO_2/SO_3 on both the LNT and SCR technologies must be understood and minimized at the same time because ensuring the selectivity of the catalysts towards N_2 formation is high in preference to NH_3 or N_2O formation.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted excellent inclusion of both suppliers and OEMs into the project. Umicore was recognized for their NSC technologies. The reviewer suggested that having monthly conference calls with all the participants was a very good way to maximize the effectiveness of the data collection, direction of the project, and characterization.

Reviewer 2:
The reviewer felt that the team was extremely strong. Umicore developed the Mercedes lean burn system used in Europe. The reviewer stated that GM had reported on lean burn several times and would appear to have good experience. The reviewer commented that University of Wisconsin, University of South Carolina, and PNNL can provide fundamental and testing expertise. The reviewer stated impressive. University of Wisconsin, Umicore, and GM are engaged and this seemed sufficient.

Reviewer 3:
The reviewer noted that the collaborative interactions with CLEERS, PNNL, industry partners (Umicore, GM), University of South Carolina, and the University of Wisconsin provided a strong framework for increasing strengths and reducing failure risks.

Reviewer 4:
The reviewer noted that good collaboration between ORNL and Umicore was evident. The reviewer inquired about GM's contributions.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that emerging technologies such as the combined TWC/NSC may be important enablers for meeting LEVIII and Tier II Bin 2 standards for lean systems. It will be of great interest to determine how the incorporation of this technology into the after-treatment system can be optimized through $DeNO_x$ and $DeSO_x$ regeneration strategies to complement and enhance the emissions performance of the entire system.

Reviewer 2:

The reviewer was anxious to see the aging data. The reviewer expressed mixed thoughts at this stage on whether to focus on transients versus other key engine drivers like EGR or other engine calibrations (one rich cylinder). The reviewer suggested that EGR and that understanding might be better to develop earlier, unless one sees more interesting transient results that can significantly impact the after-treatment fundamentals.

Reviewer 3:

The reviewer stated that the future steps were in sync with the progress made thus far and also relevant to industry needs, including sulfur effects, aging, transients and system improvement to enhance fuel economy.

Reviewer 4:

The reviewer noted the need to include purge strategy development as part of the future plans to limit the impact of the rich purges on CO, HC, and fuel economy. Also, it is important to better understand the PM and HC emissions on the vehicle. The reviewer asked if N_2O production during the purges was looked at.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the project was very relevant to U.S. marketplace where gasoline powertrains represent the vast majority of the market and the movement toward lean GDI is occurring. The reviewer added that effective $DeSO_x$ and $DeNO_x$ strategies for highly efficient lean combustion strategies must be included in the calculation of fuel penalties as well.

Reviewer 2:

The reviewer indicated that 5-10% fuel consumption savings in the 2020 timeframe may cost OEMs about $75 per percent. This leaves approximately $500 added cost to a lean burn versus a stoichiometric GDI engine. The reviewer stated that this seemed achievable, and several OEMs were working on this. The critical determinate was meeting the Tier 3 emissions requirements. The reviewer affirmed that this program was at the heart of this.

Reviewer 3:

The reviewer asserted that running lean enhancements are needed.

Reviewer 4:

The reviewer noted that the project was well focused on the stated goals of fuel economy targets.

Reviewer 5:

The reviewer stated that the project addressed emission control for lean-burn gasoline engines, which would improve fuel economy and lower national fuel use.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

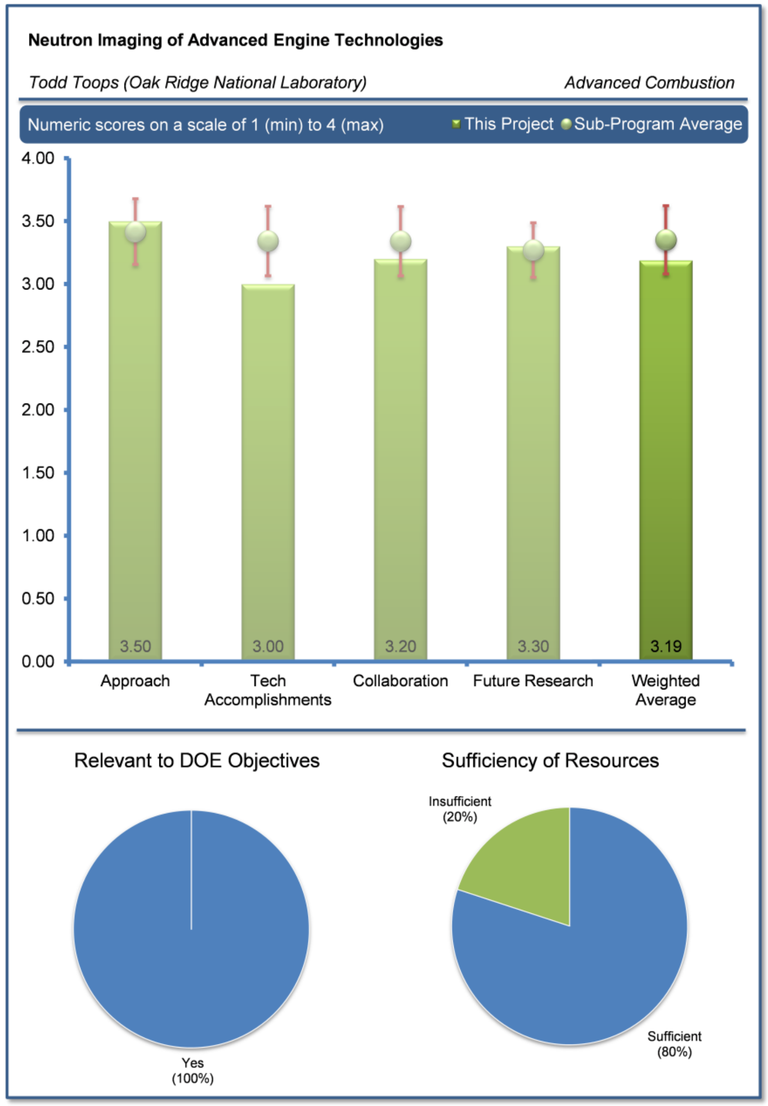
Reviewer 1:
The reviewer indicated that funding and collaboration was appropriate.

Reviewer 2:
The reviewer indicated that the remaining resources were okay for the last year. The reviewer stated that if more were needed to shift some work into the engine approaches, money should be made available, at least enough to get data for a new proposal.

Reviewer 3:
The reviewer noted that the proper use of engine, catalysts, micro-reactors, had been integrated into the project. The reviewer was not sure why modeling had not been integrated into the tasks, especially in regards to catalyst development and performance.

Reviewer 4:
The reviewer stated that the efforts were consistent with the funding level.

Neutron Imaging of Advanced Engine Technologies: Todd Toops (Oak Ridge National Laboratory) - ace052



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that exploring the potential use of neutron imaging as a nondestructive technique to advance the understanding of the internal flow dynamics of injectors, and the distribution of soot, and ash in particulate filters was worthwhile, especially at the modest funding level of $200,000. The reviewer stated this could lead to new insights versus other techniques that were typically used.

Reviewer 2:

The reviewer noted an excellent approach with much potential for studying internal flows (being that they are liquids in injectors or particles in soot filters) through neutron imaging technique. The reviewer stated it was a novel, non-destructive procedure to visualize internal structures of fuel injector and particulate filters.

Reviewer 3:

The reviewer said it was great to see an approach that could better reveal internal features of these parts.

Reviewer 4:

The reviewer stated that it was good to see more gasoline based measurements. The reviewer asked if a neutron imaging technique could be used for fuel spray in an engine.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed good progress on milestones and was appreciative of the devotion to efforts to find ways to improve techniques for injector studies. The reviewer stated that it would be interesting to see the results of the changes once fluid injection studies were performed.

Reviewer 2:

The reviewer stated that the injector results were relevant and interesting. Scans of eroded injectors were relevant to improving injector designs and may provide new insights on nozzle erosion patterns. The reviewer noted however, the temporal and spatial resolution possible require additional work before making useful measurements of injector nozzle cavitation. The reviewer noted that the particulate filter loading pattern measurement was also interesting, but also may require temporal measurements of loading and regeneration behavior in real engine operation conditions for a greater impact.

Reviewer 3:
The reviewer observed outstanding imaging and presentation but would like to see how these could impact practical issues of component design or system control.

Reviewer 4:
The reviewer hoped to see fuel spray results rather than plans. It was not clear to the reviewer what to do with the ash loading distribution inside a DPF. The reviewer felt it was interesting, but asked what would be done with the information.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed a good mix of collaborations with industry, universities, and national laboratories. The reviewer hoped the project would be successful in adding a Tier 1 fuel injector supplier.

Reviewer 2:
The reviewer noted excellent collaboration with various industry partners and academic institutions. The reviewer recommended to involve more interested parties (engine, injector, and filtration OEM's for example) to expand the scope of this project. The reviewer noted that the most obvious collaboration/coordination would be with ANL and their x-ray imaging with the APS. Clearly, these two techniques should be compared and contrasted in detail (i.e., how do they complement each other, what are the limitations of each relative to the other, etc.).

Reviewer 3:
The reviewer commented that as noted already, more interaction with industry would seem useful, but maybe this needed to wait until the processes were adequately developed.

Reviewer 4:
The reviewer remarked that it was good that the injector supplier was now involved.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the progress looked good with work in progress on evaluating the modified approach to the fuel injector studies and analyzing the DPFs.

Reviewer 2:
The reviewer remarked that the future plans looked like logical extensions of work to date, although the comments above should be considered in terms of improving the research and its impact on industry.

Reviewer 3:
The reviewer noted that an upgraded laboratory capability should improve results.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the use of novel techniques to improve the basic understanding of fuel injection and emissions equipment functioning/performance supported the DOE's goal of design of engine systems with higher efficiencies and lower emissions.

Reviewer 2:

The reviewer noted that improved diagnostics would lead to better modeling tools and, of course, better understanding of the physics which should both lead to improved efficiencies and better comparisons between different fuels (petroleum and non-petroleum based).

Reviewer 3:

The reviewer stated that the technique seemed to offer tremendous potential.

Reviewer 4:

The reviewer expected that the unique diagnostic capability of neutron imaging would provide a unique insight into the behavior of engine components that would lead to improved understanding and insight.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that progress was being made and there was no indication that funding was not sufficient.

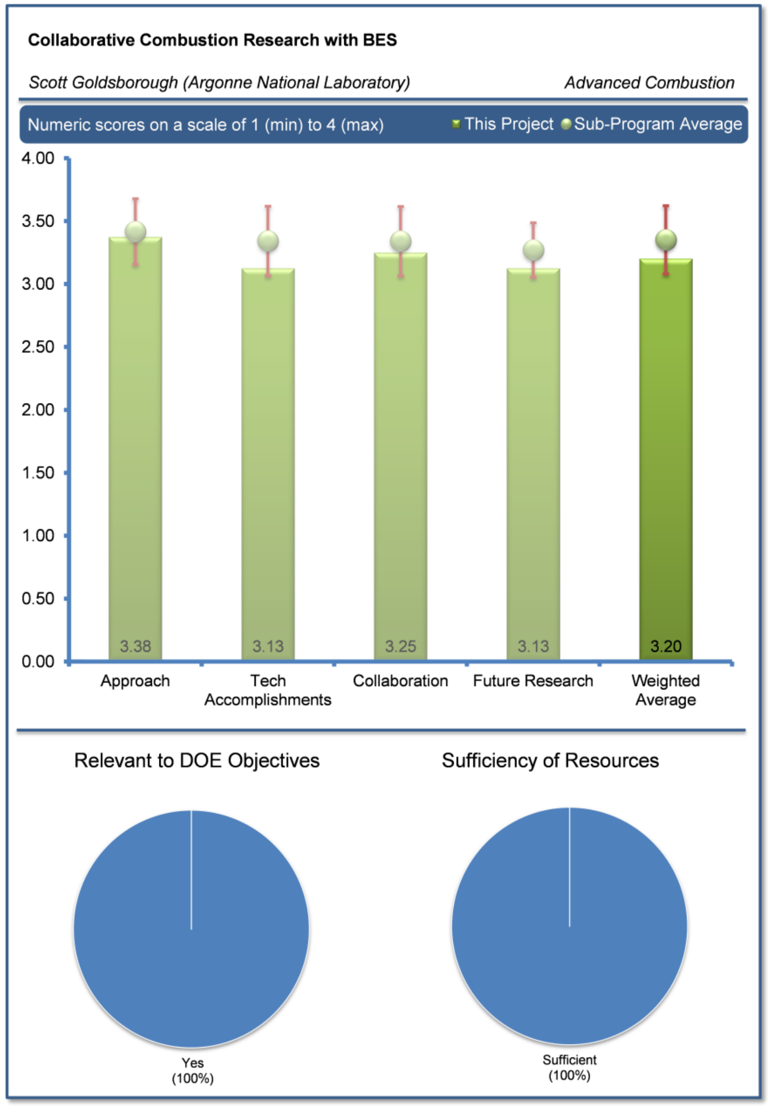
Reviewer 2:

The reviewer lauded the project as a great program for the money being spent.

Reviewer 3:

The reviewer noted that the funding seemed too low to cover any significant development. The reviewer expressed fear that $200,000 per year was largely eaten up by reporting and other non-research activity.

Collaborative Combustion Research with BES: Scott Goldsborough (Argonne National Laboratory) - ace054



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that RCM was a basic research tool for testing reaction kinetics to develop useful mechanisms for engine modeling. The reviewer remarked that the project has done a good job in overcoming some of the uncertainties associated with the device through development of an adjunct RCM system model. The reviewer added that progressive facility improvements were also underway and that useful data was being generated to guide mechanism development and refinement. The reviewer stated that overall, measured, systematic approach was excellent, if somewhat leisurely paced.

Reviewer 2:

The reviewer noted that the novel approach to interpretation of RCM results to provide chemistry information. FACE fuels and standard fuels are more interesting and should have higher priority than EHN additives.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the project had focused on a few selected gasoline surrogates and two reactivity modifiers (EHN and Di-t-butyl peroxide [DTBP]), and measured the auto-ignition delay times at 20 bar and low/intermediate temperature regimes. The reviewer noted that the auto-ignition data measured in the two-piston RCM had been successfully applied to verify the predictability and accuracy of the assembled kinetics model of fuel surrogates with or without the additive (2EHN). The reviewer added that the comparison suggested that the fuel's kinetic model (particularly the LTC chemistry pathways), as well as RCM's physics-based system model, needed further improvement. The reviewer noted that while being able to measure auto-ignition delay times, the project (1) has not explored advanced, time-resolved gas sampling and speciation, and (2) has not exercised novel probing techniques (e.g., GSA) and detailed calculations of sensitive processes (e.g., individual reaction rates) for improving kinetic models. The reviewer stated that those features were discussed in the FY 2013 report but were still in the future in this year's presentation. Therefore, it was unclear to what extent the listed milestones could be accomplished in the second half of 2014 and, most critically, how the newly measured data and the RCM physics-based model could help each other to improve the existing kinetic model or to develop the new chemistry sub-model set that can eventually update the existing petroleum fuel's chemical kinetics library.

Reviewer 2:

The reviewer asked what the plan was to address the differences between modeled ignition delay and measured ignition delay.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed good coordination effort with government labs and universities overall. The ECN-like RCM workshop was a great idea that is just taking root. The reviewer stated that time will tell if it will achieve the same level of success. The reviewer felt that it would be nice to see even more collaboration with other researchers using similar RCM/RCF-like devices as well as complementary devices like shock tubes, flame tubes, etc. This reviewer suggested that a coordinated suite of measurements (ignition delays, speciation, flame speeds, etc.) was needed for kinetics testing and it would be great to see all of the facilities doing this kind of work integrated or sharing ideas to ensure data consistency across the board. The reviewer added that greater interaction with engine companies and commercial software vendors would be welcome as well.

Reviewer 2:

The reviewer stated that the international RCM workshop to establish standardized tests was a great idea.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the proposed future research continued the project's current research direction, including improving kinetic modeling capability with model probing tools (GSA) and stratified reactor approach integrated with RCM model, and measuring and modeling of FACE surrogates and ethanol/gasoline blends. The reviewer also stated that the proposal included the demonstration of a newly manufactured single-piston RCM, designated for high boiling point fuels, together with integration of gas sampling and analytical unit. The reviewer noted that considering the capabilities of the RCM's physics-based model, it was expected that it would be a productive year.

Reviewer 2:

The reviewer asked what the advantage was of the new single piston RCM over the current dual piston RCM.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the kinetics data and corresponding mechanism development that the RCM provided and promoted was essential for understanding new combustion strategies such as RCCI as well as new fuels and additives. The reviewer stated in this regard, this project was extremely relevant to DOE objectives.

Reviewer 2:

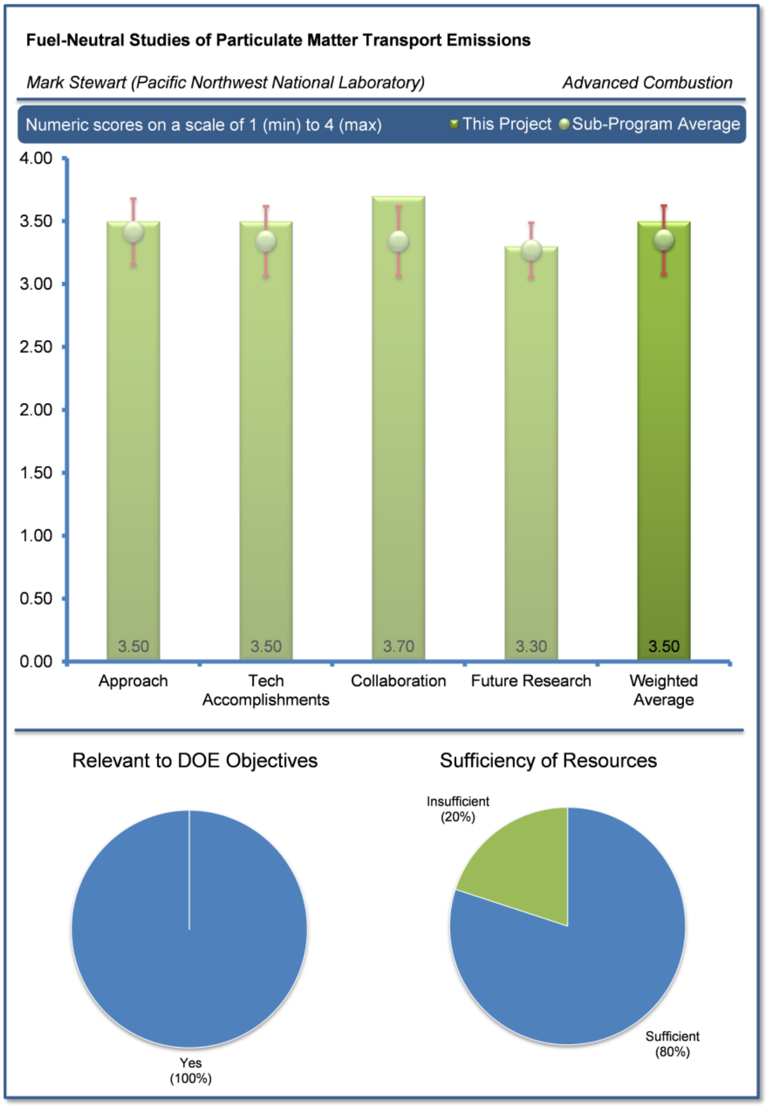
The reviewer noted that this work provides raw data to chemical kinetics models which are crucial for engine combustion simulations used by industry to design and develop engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that if all of the targeted technologies could be incorporated, this would be a world-class capability.

Fuel-Neutral Studies of Particulate Matter Transport Emissions: Mark Stewart (Pacific Northwest National Laboratory) - ace056



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that although the title was fuel neutral, it was basically a gasoline study. The reviewer’s interpretation of fuel neutral was gasoline and diesel fuel. The reviewer noted that the CT images were absolutely fabulous in giving a visual image of the pore structure of the filter. The reviewer remarked that the work utilized every appropriate tool possible and stated very good.

Reviewer 2:

The reviewer noted that this characterization of particulate matter produced by direct inject engines that are being developed to help address the need for greater fuel economy, would be an important element of effectively treating exhaust PM to meet emerging emissions standards that will be in place in future years.

Reviewer 3:

The reviewer stated that the PI continues to use his expertise in using the Lattice Boltzmann approach to particle transport and deposition. The approach is relevant and is capable of answering the related questions/ barriers in the project.

Reviewer 4:

The reviewer stated that the primary program focus is on developing improved fundamental understanding/ modeling of filtration with attention given to filtration efficiency. The reviewer remarked that the overall modeling approach using Lattice Botzmann flow simulations and multi-scale filtration models seemed reasonable (noting however that the reviewer knows little about heterogeneous multi-scale filtration modeling). The reviewer observed that there is also a parallel effort by GM and the University of Wisconsin to collect experimental data via filtration experiments along with the use of advanced CT imaging and analysis to characterize representative commercially available filter samples. The reviewer added that, to date, it appears that the primary focus has been on filtration efficiency with less focus on pressure drop, albeit the reviewer recognized that an adverse pressure drop is undesirable.

Reviewer 5:

The reviewer noted a good scientific approach for extensively characterizing PM emissions from GDI engines to enable better after-treatment of such PM emissions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed very nice modeling work and experimental work on filtration efficiencies under the representative engine conditions. The reviewer suggested that the results on Slide 17 confirm this. The reviewer felt that not being a modeling expert, it would be helpful to understand the fundamental assumptions and limitations of the models and areas for future improvement, as well as sensitivity of the model predictions to key parameters.

Reviewer 2:

The reviewer observed impressive detailed characterization of the filters that were available to the program. The good fit of the experimental data and the models is impressive.

Reviewer 3:

The reviewer noted that Slide 9 was an excellent example of the variations in substrate from manufacturers that we all have assumed occurred. The reviewer expressed that especially interesting were large flow through channels and very rough walls. The reviewer noted that the computer technology used/developed to analyze the CT scans was very helpful. The CT images found “low porosity regions near the wall surfaces”, this seemed to imply that wall inhomogeneities could have a gateway effect on filtration. The reviewer opined that Slide 13 was a step and was unsure if it qualified, yet, as a technical accomplishment. The reviewer also suggested that the project team reference SAE-01-1158. Slide 19 had a very interesting point (i.e., that some of the GDI soot distributions could be diesel-like). The reviewer then commented that “Maximally penetrating particle size shifts from larger to smaller diameter over the course of the experiment,” found on Slide 20, seemed to imply that size filtration changes with filtration loading.

Reviewer 4:

The reviewer stated that Hg porosimetry was used primarily, but the pore sizes obtained were not enough to correlate the structure of the material. The reviewer noted that the X-ray CT scan showed the distribution of the pores throughout the wall and the size distribution which is essential for modeling efforts. The reviewer indicated that although this information was important, newer approaches that emphasized dual functional catalysts (e.g., three way filters, SCRFs, etc.) should be considered in these studies as well.

Reviewer 5:

The reviewer stated that the progress shown (relative to 2013) was noteworthy, clear and objective.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that the integration between PNNL and University of Wisconsin/GM Collaborative Research Laboratory appeared to be almost seamless and added that it was a clear recipe for success.

Reviewer 2:

The reviewer stated that the partners on this project included GM and University of Wisconsin, which was very appropriate. The reviewer added that University of Wisconsin has extensive capability to help elucidate the effects of PM size and filtration efficiency.

Reviewer 3:

The reviewer noted that there was integrated collaboration with the University of Wisconsin and with GM also. This work is all about ceramics; in later stages, integration of a substrate supplier strong in R&D could help the fundamental picture.

Reviewer 4:

The reviewer stated that the team appeared well organized. Experiments were performed by UW Engine Research Center with GM serving an advisory role.

Reviewer 5:

The reviewer noted that the good collaboration between PNNL and UW-Madison was clearly evident. The reviewer felt it was not clear what GM was contributing to the project other than consultation and perhaps some of the samples.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the project/PI were clear on future work at the University of Wisconsin and PNNL. The reviewer stated that this project was all about filters and that nearly all filters were coated (as well as FWC/GPF). However, the PI had staunchly stayed away from introducing catalyst effects (either on the pore structure or on introducing basic reactions) in the investigation. One cannot find the word "catalyst" (or washcoat or coating) in the entire presentation. The reviewer stated that while on one hand it was fine (and a good idea) to start with a simple picture in the earlier project stages (as it did when starting in 2009), it was unclear why at this advanced stage of the work reactions were still being ignored. The reviewer criticized that there was more than sufficient information in the literature to allow integrating at least basic reactions in the analysis; otherwise the project ran the risk of diverging into an irrelevant domain of results and conclusions. The reviewer noted that this was one major area that the PI needed to pay close attention to, not just for scientific reasons but also for reducing the risk of producing results that may never find industry applications.

Reviewer 2:

The reviewer noted that the future work was summarized on Slide 25 and aimed to extend the experimental and modeling work. The reviewer felt it would be useful to use the models and to do a sensitivity study to determine the effect of key parameters (e.g., porosity, permeability, and etc.) on filtration efficiency and also compute pressure drop which could easily be validated by experimental measurements. The reviewer stated that it would also be interesting to see how pressure drop varies with engine operating conditions. The reviewer asked if this was something the models could predict. The reviewer questioned if this was a key goal of the work. The reviewer stated that in future work it was mentioned that additional work may be done with simple surrogate particles. It seemed to the reviewer that this was important for model validation and therefore should be done.

The reviewer stated that it was also noted that fundamental questions remained about the particle formation mechanism(s) yet it was not clear from the planned research how this fundamental lack of understanding would be addressed other than through the obvious collection of data at representative conditions.

Reviewer 3:

The reviewer stated that the extension of the program to include more filters from different suppliers should expand the database and improve the models for GPFs.

Reviewer 4:

The reviewer stated that this project was going in a very good direction and trusted the team to progress on the correct path. The reviewer disliked the following future directions; explore the use of Maximal Inscribed Sphere analysis at higher resolutions to connect 3D microstructural data with data from mercury porosimetry; explore the use of Eulierian Lattice Boltzmann filtration simulations to improve device scale unit collector models. The reviewer stated that the word explore was so vague.

Reviewer 5:

The reviewer noted that the project should also be addressing the need for characterization of hybrid filter systems. The reviewer stated that emerging bifunctional filter systems would strongly impact the porosity and corresponding diffusion characteristics of these components. Also, fuel effects and combustion strategies resulting in additional soot types had not been adequately addressed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that emissions regulations going forward suggested the incorporation of filter technology in after-treatment solutions. Therefore, optimizing the filter porosity to minimize bandpass (BP) and increasing performance were critical. The reviewer suggested that researchers should examine catalyzed filters and the effect of the washcoat location and particles on the filtration efficiency and back pressure. The reviewer stated that these were important tradeoffs for powertrain providers.

Reviewer 2:
The reviewer noted that within the contribution of after-treatment strategies, the work certainly does help toward DOE's goal and charter.

Reviewer 3:
The reviewer stated that the project is relevant and important for optimizing engine performance while mitigating undesirable emissions.

Reviewer 4:
The reviewer commented that lean-burn GDI engines will improve fuel efficiency. The ability to control the PM emissions from such engines to meet future PM regulations will be critical.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

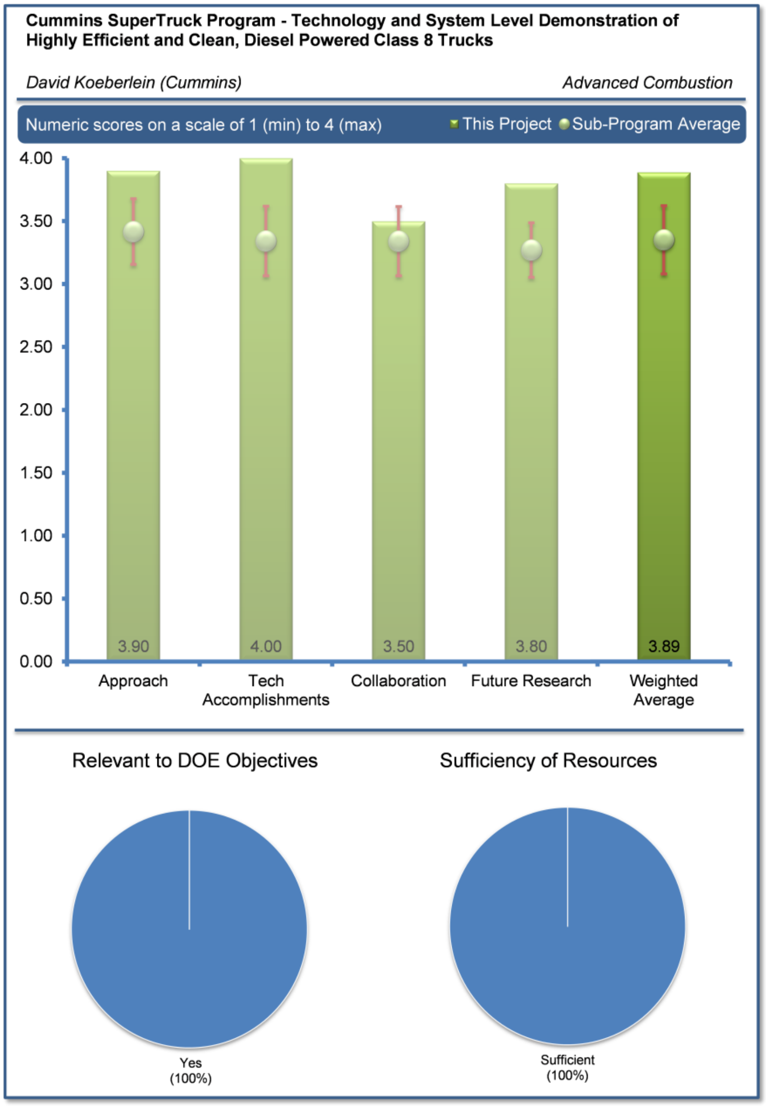
Reviewer 1:
The reviewer observed pretty limited funding for such an ambitious project. The reviewer stated that this limited level of PNNL funding was very dependent on the funding for the GM/University of Wisconsin CRL. The reviewer hoped that funding continues.

Reviewer 2:
The reviewer stated that this project is adequately funded and staffed with the appropriate researchers to accomplish the intended tasks.

Reviewer 3:
The reviewer noted that the project includes a reasonable mix of modeling and experiments. Proper resources have been used. The reviewer criticized that the comparison with literature is modest and could be more rigorous.

Reviewer 4:
The reviewer noticed a good amount of effort at both PNNL and UW. The reviewer inquired about GM's contribution.

Cummins SuperTruck Program - Technology and System Level Demonstration of Highly Efficient and Clean, Diesel Powered Class 8 Trucks: David Koeberlein (Cummins) - ace057



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed a fundamentally sound, very advanced, and technically complete approach to improving BTE to meet the program goals.

Reviewer 2:

The reviewer noted that this was a technical tour de force by a very competent organization. The reviewer said it was hard to imagine a better package of technologies.

Reviewer 3:

The reviewer stated that the program was delivering on objectives, so the approach had been successful. The reviewer noted that the analyses are world-class, with excellent implementation.

Reviewer 4:

The reviewer stated that the technology list to meet 50% BTE SuperTruck goal was well vetted and many were feasible for near term implementations. The reviewer listed gross indicated gains, calibration optimization gas flow improvements, parasitic reductions, waste heat recovery (WHR) system.

Reviewer 5:

The reviewer noted that it was an outstanding accomplishment as far as 50% goal was concerned. However, the path to 55% was not clear, which was one of the final goals of this program. The reviewer summarized that Slide 13 to 16 showed the technical progress with individual technologies, and Slide 17 summarized the benefits. The reviewer stated that it seemed that the improvement from individual technologies, such as piston, injector, and WHR, are additive, which should not be the case. The reviewer noted that the injector and piston should have some kinds of synergy effect, which would not result in 1+1 = 2. The reviewer felt that Slide 20 needed more clarification. The reviewer criticized that without scale or coefficient of variance (COV), this figure could be misleading. For example, the figure could mean a large variation from cylinder to cylinder by just looking at the way it was presented. The reviewer concluded that no technical path was shown with AFCI toward 55%, and was not so sure that this path could reach the goal too.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the results speak for themselves.

Reviewer 2:
The reviewer stated that the objectives were exceeded and even with alternate technology packages. The reviewer said that there were solid analyses to support the test data.

Reviewer 3:
The reviewer observed that the project exceeded engine and vehicle goals by large margins. Credibility and analyses would likely lead to the success in meeting 55% BTE. The reviewer noted a very impressive breakdown of opportunities and preliminary results.

Reviewer 4:
The reviewer stated that the project met the 50% BTE goal. The reviewer stated that the technology list and approach for 55% BTE stretch goal using additional WHR technology approaches and further improvements in combustion design were both mainstream and appeared within reach with R&D. The reviewer noted that also considering dual fuel approach (with WHR) which also showed significant promise at a university and national laboratory level.

Reviewer 5:
The reviewer remarked that achieving 86% and 75% efficiency on two cycles was totally amazing. The reviewer noted that the results on individual technology in achieving 55% also made excellent progress. The reviewer questioned however, if these efficiency results were additive. The reviewer commented that the results on Slide 17 were confusing for showing that they were all additive. The reviewer stated that Slide 7 showed 43% CO_2 reduction, and questioned why this was not the same as the brake l efficiency of engine. The reviewer stated that the HC emission shown in Slide 19 was very high, which would put a lot of burden on DOC. It was not clear how this high HC could be removed at a low temperature, which was a common issue for this type of combustion technology.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that it seemed that given the scope of the program, the number of collaborations might be considered limited. The reviewer noted however, their program had reached outside for collaborations as appropriate.

Reviewer 2:
The reviewer said a solid relation with Peterbilt and suppliers, and ORNL.

Reviewer 3:
The reviewer noted that it seemed that this was all Cummins, but sharing the knowledge with ORNL and Purdue was okay. The reviewer stated that obviously this collaboration delivered.

Reviewer 4:
The reviewer noted a long list of contributors and suppliers on the project. The reviewer commented that the research was well coordinated.

Reviewer 5:
The reviewer questioned why only two partners were used in this program (i.e., ORNL and Purdue University). The reviewer stated that there were no tangible results demonstrated with these two partners in Slide 21.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that the approaches being investigated to achieve the 55% BTE were uncertain, duel fuel, but should be investigated and that was what the program was doing.

Reviewer 2:
The reviewer said that it was hard to criticize anything. The reviewer noted a very fine plan and execution.

Reviewer 3:
The reviewer was looking at all the options. The reviewer stated not being sure the dual fuel approach to 55% BTE was worth it given only a small BTE advantage and the infrastructure/complexity issues with dual fuel.

Reviewer 4:
The reviewer expressed that the 55% BTE approach was well described and vetted.

Reviewer 5:
The reviewer observed very little information about future research in this presentation. The reviewer criticized that it was not clear how the project achieved the 55% goal with the road maps presented in Slides 17 and 18. There was nothing to indicate how HC could be removed or control with AFCI solution.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted amazing FE improvements.

Reviewer 2:
The reviewer stated that reducing freight fuel consumption was at the heart of this program.

Reviewer 3:
The reviewer noted that SuperTruck advanced Class 8 truck technologies for fuel economy improvement could significantly reduce fuel consumption as Class 8 tractors were the largest MD/HD fuel users in the fleet.

Reviewer 4:
The reviewer stated that most of the work related to the demonstration of the 50% goal was heading to production, thus improving fuel economy. This, in turn support overall DOE objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

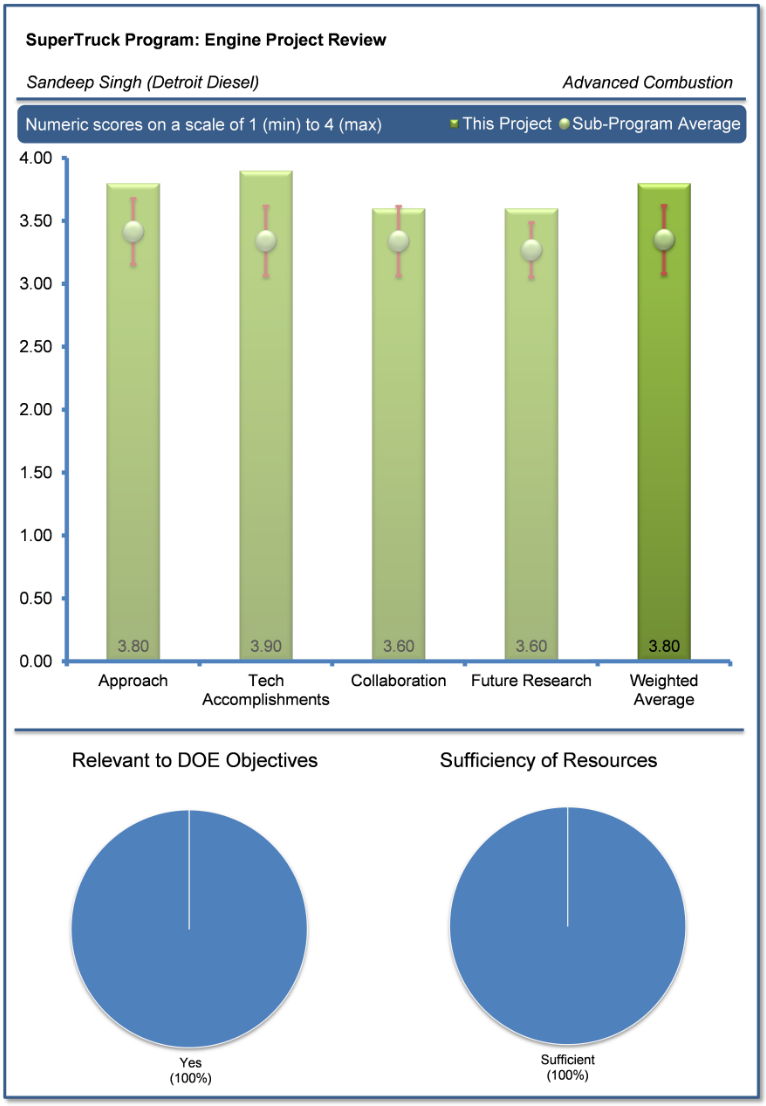
Reviewer 1:
The reviewer stated that this was a huge program, with tough goals and a big budget to accomplish it.

Reviewer 2:
The reviewer noted that this was a well-funded project covering the necessary bases.

Reviewer 3:
The reviewer stated that the project should come in on budget.

Reviewer 4:
The reviewer said just on the way to accomplish the program goal.

SuperTruck Program: Engine Project Review: Sandeep Singh (Detroit Diesel) - ace058



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted the systematic approach, which has differences from the other programs, and mentioned that the investigators had done a nice job identifying the challenges they face. The reviewer stated that the project's approach of real time engine control should provide benefits in real world driving.

Reviewer 2:

The reviewer noted a very solid approach with a broad range of technologies included.

Reviewer 3:

The reviewer stated that the approach was achieving project goals with perhaps a year to go. The reviewer saw very impressive progress in the last year. The reviewer also saw many common threads with others, as expected, but there were some unique approaches (e.g., lube oil, model based controls [MBC]).

Reviewer 4:

The reviewer noted that the team identified a clear path and implementation for the targeted 20% increase via engine improvements, 50% brake thermal efficiency and pathway to 55% brake thermal efficiency via modeling and analysis.

Reviewer 5:

The reviewer stated that the program focused on engine core technologies, where it demonstrated 47.9%, which is quite impressive. However, WHR can only bring up 2.3% benefits, which seemed to be low when compared to its competitors. The reviewer stated that it showed that more work could be done in WHR and its improvement. The reviewer stated that it seemed that the core engine technology was developed based on a bigger engine, and queried whether it was DD13, which include WHR. It was not clear to the reviewer if WHR could be applied directly to a 10.7L engine.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted good progress over the last year.

Reviewer 2:

The reviewer stated that very strong results were shown. The reviewer noted solid progress in many areas, meeting program targets.

Reviewer 3:

The reviewer noted very impressive progress in the last year. Objectives achieved on 50% BTE. The reviewer expressed nice success on oil, MBC, SCR, WHR.

Reviewer 4:

The reviewer noted a successful integration of complex technologies (i.e., EHR, hybrid and high voltage (HV) systems, controllers and network architecture, new cooling layout, new hydraulic systems, and powertrain).

Reviewer 5:

The reviewer stated that the overall achievement was excellent. The reviewer indicated that 2.3% on single point with WHR was not too impressive. It seemed to have more potential. The reviewer opined that most technology development was on a bigger engine. The reviewer commented that once downsizing to 10.7 liter, the reviewer was not sure if all technologies could be applied to smaller engine.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed a nice collaboration effort.

Reviewer 2:

The reviewer noted good utilization of various resources.

Reviewer 3:

The reviewer noted very impressive project management with main partners and supply chain. The reviewer indicated that the results showed this.

Reviewer 4:

The reviewer highlighted a highly recognized team and observed a coordinated effort to leverage expertise across the industry.

Reviewer 5:

The reviewer stated that the partners that were involved in engine control in Slides 8 and 9, such as Atkinson, should be acknowledged. The reviewer stated that the entire program seemed only to have three outside partners MIT, ORNL, and Atkinson, but no university was involved, and that more would be better.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the plan for how the project would achieve the 55% BTE goal seemed to rely heavily on new combustion technology. The reviewer felt it would be nice to see a projection of what would be the best the project can do if those technologies did not pan out. The reviewer noted that it would have been nice if more information could have been given as to the approaches being considered to overcome the challenges identified. As presented, the project was more of an identification of challenges with little information about the approach to addressing these challenges.

Reviewer 2:

The reviewer stated to keep going on the good planning.

Reviewer 3:

The reviewer noted that all the key levers seem to be investigated. The reviewer commented that early scoping on dual fuel and MBC looked good, new, and interesting.

Reviewer 4:

The reviewer stated that for the 55% target, to plan to continue to leverage combustion improvements and waste heat recovery, which if achieved were reasonable production pathways. The reviewer indicated that supporting ORNL development on dual fuel approaches, which also show promise for productive solutions. The reviewer noted that additional discussion of after-treatment needs and costs were also an important topic for 55% BTE and 50% BTE goals.

Reviewer 5:

The reviewer stated that the program seemed to achieve the final goals except 55% BTE goal. The reviewer felt that the path seemed to rely too much on dual fuel, where the actual BTE was not very high due to pumping loss. The reviewer criticized that the program also failed to address the high HC emission issue with this dual fuel or LTC.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer noted direct FE gains.

Reviewer 2:

The reviewer stated that technologies developed to meet 50% BTE goal and 55% BTE stretch goal when implemented on a Class 8 truck could significantly reduce petroleum use.

Reviewer 3:

The reviewer stated that the program was able to achieve over 50% BTE, which supported the overall DOE objectives of petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

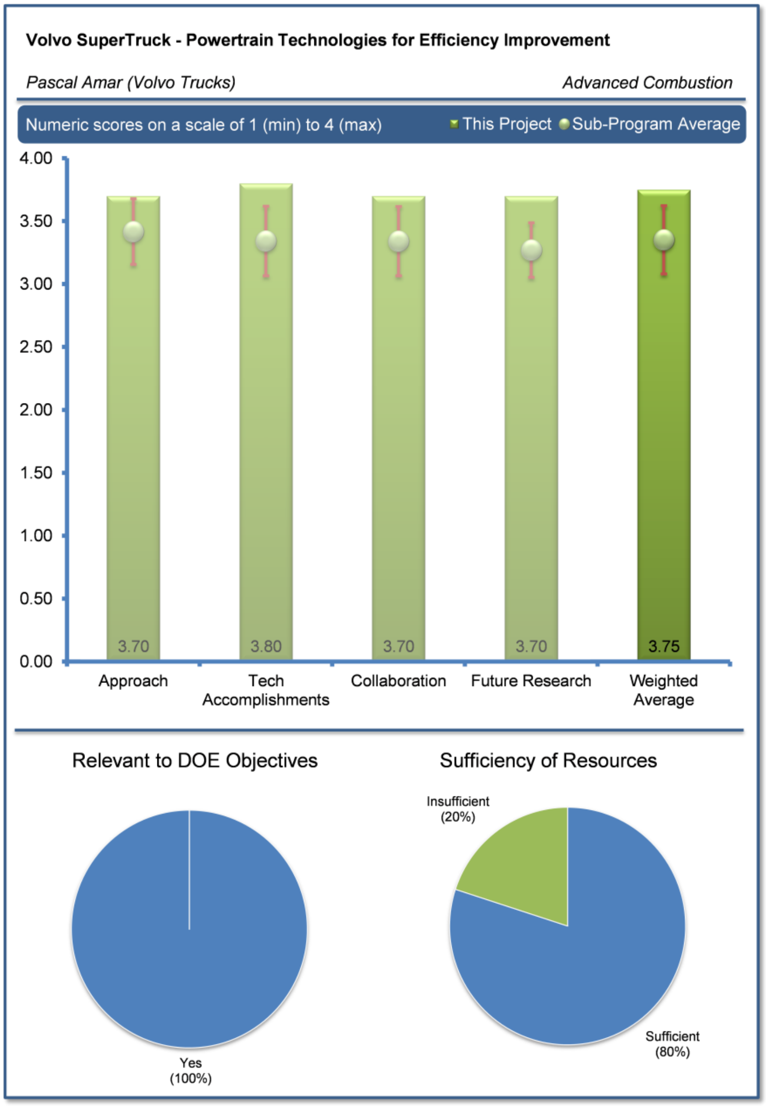
Reviewer 1:

The reviewer indicated seemed appropriate for the effort.

Reviewer 2:

The reviewer stated that it already achieved most of program goals except 55% BTE. It should be on the way to get all, since 55 BTE mainly relied on analysis.

Volvo SuperTruck - Powertrain Technologies for Efficiency Improvement: Pascal Amar (Volvo Trucks) - ace060



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated very nice work. The reviewer indicated that the program started later than the other programs, so the current position was behind, but the project seemed to be on track to meeting the goals.

Reviewer 2:

The reviewer noted a solid plan of comprehensive analysis and testing.

Reviewer 3:

The reviewer stated that the technology screen at first seemed a little backwards - itemize 55% BTE, screen for 50% BTE, and then screen for freight efficiency. The reviewer said however, that this was a nice conceptual model for attaining long term goals. The reviewer liked that the project was running lean on funding, which necessarily required practicality, however, it also had the advantage of coming in late and getting some guidance from others.

Reviewer 4:

The reviewer noted an outstanding approach to meet project goals (test 48% BTE powertrain in concept vehicle, develop powertrain technologies capable of 50% engine BTE in vehicle environment, simulate technologies to achieve 55% BTE). The reviewer stated that with specific consideration for entire vehicle impacts (cost effective and timely evaluation of advanced components and configurations considering added weight, packaging, and complexity of technologies, reduced after-treatment efficiency at low temperatures and integration of interdependent technologies).

Reviewer 5:

The reviewer stated that the path to 55% BTE goal was not convincing. The reviewer questioned how partially premixed combustion (PPC) could just contribute so much for 55% BTE goal. The reviewer commented that for this type of combustion analysis, it could only show indicated thermal efficiency and that HC would be a main issue for this type of concept. The reviewer stated that Slide 8 needed more description and explanation of how 55% BTE was reached. The reviewer indicated that downsizing the engine from 13L to 11L would be challenging to raise the BTE from the current 48% to 50%.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted very good progress, and an honest presentation of where the challenges were. The reviewer commented that 48% BTE on a generation one system was impressive and led one to believe that the project would be able to achieve the 50% target.

Reviewer 2:
The reviewer stated that the results to date supported the pathway to the targets.

Reviewer 3:
The reviewer noted that getting all those rigs up and running in parallel was a major advance and progress seemed ahead of schedule on 50% BTE. The reviewer stated that downsizing was unique and impressive. The reviewer stated that 48% BTE was being installed to keep vehicle program moving and that next year was key for the project.

Reviewer 4:
The reviewer indicated excellent results in getting the technologies to the vehicle fast. The reviewer recounted that testing was completed for intermediate (48% BTE) powertrain in the chassis, and the 50% BTE powertrain had three engines running and six component stands, maturing technologies in parallel.

Reviewer 5:
The reviewer indicated it was not clear how 48% BTE was achieved. The reviewer pointed out that the figure in Slide 10 had not been updated. The reviewer criticized that specifically, it was not clear how WHR was contributing to the overall BTE improvement, which was the key to the final goals. The reviewer stated that Slide 11 was confused, since many vehicle related technologies were added into the engine program, such as axle and dual clutch transmission.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated very good collaboration.

Reviewer 2:
The reviewer noted collaboration with a wide range of suppliers, universities, and etc.

Reviewer 3:
The reviewer noted impressive collaboration, but much of it seemed internal. The reviewer stated that modeling support was critical from partners.

Reviewer 4:
The reviewer stated leveraging internal capabilities, universities, and suppliers as needed to complete the project's goals.

Reviewer 5:
The reviewer noted that many partners were involved, which was shown in Slide 17. However, it was puzzling why three universities were involved 55% BTE simulations, which could not be cost effective in terms of spending. The reviewer commented that at the same time, Volvo's funding level from DOE was much smaller than its competitors.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated that the statement that the project is developing different diesel engine architecture to reach 50% BTE without after-treatment is intriguing. The reviewer indicated looking forward to seeing the future reports.

Reviewer 2:
The reviewer suggested continuing with the solid work plan and results.

Reviewer 3:
The reviewer stated that progress to 50% BTE was coming through the long term 55% BTE pathway. This person highlighted the impressive long term perspective. The reviewer further indicated that the team had a high probability of achieving the 50% BTE goals.

Reviewer 4:
The reviewer recounted evaluating alternative combustion cycles through modeling/CFD and single cylinder testing.

Reviewer 5:
The reviewer indicated that 2% BTE more from the current status would be challenging and that the program did not provide a clear path to reach that goal.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted high FE for petroleum reduction.

Reviewer 2:
The reviewer noted that technologies developed to meet 50% BTE goal and 55% BTE stretch goal when implemented on a Class 8 truck could significantly reduce petroleum use.

Reviewer 3:
The reviewer noted that focusing on BTE improvement supported the overall DOE objectives of petroleum displacement just like all of its competitors.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

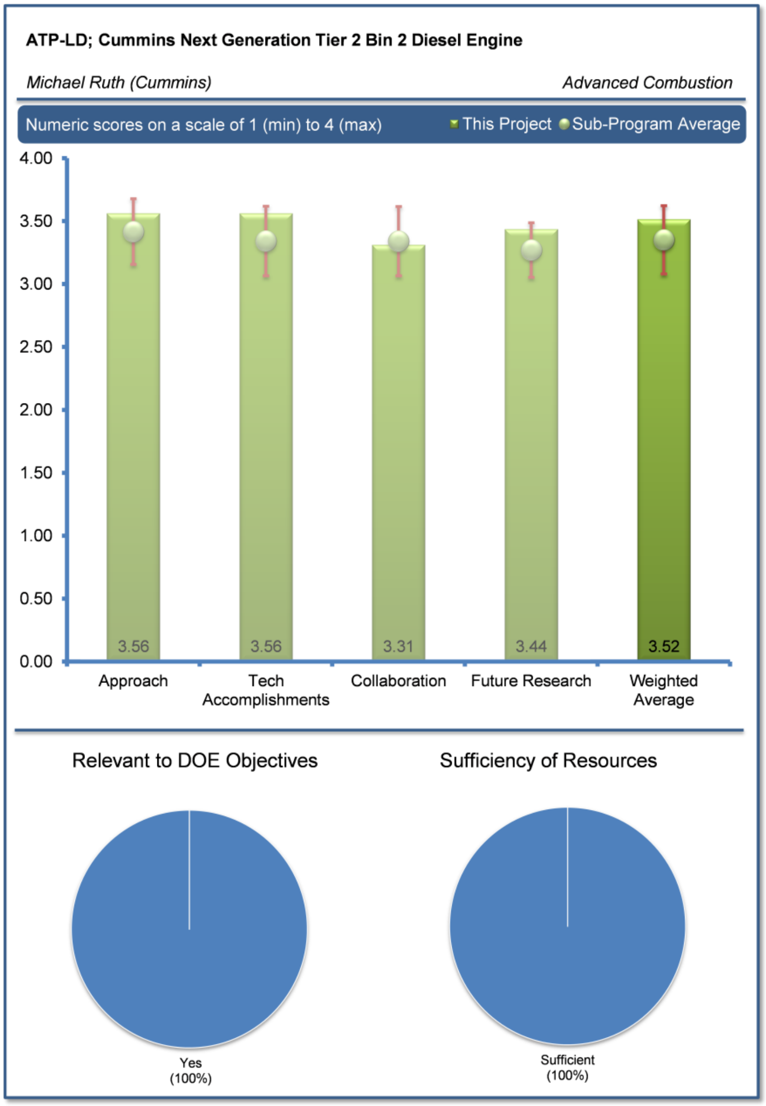
Reviewer 1:
The reviewer felt that this program was funded at a lower level than the others, so the project's approach to concentrate more on technologies that could be brought to market more quickly, and not engage in highly fundamental concepts that are further from market introduction, made sense.

Reviewer 2:
The reviewer said the resources seemed to be appropriate for the large effort in this program.

Reviewer 3:
The reviewer stated that the project was only about halfway through the program with impressive progress given the resources. The reviewer indicated no resource issues within this project scope and much commitment demonstrated outside of public funding.

Reviewer 4:
The reviewer criticized if the funding was adequate compared to its competitors with the same performance goal, since the funding level was much less than others.

ATP-LD; Cummins Next Generation Tier 2 Bin 2 Diesel Engine: Michael Ruth (Cummins) - ace061



Reviewer Sample Size

A total of eight reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted very thorough development and impressive work.

Reviewer 2:

The reviewer stated that Cummins aims to achieve a 40% fuel economy improvement in a half-ton pickup truck. The reviewer indicated that Cummins has designed and developed a new diesel engine that yields very high engine efficiency while emitting almost Tier 2 Bin 2 emissions. The reviewer noted an excellent engineering approach that combines the benefits from engine optimization with that from after-treatment was followed.

Reviewer 3:

The reviewer noted a very solid program plan with solid assumptions and great results.

Reviewer 4:

The reviewer noted an excellent approach starting with an aluminum-based concept taken from gasoline experience. The reviewer stated nice fundamental design. The reviewer noted that after-treatment was cutting edge in all aspects, which was needed to achieve Tier 3 and important in a government-financed project. The reviewer stated that everyone could learn if more details were provided.

Reviewer 5:

The reviewer noted maintaining weight neutral and meeting performance/F.E. CAFE goals. The reviewer listed using aluminum in a diesel, aftertreatment, CSC, future allowance for cam phasers, and balance shafts.

Reviewer 6:

The reviewer noted an excellent approach to designing a downsized aluminum diesel engine with enhanced emission system (Low pressure EGR, CSC TM series catalyst for NO_x and HC, NH_3 gas system) to replace a state of the art aluminum V8 as it addressed identified barriers (2015 GHG requirements 28 MPG CAFE in a half - ton pickup truck, low emission – Tier 2 Bin 2, cost effective solution) as well as significant clear and appropriate metrics challenges (net zero weight, cost effective production, viable durable design which could meet tailpipe emission goals with a 40% fuel economy improvement over current gasoline V8). The reviewer stated that the engine design also considered future state with capability for variable valve train which may be an alternate solution for cold start emissions and provide further economy.

Reviewer 7:
The reviewer stated that this project addressed barriers to entry of fuel efficiency vehicles into the marketplace and particularly addressed those barriers as related to larger vehicles (pickup trucks, sport utility vehicles [SUVs], vans, and etc.). The reviewer noted that the approach entailed a clean diesel combustion engine design as well as emission control for clean diesel engines; both of these areas were relevant barriers that needed to be addressed. The reviewer stated that cost was part of the barrier as well and was being addressed.

Reviewer 8:
The reviewer stated that this work took a systematic approach toward the goals which were fairly aggressive. The reviewer noted that efforts were excellent in integrating latest technologies in engine design, manufacturing, combustion strategy (LD EGR) and after-treatment (low temperature catalyst to reduce HC and CO during cold start). The reviewer noted that the main concern this reviewer had was that gaseous NH_3 seemed to be a major enabler for the approach to meet the NO_x target. The reviewer stated there were issues with onboard vehicle storage, cost as well as refill infrastructure which needed to be adequately addressed. The reviewer stated that the second concern was the robustness/durability of the concept which has yet to be demonstrated.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted outstanding work. The reviewer lauded that meeting the weight neutral target was a great accomplishment.

Reviewer 2:
The reviewer stated following an optimal combination of advanced engine technologies with that of advanced after-treatment, Cummins has demonstrated a performance with 40% improvement in efficiency, but emissions were a tad bit short of Tier 2 Bin 2 levels. The reviewer added, moreover the project’s technology package also appeared to be cost-competitive with the existing engine.

Reviewer 3:
The reviewer stated that all targets (even the aggressive ones) seemed to have been met.

Reviewer 4:
The reviewer stated that this report was very general but this was not surprising given the new engine design and the need to get it up and running. The reviewer stated that the gains in the CSC system were impressive as was the increased HC efficiency and the freedom this allowed in engine calibration. SCRF advancement was also impressive.

Reviewer 5:
The reviewer stated that the weight goal was achieved with extensive aluminum usage. The reviewer indicated that catalyst results were not with the Cummins engine and asked what engine, Slide 14. The reviewer stated that emissions targets were very close to Tier 2 Bin 2 vehicle. The reviewer stated catalyst technology and questioned if it would be ready for the targeted cafe and emissions targets.

Reviewer 6:
The reviewer noted excellent accomplishments as virtually all metrics and barriers had been met on development engines/vehicle with prototype hardware including weight neutral goal through engine weight reduction of 152 lbs. which reallocated to added diesel exhaust (with catalysts), reductant and delivery system, cooling circuit for cooled EGR, achieving T2B2 engine out targets approximately 0.37 g/mi NO_x and 0.33 NMOG on test cell and approaching with vehicle results, achieving engine cost effective solution with 15-30% change in engine cost and 40% fuel economy improvement. The reviewer stated that the costs of vehicle system integration (cooling system) and aftertreatement (CSC) (multi-dosing locations and multiple components) were significant cost increases, and understood to be 2-5 times base technology. The reviewer suggested mitigating some of these costs and mitigating system complexity risk were likely required for commercial application and an outstanding rating. The reviewer noted that CSC catalyst technology durability demonstrations were also needed for production solution and an outstanding rating. NO_x passive NO_x adsorber (PNA) technology has not historically been durable throughout life use and therefore received limited production application. Complex systems such as CSC,

with multiple dosing locations for example, could produce unexpected durability concerns, warranty issues. The reviewer noted good vision as engine design also considered future state with capability for variable valve train.

Reviewer 7:

The reviewer stated that the project was on track and good progress being made with significant improvements in emission control system noted.

Reviewer 8:

The reviewer stated that good progress had been made against the milestones. The reviewer stated that a Tier 2 Bin 5 vehicle had been demonstrated with FE above target and Tier 2 Bin 2 after-treatment technology had been made into scale for actual engine use. The reviewer noted that the performance of the catalyst was very promising. It was reassuring to hear the PI stated that the internal FE goal was higher than the DOE program target.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated a strong collaboration with the relevant stakeholders.

Reviewer 2:

The reviewer noted that Cummins had partnered with Nissan for LD truck integration and with Johnson Matthey for after- treatment development. The reviewer indicated that on both fronts, there were fruitful collaborations that have progressed; however, the task of variable valve engine testing at Purdue University was not well integrated with the rest of the program.

Reviewer 3:

The reviewer observed very good collaboration with a catalyst supplier and an OEM vehicle customer. The reviewer stated that outside this program, Cummins had great collaboration with national laboratories and others.

Reviewer 4:

The reviewer stated that the important parties were there; engine, vehicle, and emissions. The reviewer stated that the Cummins-JM collaboration was obviously close, but it was not clear how Nissan was contributing. However, at this stage, the powertrain development was key to the project. The reviewer stated that in the end, this was government funding to Cummins to develop an engine with one significant subcontractor and that subcontractor would give it their best to satisfy the customer.

Reviewer 5:

The reviewer noted JM catalyst and attributed modeling and camless engine to Purdue University.

Reviewer 6:

The reviewer noted excellent collaboration with OEM, engine manufacturer, and universities with a clear path to production in mind.

Reviewer 7:

The reviewer indicated good collaboration with Johnson Matthey and Purdue University, also a partner on the project.

Reviewer 8:

The reviewer noted good collaboration with partners and subcontractors, especially Johnson Matthey. The reviewer indicated that work with Nissan on vehicle integration and NVH showed good cooperation. Work with Purdue was a good example of applying knowledge gained from different research on the existing hardware. The reviewer stated that the improvement, if any, would be an added bonus.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that Cummins planned to complete a Tier 2 Bin 2 vehicle demonstration as a part of future work.

Reviewer 2:
The reviewer observed every reason to expect successful results and demonstration.

Reviewer 3:
The reviewer stated wrap-up with vehicle testing and demonstrating the whole package. The timeline appeared tight but doable. The reviewer agreed that it was important to benchmark this vehicle to others in the same weight class in Europe, although emissions were an order of magnitude different, a valid compare and contrast would help everyone evaluate the effectiveness of this kind of program.

Reviewer 4:
The reviewer indicated an excellent plan for future work. Emphasis on variable valve actuation (VVA) and calibration efforts to reduce cold start after-treatment requirements and cost were very good priorities for production solution. VVA performance likely also can be leveraged in other regions beyond cold start. The reviewer stated that JMI focus on cost reduction, durability, and simplification of after-treatment are high priority. The reviewer stated a high expectation for demonstration vehicle hitting all targets.

Reviewer 5:
The reviewer saw a good path forward for the project.

Reviewer 6:
The reviewer stated that the project was on the right path. The reviewer noted that the proposed future research was quite logical given the accomplishment so far. Given the new system design and new technology integration, especially with heavy usage of aluminum, the robustness of the concept was a concern. The reviewer stated that it was sensible to conduct some engine life test in parallel with vehicle development.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer indicated that the project intended to develop an engine for light-duty trucks with an improved fuel efficiency of 40%. Thereby it met the overall goal of DOE to reduce our energy consumption.

Reviewer 2:
The reviewer noted a big FE improvement to meet DOE petroleum reduction goals.

Reviewer 3:
The reviewer stated that LD diesel in the pick-up sector would help drop fuel consumption (FC). This sector is now high percentage of diesel due to FC and torque. The reviewer stated getting these to Tier 3 was a real challenge, and critical.

Reviewer 4:
The reviewer stated that yes, 4a 0% fuel economy improvement while meeting Tier 2 Bin 2 emissions on pickup application were critical to petroleum reduction as large percentage of U.S. market sales are pickup trucks.

Reviewer 5:
The reviewer stated that this project directly supported the goal for petroleum displacement. Market penetration of clean diesels could lower petroleum consumption. Many citizens were highly opposed to purchasing smaller vehicles; the demonstration vehicle size for this project was relevant to many customers in the US. The reviewer stated thus, this project was an important approach for market

penetration in the pickup/SUV/van sector where important fuel economy gains must be made. The reviewer concluded that the project addressed emissions as well which was critical to the sustainability of this approach and an important part of the DOE objectives.

Reviewer 6:

The reviewer stated that if the vehicle could meet the 2015 GHG target, it could provide substantial savings in petroleum consumptions, thus supporting the overall DOE objective.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the team appeared to leverage the resources at Cummins, JMI, and Nissan adequately.

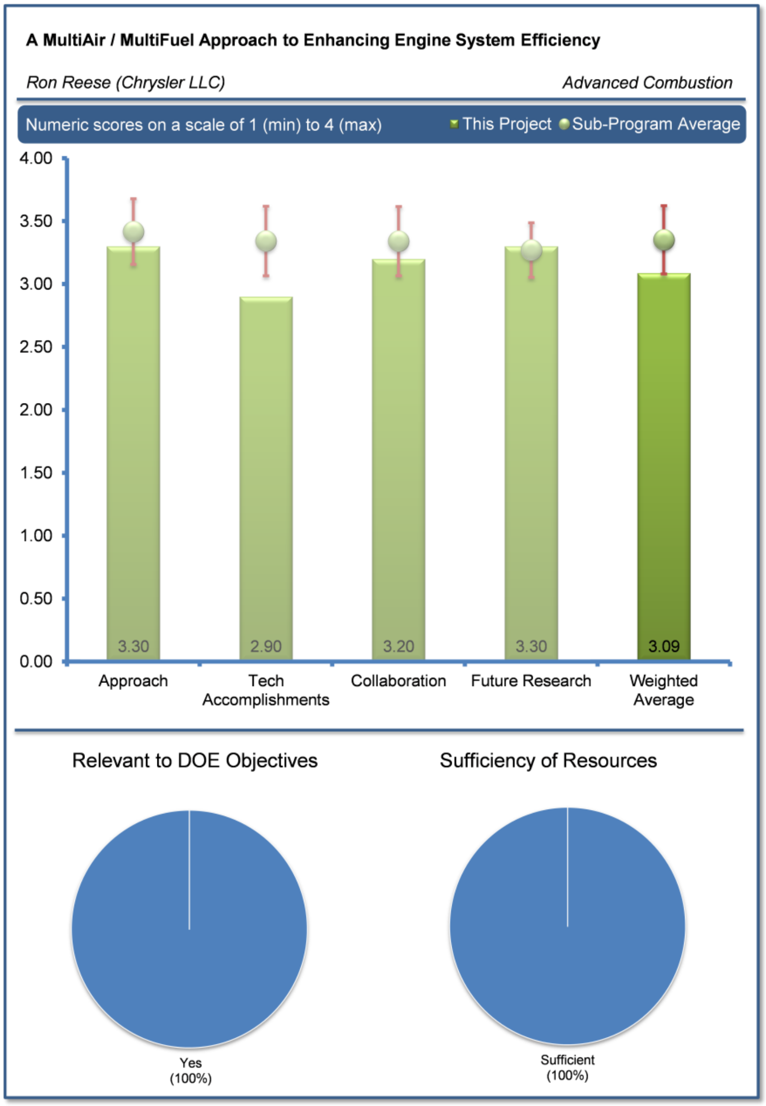
Reviewer 2:

The reviewer stated that the funding seemed appropriate.

Reviewer 3:

The reviewer indicated that the funding appeared to be sufficient for the remaining tasks.

A MultiAir / MultiFuel Approach to Enhancing Engine System Efficiency: Ron Reese (Chrysler LLC) - ace062



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed a strong approach. The reviewer said it was good to see such a system run through the design/development process to translate lab research closer to the real world.

Reviewer 2:

The reviewer noted a good approach and technology menu to demonstrate a 25% improvement in combined city FTP and highway fuel economy relative to port fuel-injected 4.0L V6, 6-speed while maintaining comparable vehicle performance and meeting Tier 2, Bin 2 tailpipe emissions. The reviewer stated transmission to nine speeds from six, a high compression ratio, downsized boosted DI, high energy ignition system, PWM alternator, WHR system, low lockup speed crank device all are viable technologies. The reviewer noted value proposition for some technologies on the menu presented significant production challenges. Identifying these challenges and possible mitigation strategies (even if outside the scope of the project) would be highly productive. The reviewer noted a great approach of engine head design to facilitate future dual fuel gasoline/diesel work, however, the additional scope outside the main focus of fuel economy activity path diluted the focus on the mainstream goals of the project.

Reviewer 3:

The reviewer stated that the Chrysler team was developing, a purpose built HEDGE engine. The 3-valve, 3-plug, and 2-stage boosted architecture appeared to be integral to their approach and good progress had been made in these topics. The reviewer noted that the lack of enrichment anywhere in the operating map was a notable achievement as was the smart charging and turbo bypass. It would have been helpful to have heard more details about fuel switching strategies (e.g., how does the engine transition from gasoline to ethanol and what are the challenges with respect to engine controls). The reviewer stated also, given the challenges with dual fuel strategies that it would have been helpful to understand what benefits would be realized from the project if the ethanol fuel piece were to be abandoned. The reviewer questioned in other words, if the project were to build a gasoline only version of this engine what economy advantages obtained would be.

Reviewer 4:

The reviewer stated that this project addresses improved fuel economy for van size classes in the light-duty market. This class is important to address, as a large segment of the U.S. fleet is composed of such vehicles. The reviewer indicated it is also very relevant to Chrysler's business health; so, it is good that the technical work and potential business strengthening outcomes coincide.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that there were lots of great results so far.

Reviewer 2:

The reviewer observed goals reported to be achieved and providing data to support which was very good. The project reported to meet 25% fuel economy goal, comparable engine performance. The reviewer stated that concern areas were lack of any emission results, value proposition for fuel and technology to production, and possibly a weight comparison to insure that total vehicle weight was downsized. The reviewer criticized that emissions from dynamometer or chassis tests should be presented and it was possible to project FTP with dynamometer test. The reviewer felt that it was unfortunate that to meet engine performance targets required E85 fuel. The value proposition was not clear for many technologies. Some technologies such as PWM alternators had been applied on vehicle since the 1990s to improve cycle fuel economy but in many production cases the value proposition $/FE had been too high for PWM alternators to be used. The reviewer noted that it would be helpful to understand the cost versus benefit value proposition for large powertrain changes relative to unit cost, manufacturing implementation, and risk. Specifically nine speed transmission and crankshaft dampener were effective in the R&D project for the 6% fuel economy benefit, but likely had very high cost/risk. The reviewer stated that reporting relative cost to baseline or relative to other options would improve project value. Other options such as electric assist, start stop 48 volt (or belt-driven starter-generator (BSG) considered in project) electrification options seemed to be in the same or lower value proposition range with a pathway toward vehicle electrification but it was not revealed. The reviewer noted that the cold mass of turbos presenting concerns for cold start light off emissions was well known by the emission development community and that turbo bypass valves have historically had durability concerns and/or cost issues limiting their use to demonstration cases. The reviewer stated that it would benefit the rating to understand which elements of the technology set in the project could be effectively implemented in a near-term successful mass produced vehicle. (E85, 9-speed transmission, active crank damper, twin turbo with a bypass valve, cooled EGR, high energy 3-plug ignition, and WHR). The reviewer indicated excellent work to optimize thermal management system for fast warm-up and concur with challenge of after-treatment solutions for low exhaust temperatures.

Reviewer 3:

The reviewer stated that the project apparently had some setbacks in the program with regards to hardware failures but seemed to be recovering. Progress towards demonstrating power density, emissions and fuel economy appeared to be adequate. The reviewer noted that the work on the turbo bypass and manifold design was good as was the overall focus on thermal management. More discussions on the three plug/three valve architecture would have been helpful as these seemed to be a significant enabler yet little was discussed in detail.

Reviewer 4:

The reviewer stated that the project was making good progress. There was some delay for the final vehicle evaluation, but was understandable due to the intensive work requirements to complete this task. The reviewer stated that there was great progress demonstrated on the design and implementation to improve the exhaust warm-up and catalyst light-off during cold start. Although good progress was made on combustion and dual fuel research, it was unclear how the different combustion approaches would affect the final vehicle fuel economy. The reviewer asked if the dual fuel approach would be integrated into the vehicle.

Reviewer 5:

The reviewer stated that Chrysler had adapted to hardships to meet goals and that achieving a 24% fuel economy improvement was great. Achieving a 25% improvement was marginally better but allowed for checking a box. The reviewer stated that perhaps milestones needed not to have such sharp lines that need to be crossed for success.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated good interaction with a range of suppliers and ANL.

Reviewer 2:
The reviewer noted a good list of partners, however, other than the efforts of Ohio State University (OSU) to optimize the PWM alternator and the warm-up strategy it was not clear how the partners contributed directly to the FE technology menu and overall results.

Reviewer 3:
The reviewer felt that it was difficult to judge from the presentation what value the individual partners brought to the project. One could infer that Bosch and Delphi supplied hardware and that OSU supplied the VES and VEM but it was not clear how the project team worked with the Chrysler team in any way other than suppliers. The reviewer felt that it was not at all clear how the CFD work was supporting combustion development. The work seemed tangential to the project.

Reviewer 4:
The reviewer stated that the collaboration was excellent; collaborations existed with a national laboratory, a university, and other industry (suppliers). The reviewer affirmed that the roles and contributions were well balanced for all.

Reviewer 5:
The reviewer noted that there was a lot of collaboration here, and that the reviewer was giving a good score for this criterion. However, that DOE puts too much emphasis on collaboration (across all projects at AMR). The reviewer stated collaboration was not necessary in every program. Chrysler or any OEM is capable of launching a downsized engine in a vehicle without extensive collaboration. (Many other projects, similarly, can be executed successfully without extensive collaboration).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the program is nearing the end. The reviewer hoped to see this work continue.

Reviewer 2:
The reviewer noted a good approach to zero in on the goals of 25% with a current target basket of technologies, but to comment on others not selected or needed (BSG). The reviewer pointed out a need to provide emission results. The reviewer indicated that the project scope initially encompassed a large basket of technologies which had been narrowed to the select few, yet had included insights into enabling technologies such as high energy ignition, and 9-speed transmissions, and possibly the novel crank damper system. The reviewer observed that the dual fuel diesel gasoline combustion is at an R&D stage and not mature for vehicle demonstration, so it was good to exclude from the project at this point.

Reviewer 3:
The reviewer stated that the work was 98% complete. Not much left in the way of future work to report.

Reviewer 4:
The reviewer indicated that the project was nearing the end stage.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer observed a large FE improvement.

Reviewer 2:

The reviewer stated that demonstrating 25% fuel economy improvement in a mid-sized sedan with no or limited degradation in vehicle level metrics while also meeting Tier 2 Bin 2 emissions on FTP-75 cycle and a possible path to production for some technologies have the possibility to effect petroleum use reduction in the marketplace in the future.

Reviewer 3:

The reviewer noted that highly dilute, downsized and boosted engines with 9-speed transmissions were likely a prime path going forward and would be integral to meeting future cafe regulations. This work appeared to be accelerating Chrysler down this necessary path.

Reviewer 4:

The reviewer stated that this project could impact fuel economy for the van/SUV market sector which was an important sector for the U.S. market. According to this reviewer, many consumers greatly prefer the larger vehicles in this market; addressing fuel economy for this market is critical to achieving petroleum reduction in the United States.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer thought it seemed to have been sufficient for a large set of efforts.

Reviewer 2:

The reviewer stated that with many divergent paths, the funding was sufficient. Main path vehicle funding was perhaps excessive considering the current vehicle level results. However, because the activities to support other technology developments (not directly applied to the vehicle) enabled other valuable work, this balanced the excessive to sufficient. The reviewer indicated that dual fuel heads, ION sense controls for combustion phasing, BSG, and WHR, which were now not on the main vehicle path, were worthy of R&D and were advanced through funding for this effort.

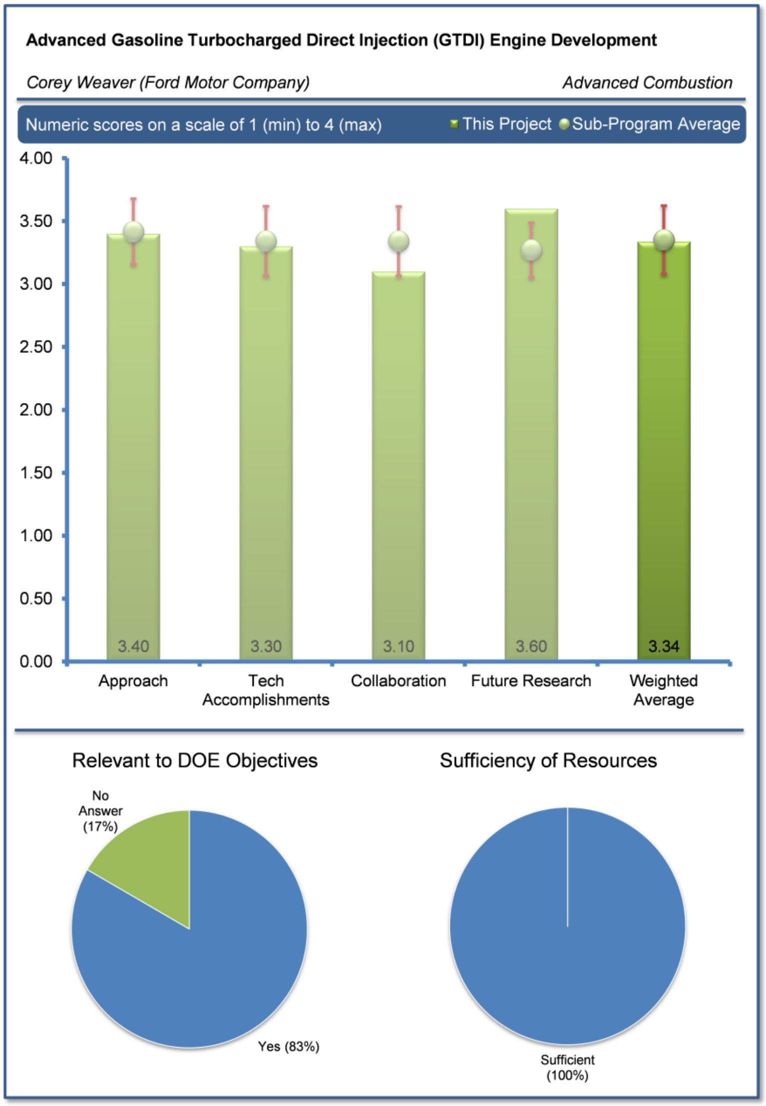
Reviewer 3:

The reviewer stated again, that the project was wrapping up so the question of resources was a bit moot. However, the project did appear to be funded at an appropriate level to make good progress.

Reviewer 4:

The reviewer noted the largest budget of all projects reviewed.

Advanced Gasoline Turbocharged Direct Injection (GTDI) Engine Development: Corey Weaver (Ford Motor Company) - ace065



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted a clearly solid approach launching off Ford's gasoline turbocharged direct injection (GTDI) expertise and pushing it forward in a strong manner.

Reviewer 2:

The reviewer stated assumptions.

Reviewer 3:

The reviewer noted outstanding technology to production development focus to productively implement high percentage of efficiency technology options considered to meet project goals (demonstrate 25% fuel economy improvement in a mid-sized sedan using a downsized, advanced GTDI engine with no or limited degradation in vehicle level metrics while also meeting Tier 3 SULEV30 emissions on FTP-75 cycle). The reviewer stated that effective value proposition analysis, modeling and vetting on the front-end of project and clear integration into the production pathway were outstanding to achieve R&D goals and resulted in timely efficiency gains in the marketplace.

Reviewer 4:

The reviewer stated that the approach was highly conservative and appeared to have a good chance of meeting the programmatic goals. However, very little technical detail was shared and the chance of success could only be gauged by the presenter’s comments. The reviewer indicated that most slides simply contained pictures of the car, engine or a CAD drawing with bulleted statements lacking detail. The work on micro stratified charge appeared to have been inserted to show efforts towards advanced concepts but did not tie into the main vehicle demonstration effort in a meaningful way.

Reviewer 5:

The reviewer noted that this project sought to increase fuel efficiency for light-duty vehicles. The Ford EcoBoost is the basis for the vehicle research/demo. The reviewer stated it was nice and appreciated seeing that the team was pursing lean engine operation as part of the project after that effort was seemingly dropped previously based on the previous year AMR. Although extremely challenging, the lean approach does offer potential for greater fuel economy gains and as such is an excellent pursuit for a government-funded project. The reviewer indicated that the engine advancements shown were notable and good for lean combustion.

Reviewer 6:
The reviewer stated that the project was resulting in a nice demonstration, and had achieved all fuel economy and emissions goals. Ford is very capable and has done a good job; however, a more extreme downsizing would have been more relevant. The reviewer noted that Ford has a 1.0 liter EcoBoost in the market today, and a 2.0 liter engine available in the target vehicle on the market today. The reviewer stated that many of the engine improvements are simple near-term off-the-shelf technologies.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted a lot of good data meeting objectives and illustrating a solid understanding of the technical issues. The reviewer suggested that it would be nice to know more about how the optimization of so many engineering variables was done. The reviewer inquired about how one would know when at the right, optimal place.

Reviewer 2:
The reviewer stated optimization, engine dynamometer testing. The reviewer questioned if there were any modeling that the extensive data was verifying. The reviewer said yes with single cylinder testing. The reviewer listed that the vehicle build engine would be stoichiometric, not lean combustion, fuel premium E10.

Reviewer 3:
The reviewer stated that targets were met with productive technology in dynamometer engine using standard test points to predict performance and emissions. The reviewer noted that the clear production pathway in vehicle development process demonstrated convincing results beyond the reported data.

Reviewer 4:
The reviewer stated that basic engineering work appeared to be progressing well but little had been reported in any of the ground breaking technologies other than some results with twin spark timing and some initial results on the micro stratified work. The reviewer added that the progress towards the vehicle demonstrations looked to be on track.

Reviewer 5:
The reviewer noted good progress on the GTDI engine efficiency and the system level engineering on the project. This reviewer also reported that low pressure EGR benefits were displayed. The reviewer indicated good progress on ignition both for the base engine case and the lean operation (collaboration enhanced ignition progress).

Reviewer 6:
The reviewer stated that despite the somewhat routine approach, the project has been executed very well and achieved all targets.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated good interaction with Michigan Technological University (MTU). The reviewer added that, undoubtedly, there were many collaborations with component and system suppliers that were not visible in this presentation.

Reviewer 2:
The reviewer highlighted MTU papers and PhD. The reviewer added that the two strike spark dwell between strikes must be optimized, and also noted multiple flame kernels.

Reviewer 3:
The reviewer noted excellent results so expected that supplier base has supported Ford in the effort but no details specified. Interesting ignition results from MTU on multi-strike ignition are valuable. The reviewer stated that for outstanding, additional collaboration for methodologies to move the industry bar up.

Reviewer 4:

The reviewer stated that the only partner mentioned is MTU. This person also described the work on spark discharge as interesting. Apparently, the relationship has added value to Ford as it was indicated that Ford is now directly funding the school. The reviewer felt this project could have stood to have more partners involved from the beginning. The MTU role, while good, was fairly small with respect to the overall effort.

Reviewer 5:

The reviewer stated that progress via collaboration with MTU was good, but that overall, there was not a great deal of collaboration with other entities on the project.

Reviewer 6:

The reviewer stated that DOE puts too much emphasis on collaboration (across all projects at AMR). It is not necessary in every program. Ford is capable of launching a downsized engine in a vehicle without collaboration (many other projects, similarly, can be executed successfully without extensive collaboration).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated there is every reason to expect a successful completion of the development and demonstration, with a high likelihood of much of this technology leading to production improvements.

Reviewer 2:

The reviewer stated that continuing parallel pathway with productive technology stoichiometric engine vehicle development and dynamometer based lean development with focus on combustion and after-treatment are excellent. The reviewer stated it was excellent that final vehicle demonstration performance of 25% FE improvement and SULEV emissions efforts appeared to be on production path for the possibility of real world benefit in the short term beyond the R&D project.

Reviewer 3:

The reviewer stated that this project had always put emphasis on hardware build and testing. The team seemed to have a solid plan toward getting to final vehicle calibration and test. The reviewer noted that the project appeared to have a good chance of success toward final goals.

Reviewer 4:

The reviewer stated that the project was generally on track. The future plans were suitable.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer observed that the project directly addresses reduced petroleum objectives.

Reviewer 2:

The reviewer stated that demonstrating 25% fuel economy improvement in a mid-sized sedan with no or limited degradation in vehicle level metrics while also meeting Tier 3 SULEV30 emissions on FTP-75 cycle and the clear path to production for many technologies have a high probability to effect real petroleum use reduction in the marketplace in the near term.

Reviewer 3:

The reviewer stated that projects such as these which help the U.S. auto industry accelerate its portfolio to meet future CAFE standards are, by design, focused on improved fuel efficiency which then directly relates to the DOE objective of petroleum displacement.

Reviewer 4:

The reviewer indicated this project directly involved integrating fuel efficiency improvements into vehicles suitable for market introduction and thus was directly in support of the DOE goal of petroleum displacement (reduction). The reviewer added that it was good for DOE to have projects like this that translate new technology to market ready products.

Reviewer 5:

The reviewer stated that improved fuel economy through engine and vehicle technology advancement was very relevant, although it seemed that the technologies demonstrated were all in production or ready for production. The reviewer was glad to see some effort toward lean burn, even if it was not implemented in the final demonstration. The reviewer continued to say that it would be nice to see the work published.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer indicated that there seemed to be sufficient funding.

Reviewer 2:

The reviewer stated that the given the amount of hardware developed and tested, it would appear the project was adequately funded and staffed. No resource issues were noted.

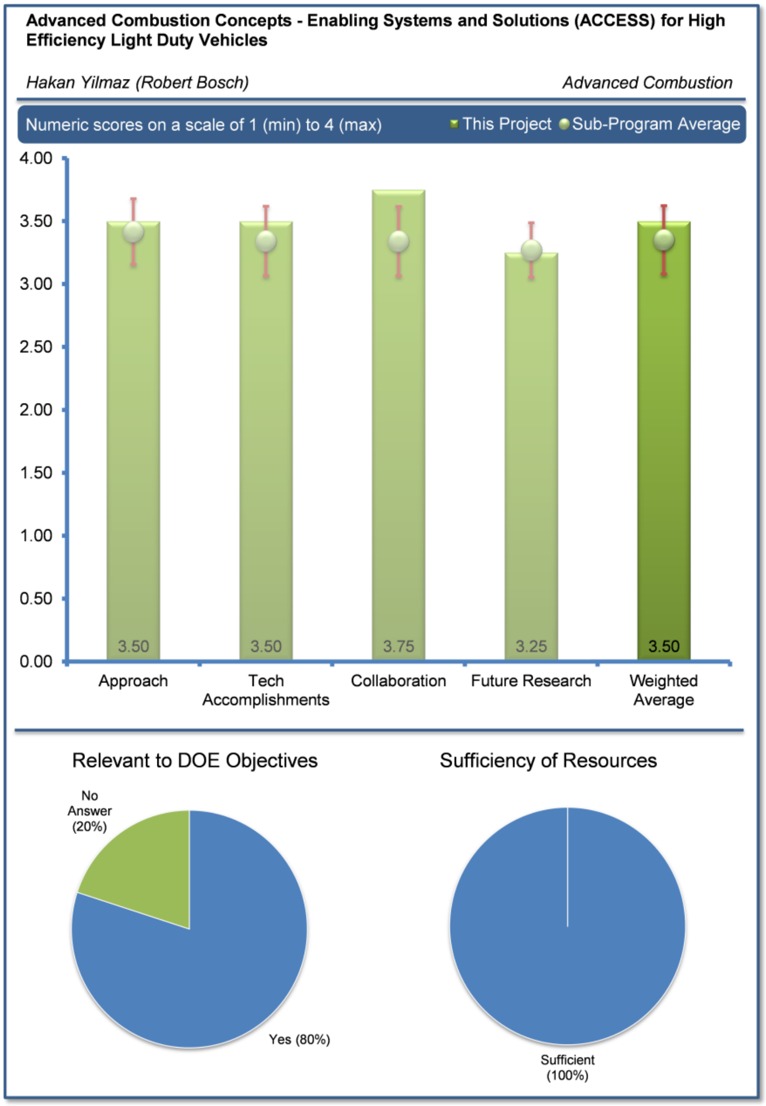
Reviewer 3:

The reviewer stated that the resources are sufficient, but the balance of resource allocation could be better. It was good to see the project devote more resources to the higher risk research of the lean engine approach. The reviewer indicated further resource allocation in that direction (higher risk approach) would be nice.

Reviewer 4:

The reviewer stated that the budget was large compared to most of the AMR projects, but that it was one of the smaller OEM light-duty vehicle demonstration projects.

Advanced Combustion Concepts - Enabling Systems and Solutions (ACCESS) for High Efficiency Light Duty Vehicles: Hakan Yilmaz (Robert Bosch) - ace066



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated first that it was comforting to see a GDI baseline rather than a multi-point injection (MPI) baseline. Multimodal engines were also nice opportunities, and the project was using all, with the possible exception of lean SI. The reviewer stated that managing the controls would be critical and that the project was addressing this.

Reviewer 2:

The reviewer stated combustion controls were integrated into the engine control unit (ECU) including a combustion pressure sensor, combining several technologies with improved controls.

Reviewer 3:

The reviewer indicated a good balance of solid engineering approaches with advanced research technologies. Like most others, this team is looking at practical approaches like downsizing and start stop. The reviewer stated at the same time the team was investigating an interesting blend of combustion modes, including a novel spark assisted compression ignition concept. Overall the project was doing a good job in balancing these activities.

Reviewer 4:

The reviewer stated that this project addressed very challenging goals of implementing HCCI and SACI together with downsized GDTI engine technology. Such goals are aggressive and very appropriate approaches for government funded research in the VTO program. The reviewer noted that the unique structure of the collaborations in this project was also quite impressive and was a critical part of the approach.

Reviewer 5:

The reviewer indicated that the project leadership made appropriate down selects in this short program to ensure that both fuel economy and emissions targets were met. The reviewer appreciated that advanced combustion was maintained in the final demonstration. The additional gains available with more advanced aftertreatment were clearly spelled out and will contribute toward future research and development programs.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that it was quite the achievement to develop and control such a complex multi-mode strategy and achieve SULEV. The results to date as expressed verbally appeared to be able to meet the goals (24 vs. 25% FE improvement). The reviewer stated that the oxygen storage issue in transitions was quite interesting.

Reviewer 2:
The reviewer listed HCCI, SOCI, SI/EGR, Si, and SI/EGR. The reviewer stated that after-treatment becomes a challenge with the multi-mode combustion. The reviewer questioned controls and transitions. The reviewer stated high octane pump 98 RON with 10% ethanol.

Reviewer 3:
The reviewer stated that the team had done a good job in describing the technical approach, the challenges they were facing and their plan to address these challenges. The team appeared to be well managed and had a rational plan moving forward.

Reviewer 4:
The reviewer indicated that the project had made good progress getting to the vehicle stage. Excellent progress was made on the challenge of mode switching between conventional and advanced combustion modes and the corresponding effect on emission control devices.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer criticized that the project has too many players with something like 35 names mentioned over seven organizations. However, the bottom line is that the program shows a strong indication of being successful.

Reviewer 2:
The reviewer listed Stanford, Michigan, Chevron AVL, Emitec, USOEMx and asked what the feedback mechanism was.

Reviewer 3:
The reviewer indicated that a good blend of partners was indicated. It was valuable that the project had Emitec onboard for after-treatment development and AVL on board for combustion work. The reviewer stated that the project seemed to utilize the team members appropriately and in an integrated fashion.

Reviewer 4:
The reviewer noted outstanding collaboration across a broad range of partners. It would be interesting to know how much of the project resources were devoted to managing the multiple partners (versus R&D work) for the purpose of understanding the ideal balance between collaborating and independent R&D for projects.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that more refinement, mode extension, 50% more emissions reductions with cold start and lean NO_x challenges, all appeared to be the upside with plenty of margin to meet the project objectives.

Reviewer 2:
The reviewer stated higher compression ratio (CR), single cylinder.

Reviewer 3:

The reviewer indicated no issues or concerns were noted with regards to the future plans. The team is well positioned to complete the project deliverables as indicated in the presentation.

Reviewer 4:

The reviewer stated that the future direction was good, but there was some confusion regarding the future direction of the advanced combustion role in the project. It seemed that much had been learned, but it was not clear what the next steps were for the SACI/HCCI roles in the final vehicle.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer associated the United States with gasoline. Mode switching is a way to optimize gasoline engine performance and certainly worthy of investigation. The reviewer emphasized that 25% FE improvement over GDI was a challenge and apparently within reach.

Reviewer 2:

The reviewer stated that this work was quite relevant. As noted above, this team was using a good blend of solid engineering and research. The reviewer indicated that the knowledge gained should certainly help the industry move forward to achieve the fuel economy challenges brought forth by CAFE regulations.

Reviewer 3:

The reviewer stated that petroleum displacement was enabled by the greater fuel economy of the vehicle being demonstrated in this project.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

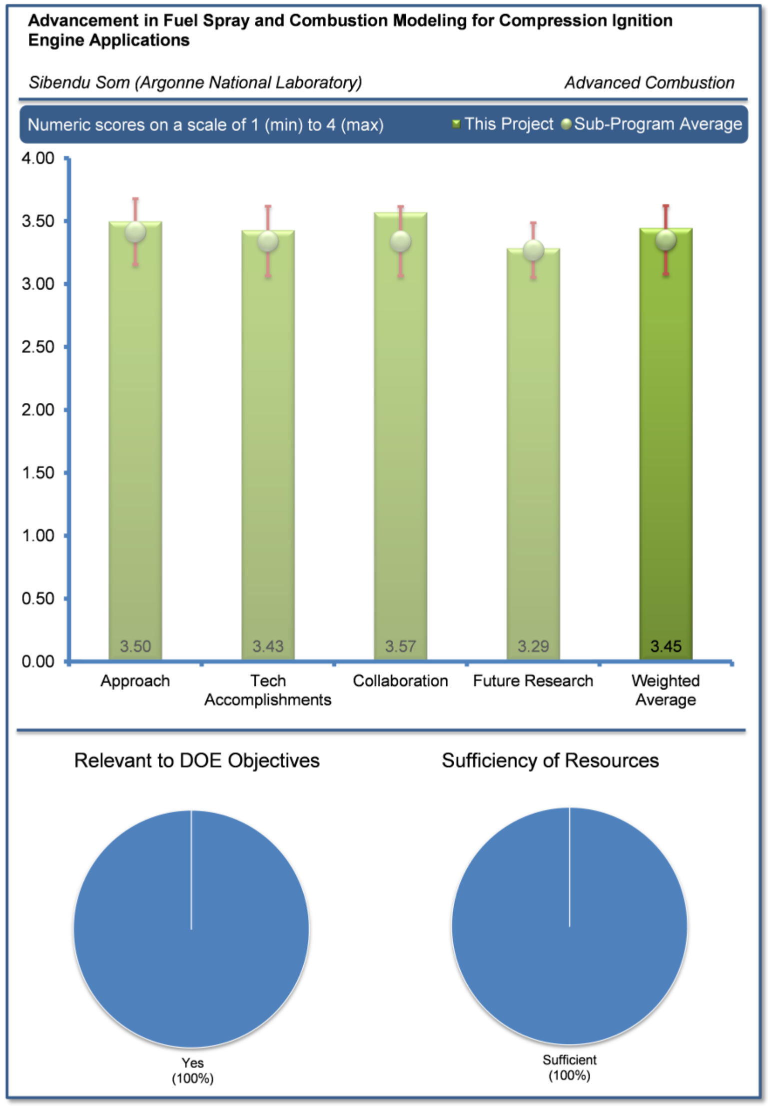
Reviewer 1:

The reviewer stated that the program was closing and funding seemed adequate to finish and meet the objectives.

Reviewer 2:

The reviewer noted that the presenters made no mention of shortfalls due to the budget. The activities seemed to be well staffed and progress was good, indicating that the resources were adequate.

Advancement in Fuel Spray and Combustion Modeling for Compression Ignition Engine Applications: Sibendu Som (Argonne National Laboratory) - ace075



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the work was unique in providing an analytical means of understanding variability in fuel injection systems, and the effects in near-field spray behavior.

Reviewer 2:

The reviewer noted that the approach of using high performance computing coupled with detailed chemistry combustion models, high fidelity LES based turbulence models, and 2-phase physics based fuel spray and nozzle flow, seemed reasonable.

Reviewer 3:

The reviewer stated that the projective approach is commendable, seeking to develop reliable engine modeling capability with fewer tuning constants. The sub-models are published in open literature and available to the industry through commercial software. The reviewer observed a simulation approach encompassed three prongs, spray and nozzle modeling, combustion modeling using detailed chemistry, and high performance computing.

Reviewer 4:

The reviewer stated that the PI was pushing the envelope on the capabilities of a current engineering CFD toolset by leveraging high-performance computing capabilities available at ANL. The reviewer indicated that the PI was able to push the upper limits on mesh refinement to demonstrate grid convergence with the goal to minimize model turning.

Reviewer 5:

The reviewer noted a solid approach to an interesting problem. The reviewer indicated a useful approach to generate understanding and ultimately industrially useful models.

Reviewer 6:

The reviewer noted excellent coupling of experimental and simulation work.

Reviewer 7:

The reviewer stated that the approach was sound in that a commercial code like Converge was being used as the platform to conduct simulations. The focus is more on developing reliable models of fuel spray and combustion kinetics by comparing to experimental data.

The reviewer stated that grid dependence is also being explored. The number of processors is being kept around 50 so it is within reach of OEM capabilities. The reviewer indicated that these important steps have to be extensively carried out before predictive simulation of engine combustion can be accomplished.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the initial progress on injector wobble and the effects on spray is very insightful for efficiency, emissions performance and local mixture prep at SOC conditions. The progress toward understanding of computational overhead tradeoffs will also be useful going forward, as hardware advances.

Reviewer 2:

The reviewer noted good progress in meeting milestones. The reviewer added that there were interesting results on simulation of plume-to-plume variations due to needle wobble during needle transients. The reviewer indicated that in the near nozzle region, the EE model, LE model, and decoupled EE model, performed as well as the coupled EE model, but was three times less expensive.

Reviewer 3:

The reviewer recounted that the work performed includes nozzle and spray research. The project provided a thorough plume-to-plume variation owing to needle wobble effect. The reviewer emphasized that the work included needle transients focusing in the end-of-injection. The work is very good and one suggestion given here by the reviewer is that the project may be better served by documenting these effects with respect to the manufacturing tolerances of a typical injector. The reviewer stated that performance measures may be given with respect to overall flow variability. The reviewer added that the work covered the validation of the coupled Eulerian spray model, including its advantage over the Lagrangian approach. Finally, the work documented the multi-component diesel surrogate mechanism validation composed of n-dodecane and m-xylene.

Reviewer 4:

The reviewer observed noteworthy technical accomplishments in terms of simulating at sprays, flows, and combustion. The reviewer said the work was very relevant to industry and indicated by the CRADA agreements that are currently in place. The reviewer indicated that there had been discussion and debate in the industry over the accuracy of the cut-cell treatment at the domain boundaries. The reviewer encouraged this group to help the industry understand the accuracy of this approach. The reviewer questioned if this work was important as many engine CFD users were placing significant efforts into LES simulations. As the PI transitions from cluster to super-computing, the reviewer asked if the PI could comment on plans to improve code scalability.

Reviewer 5:

The reviewer noted good results and significant progress. The understanding of wobble and its effects, as well as the modeling of cavitation at edge on impact (EOI), are very useful.

Reviewer 6:

The reviewer stated that when experimental imaging revealed needle wobble, it was not clear how this would impact the spray. The reviewer lauded the great work in showing the variation in mass flow among the various nozzles as a function of needle wobble. The reviewer noted that the next step is to show the impacts on combustion.

Reviewer 7:

The reviewer stated that the computational results on plume-to-plume variation of sprays, as a result of needle wobble, was very interesting and exciting. The physics of the ingested gas in the sac at the end of injection is also very enlightening. The reviewer indicated that the work done on the various Eularian and Lagrangian approaches, the validation of reduced models for diesel surrogate fuel, and the diesel engine simulation performed are all very important steps of progress that have been made.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted an excellent collaboration, but that more diverse collaboration with industry, especially other fuel injection system manufacturers, would help to better guide future work.

Reviewer 2:
The reviewer said it looked like good collaboration with a few heavy duty engine industry partners (Cummins and Caterpillar), other national laboratories, and two universities and also through the ECN.

Reviewer 3:
The reviewer noted that the team was very complete, including OEM representation, a commercial software developer, and other national laboratories and universities. The team was also part of the Engine Combustion Network Organization.

Reviewer 4:
The reviewer stated that the PI had strong leveraging with the ECN, in-house measurements, and industry. The reviewer would have liked to understand the linkage between the applied chemistry solver and improvements being proposed by LLNL to the simulation work at ANL. The reviewer added that it seemed like there should be tighter linkage between the groups.

Reviewer 5:
The reviewer stated that participation in ECN the interaction with Convergent Science, along with the related CRADA work showed strong collaboration and movement of the knowledge gained into others' hands.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that future work should include the effect of biofuels on spray formation, as well as distillation curve effects on entrainment and mixing.

Reviewer 2:
The reviewer noted very good elucidation of plans for future work and seemed reasonable.

Reviewer 3:
The reviewer stated that the project outlined the future work. LES and Eulerian-Lagrangian model work is planned. The reviewer noted that the in-nozzle flow simulations with Cummins hardware would be particularly interesting.

Reviewer 4:
The reviewer stated that the current efforts have been mostly diesel-focused and that the group was encouraged to ramp-up the investigation of gasoline spray and combustion modeling.

Reviewer 5:
The reviewer noted excellent plans to continue and expand the work.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the work provided a greater understanding into secondary effects that were important to achieving high efficiency with low engine-out emissions, with more robust controllability.

Reviewer 2:
The reviewer stated that improved models should lead to better engine design, leading to improved engine efficiencies and lower fuel consumption.

Reviewer 3:
The reviewer stated that the project promoted improved modeling tools that would help in the overall fuel efficiency roadmap.

Reviewer 4:
The reviewer affirmed that the proposed work and plan were very relevant to industry by demonstrating the capability and best practices of toolsets that were commercially available.

Reviewer 5:
The reviewer stated that spray was critical to both diesel and gasoline DI engines and combustion systems and therefore to the DOE mission.

Reviewer 6:
The reviewer stated that this project was extensively involved in the development and validation of computational capabilities that have a chance of being used in industry.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that the resources were sufficient for the work undertaken.

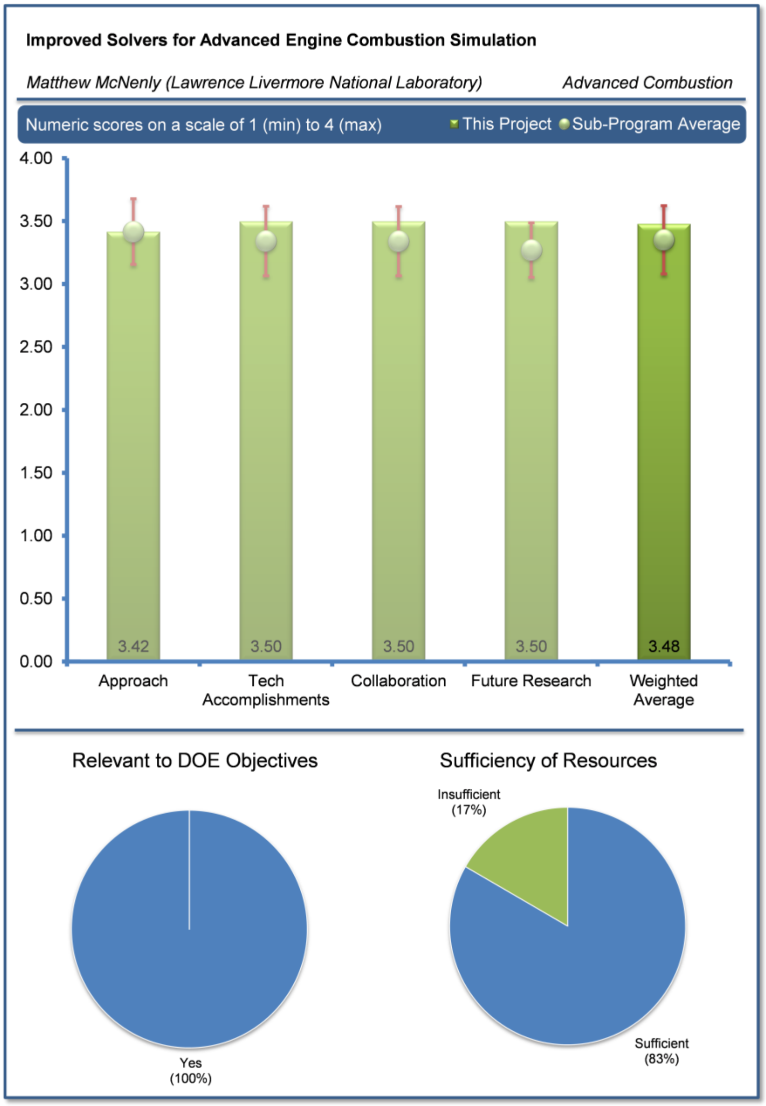
Reviewer 2:
This person stated that the resources seemed sufficient.

Reviewer 3:
Sufficient resources were observed by this reviewer.

Reviewer 4:
The reviewer stated that the investment seemed to be allocated to developing a good team of post-doctoral scholars.

Reviewer 5:
This reviewer noted that funding seemed to be appropriate for the effort required.

Improved Solvers for Advanced Engine Combustion Simulation: Matthew McNenly (Lawrence Livermore National Laboratory) - ace076



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approaches of developing better algorithms, new compiling architecture, and improved physical models should enable the development of faster models with better predictive capabilities. According to the reviewer, the identification and resolution of model/simulation solver bottlenecks should help greatly.

Reviewer 2:

The reviewer stated that the group was leveraging expertise in advanced mathematics and GPUs to improve combustion solvers in engine CFD codes which traditionally have limited the industry from using highly detailed chemical kinetics schemes.

Reviewer 3:

The reviewer stated that the approach addressed challenges to using engine simulations for product development in industry.

Reviewer 4:

The reviewer noted that this project appeared linked to ace012 and thus had an inherent synergy. The continue attempt to validate solvers against as-realistic-as-possible engine relevant conditions is critical as linked to ace012. The reviewer recommended that the project team incorporate these types of benchmarks in future work.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed significant recent accomplishments, including completion of initial scaling analysis of chemistry and multi-species transport in CFD, and completion of multi-processor reaction rate sensitivity tool that reduces wait time from days to less than 1 hour.

Reviewer 2:

The reviewer stated that the PI had shown results improving both the speed-up combustion and improved the physical sub-models. The reviewer questioned what the pathway for industry was to have access to these solver routines. The reviewer questioned if it would be available as a user-defined function or if the industry would have to bear the burden of paying additional licensing cost.

Reviewer 3:

The reviewer said it was amazing that there was continued progress toward further speed up of the chemistry solver.

Reviewer 4:

The reviewer stated that the past year's work has shown a significant speed-up in computational speed for selected problems. To this reviewer, this was excellent progress to date, but the future work should focus on demonstrating continual speed-up on as realistic as possible engine type combustion problems.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the impression was that there are significant interactions with OEMs (Ford, GM, Bosch, Volvo, Cummins), the national laboratories and universities, and software developers.

Reviewer 2:

The reviewer said that it was good to see a nice mix of industry and academia partners.

Reviewer 3:

The reviewer stated that there is a strong linkage of industry and national laboratories with commercial software providing software improvements to help simulate advanced engine concepts. The PIs decided to invest resources in improving CONVERGE. The reviewer questioned if the work in the project could also assist in the development of the new KIVA code being developed at LANL. Tabulated chemistry approaches (such as flamelet generated manifold (FGM)) are an alternative method to running larger chemical mechanisms. The reviewer asked if the PIs had done a comparison (e.g., time, accuracy) of the current approach with tabulated chemistry formulations.

Reviewer 4:

The reviewer observed good collaboration with NVIDIA to improve the use of GPUs.

Reviewer 5:

The reviewer stated that this project was linked to work at another national laboratory and continued to have this type of strong partnership. The reviewer suggested that another partner that can bring metal engine type experimentation be considered for future work (validation).

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that proposed plans should enable good continued progress in meeting the ultimate goals of this project.

Reviewer 2:

The reviewer expressed that the PIs propose to improve the species transport solver in the future. The reviewer believed this was the correct direction. However, the reviewer questioned if the PIs anticipated having the necessary source code access, assuming these improvements would be demonstrated in CONVERGE.

Reviewer 3:

The reviewer noted the need to find the next bottleneck to help further speed up the computations.

Reviewer 4:

The reviewer stated that the only recommendation was to consider more comparison to realistic engine combustion problems as outlined in earlier commentary.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the development of better algorithms, new compiling architecture, and improved physical models would enable the development of faster models with better predictive capabilities which are needed for design of high efficiency, clean combustion engines.

Reviewer 2:

The reviewer noted that faster and more accurate CFD was critical to advancing combustion technology.

Reviewer 3:

The reviewer stated that this work was relevant and the key to many low-temperature combustion concepts (e.g., the intermediate temperature heat release shown by John Dec) required for high-fidelity kinetics schemes in model validation.

Reviewer 4:

The reviewer stated that this work had improved simulation speed used in industry and was therefore highly relevant. Collaborating with Converge and NVIDIA is an enabler for this improvement and should continue.

Reviewer 5:

The reviewer indicated that this was another project working key details that ultimately would enable engineers to explore various combustion strategies for future direct injection engines with improved thermal efficiency and acceptable engine out emissions.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that good progress on milestones suggested that resources were sufficient.

Reviewer 2:

The reviewer indicated good utilization of the allocated resources.

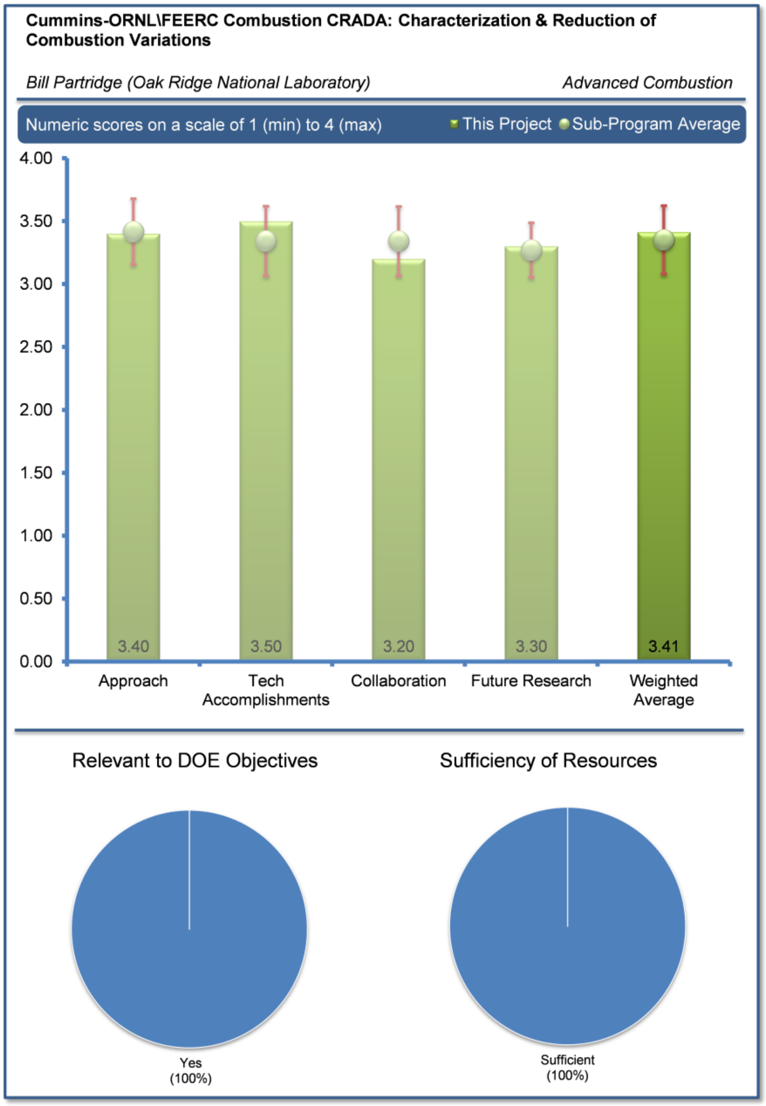
Reviewer 3:

The reviewer stated that if additional resources could be used to accelerate progress, then more funding should be pursued.

Reviewer 4:

The reviewer stated that it would be useful to see a funding breakdown comparing this project with ace012.

Cummins-ORNL\FEERC Combustion CRADA: Characterization & Reduction of Combustion Variations: Bill Partridge (Oak Ridge National Laboratory) - ace077



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer felt that Slide 6 was the holy grail of tracking gas distributions in the intake manifold and the cylinder. This person expected huge differences in the development of engine combustion technology, if totally successful.

Reviewer 2:

The reviewer stated that this project has a very unique approach via a smart way of monitoring EGR variations to stabilize combustions supporting high efficient engine development program. However, the practicality of this probe would still be questionable.

Reviewer 3:

The reviewer stated that the project included a creative approach to some of the challenges; it combined test, modeling and methodology well. On the flip side, however, the project focus was heavily on EGR and the effect of other combustion parameters did not appear to have received as much attention as EGR has.

Reviewer 4:

The reviewer stated that the primary focus and approach was to acquire experimental data on internal and external EGR with the use of a laser based EGR probe that quantifies CO_2 and H_2O concentrations in addition to local temperature. The goal was acquire baseline data and compare/ validate 1D and 3D model predictions (Slide 3) and ultimately use the data/ models for advanced control strategies. The reviewer noted that the approach seemed reasonable and made sense.

Reviewer 5:

The reviewer noted the innovative technique to measure external EGR and backflow in each cylinder using CO_2. The reviewer said that particular interesting was the ability to distinguish hot CO_2 (backflow) and cold CO_2 (external EGR).

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted an impressive design in Slide 8. Regarding Slide 9, this was the information that was needed routinely with each engine design change. The reviewer also noted an impressive design in Slides 10-11.

Reviewer 2:

The reviewer noted a very good outcome. The PI has demonstrated quite a solid achievement for the last few years.

Reviewer 3:

The reviewer stated that the project appeared on course with the scheduled progress. There was a rather long list of what was to be accomplished next. The reviewer emphasized that the team (presenter) was clear that some of the remaining tasks would be challenging.

Reviewer 4:

The reviewer stated that the 2013 and early 2014 milestones had been achieved with the primary focus on extending the probe to measure H2O and temperature (used to correct CO_2 measurement at elevated temperature). Initial measurements are presented on Slide 9 showing the ability to measure external EGR and residual gas backflow. The reviewer felt it would be interesting to compare measured date to model predictions mentioned earlier in the presentation. Also, it would be of interest to the reviewer, to discuss the effect of the probe on the EGR as it is intrusive noting that resonance of the probe with engine harmonics was mentioned and apparently addressed. The reviewer questioned if any effects of the probe on the hydrodynamics. The reviewer questioned in practice, if there were any issues with quantification due to obscuration of optical probes/windows with carbon/soot. The reviewer wanted to know if so, how this issue would be addressed.

Reviewer 5:

The reviewer observed good progress had been made to characterize the contributions of external EGR and backflow EGR to the total charge of the cylinder. The ability to measure H2O and to estimate the temperature with the water spectra was also innovative. The reviewer stated that the re-design of the probe to better measure backflow EGR was good.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the contribution of Cummins seemed to be quite supportive; it showed good team work.

Reviewer 2:

The reviewer stated that the collaboration was limited to one key partner (Cummins). The project had successfully looked into and integrated applications in Cummins's SuperTruck pursuits. The reviewer indicated that collaboration with the University of Central Florida had been developed (though limited to the probe development). The reviewer noted that room existed to include another key partner (e.g., an engine development partner from the supplier industry) into the project, in order to increase the impact of the project deliverables across a much wider, relevant industry.

Reviewer 3:

The reviewer observed that the relationship between ORNL and Cummins was mature and successful. There was very little more upside to this relationship.

Reviewer 4:

The reviewer noted collaboration with Cummins. Cummins was working on the modeling and controls. The reviewer stated that little information on Cummins accomplishments were presented including modeling results and control strategies that work with the laser EGR probe. The reviewer indicated that in future presentations, it would be helpful to detail both Cummins progress with comparisons between model predictions and measurements. Perhaps this was covered in other/ earlier presentations and not included due to limited time.

Reviewer 5:

The reviewer noted good collaboration between a national laboratory, a university, and an industrial partner. The reviewer was not sure from the presentation what Cummins was contributing to the project. The reviewer questioned if Cummins would apply this diagnostic technique to one of their multi-cylinder engines in the future. The ability to measure CO as well as CO_2 with the UCF contribution would be valuable.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer was not sure how this could be done better.

Reviewer 2:
The reviewer stated that this proposed future plan seemed well-planned and executable.

Reviewer 3:
The reviewer stated that the project lead was clear on what was left in the overall course and what needed to be done next.

Reviewer 4:
The reviewer noted that the program ends in September 2015. Significant progress has been made demonstrating the EGR CO_2/H_2O/T laser probe. The reviewer stated that significant work remained to quantify results and apply it to the CRADA/ SuperTruck campaigns, etc.

Reviewer 5:
The reviewer noted that it was not clear how the residual contribution would be measured or estimated.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated yes, for both fuel economy and in cylinder emissions reduction.

Reviewer 2:
The reviewer stated that this work was very much related to high efficient engine development and one of enabling technologies to meet 55% fuel economy improvement; however, the implementation of this probe would be still challenging in a cost-effective way.

Reviewer 3:
The reviewer stated that EGR and fuel economy had direct, one-to-one correspondence. Hence, success in this EGR study could potentially translate into fuel economy.

Reviewer 4:
The reviewer indicated efforts to quantify EGR composition and temperature were relevant and useful for extending operating limits and reducing fuel consumption/displace the use of petroleum.

Reviewer 5:
The reviewer stated that this effort to measure cylinder-to-cylinder and cycle-to-cycle variations would lead to improved engine designs which minimize these variations and thereby improve the engine efficiency and fuel economy.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the integration of the ORNL and Cummins resources was so seamless that it was difficult to tell where one began and where the other took over. However, the reviewer would like to know where the edges are.

Reviewer 2:
The reviewer stated that the resource seemed to be at the right level.

Reviewer 3:

The reviewer indicated that the project had not shied away from developing synergistic use of testing, CFD modeling and innovative use of probes in the study.

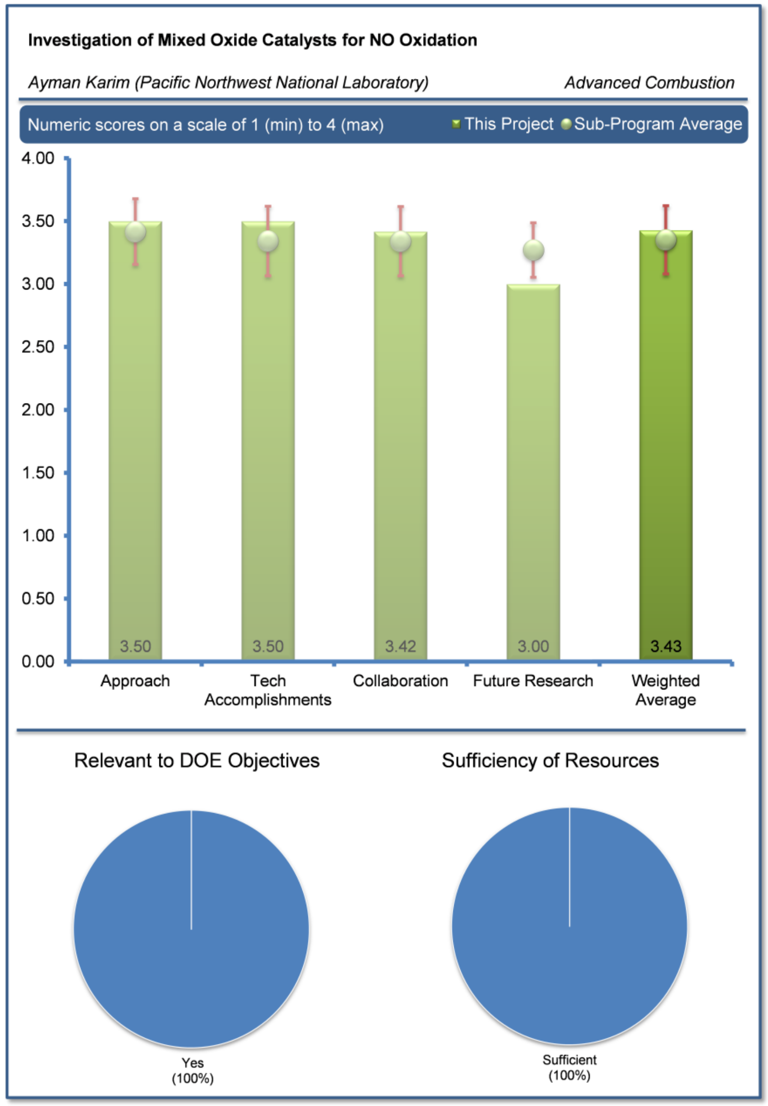
Reviewer 4:

The reviewer said it seemed acceptable.

Reviewer 5:

The reviewer stated that the progress seemed to be consistent with the funding level.

Investigation of Mixed Oxide Catalysts for NO Oxidation: Ayman Karim (Pacific Northwest National Laboratory) - ace078



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted potential for using this system as a low-temperature NO adsorber. Still need another component to oxidize CO. The reviewer indicated sulfur tolerance reversibility was shown only once and questioned what happens when it is repeatedly poisoned and regenerated (some unreported data indicate that higher temps and greater H_2 percentages increase regeneration to a greater degree). The reviewer observed a combination of analytical and experimental approaches.

Reviewer 2:

The reviewer stated that this technology was intended for a platinum (Pt) replacement technology. As reduced Pt, catalyst showed good NO oxidation capability, but did not address the CO oxidation activity that is needed by a DOC for lean systems. The reviewer questioned how much Pt could one really reduce to maintain a high CO conversion rate.

Reviewer 3:

The reviewer stated that work on zero-PGM materials could only be handled by tackling the very fundamentals of oxides in catalysis formulation. Dr. Karim's approach capitalizes on the fundamentals and uses state-of-the-art instruments at PNNL.

Reviewer 4:

The reviewer stated that focus on low temperature conversion was needed for advanced combustion regime and PGM thrifting was always a continuous improvement effort for cost due to scarcity. The CRADA approach generally insures focused priorities for R&D.

Reviewer 5:

The reviewer stated that catalysts were prepared and tested, x-ray photoelectron spectroscopy (XPS), x-ray absorption fine structure (XAFS), FTIR experimental measurements made and DFT calculations performed. A comprehensive approach was presented for determining the activity and stability of the catalyst with improved understanding of the reaction mechanism associated with performance of MnO_2- CeO_2 and Mn-doped ceria.

Reviewer 6:
The reviewer stated that the reduced use of PGM was a critical need, particularly with expanding car markets in China and India and other countries. The use of labeled gases to better understand the mechanisms is commendable. The reviewer indicated however, it might be appropriate to focus on reactions other than NO oxidation, such as HC and CO oxidation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted that milestones were being achieved and objectives were being addressed. Non-intuitive results were observed and validated the value of this research.

Reviewer 2:
The reviewer said the project showed very good NO oxidation activity down to very low temperatures which is consistent with the low temperature after-treatment challenges of future, highly efficient combustion engines.

Reviewer 3:
The reviewer stated that the project appeared to have met initial goals; some of the aging/sulfur work was promising but still preliminary. More application-based type sulfur testing was needed.

Reviewer 4:
The reviewer indicated excellent accomplishments and potential with MnO_x and CeO_2 and ZrO_2 into MnO_x-CeO_2 activity to improve hydrothermal performance and poisoning characteristics.

Reviewer 5:
The reviewer stated that the program was wrapping up. With a relatively modest budget, the project performed impressive experimental work with mixed metal oxide reactivity and stability for NO oxidation. The reviewer noted that the project considered two synthesis techniques with different MnO_2 weight loadings and determined no impact of MnO_2 percent with incipient wetness technique. Further, the project showed mixed oxide was more active and more reducible than either MnO_2 or CeO_2. The reviewer noted performing aging and sulfur tolerance tests in collaboration with GM.

Reviewer 6:
The reviewer noted a good understanding of the active MnO_2/ceria structure.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that GM and PNNL were performing somewhat different but complementary tasks that leveraged the strengths of each; catalyst formulation, and characterization, respectively. The reviewer noted that the person doing the DFT calculations at Tianjin University left during the project, so additional calculations were done by PNNL.

Reviewer 2:
The reviewer observed an excellent inclusion of both suppliers and OEMs in the project. Umicore is recognized for their NSC technologies. The reviewer stated that having monthly conference calls with all the participants was a very good way to maximize the effectiveness of the data collection, direction of the project, and project characterization.

Reviewer 3:
The reviewer stated that the partnership was limited to PNNL and GM. No university or another national laboratory had been integrated into the project, which could have expanded the diversity of the investigation scope and reduced the associated risks. The reviewer felt that given its proprietary nature however (an industrial partner is on-board), this was understandable on practical ground, but not on scientific ground.

Reviewer 4:
The reviewer noted a good scope split with CRADA partner GM developing new catalyst formulations, aging/testing and providing real world vetting for PNNL characterization and synthesis processes /performance assessments.

Reviewer 5:
The reviewer noted work with GM and Tianjin University. Repeated all Tianjin DFT calculations having better facilities after Tianjin personnel reported left project. The reviewer questioned what other role Tianjin had.

Reviewer 6:
The reviewer noted a very clear delineation of effort between PNNL and GM.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the goals for future work were appropriate.

Reviewer 2:
The reviewer stated that the program was nearing completion with active work being done on stability and sulfur tolerance. The reviewer was highly confident the results would be lasting. The reviewer indicated interest in upcoming invited presentation and publications.

Reviewer 3:
The reviewer criticized that the suggestion that LNT technologies were less important than SCR for NO_x control was not necessarily correct. New, passive NO_x control systems that are capable of addressing low temperature challenges of more efficient combustion systems and vehicle drive cycles may have to rely on NO_x storage technologies that are active at lower temperatures. The reviewer stated also, many hybrid catalysts are incorporating LNT/NSC functionality into a TWC or a filter.

Reviewer 4:
The reviewer stated that a vision into future work was observed, but appeared limited. Given that this is the third (and final) year of the investigation, it was not clear why such fundamental considerations such as effects of sulfur and regeneration had not progressed further and still required much work. The reviewer stated also, a faster transition to full-size sample testing was warranted.

Reviewer 5:
The reviewer noted that the CRADA was scheduled to end in September 2014. The reviewer noted much work to do in this area.

Reviewer 6:
The reviewer observed a need to evaluate durability under more realistic thermal environments, such as 800 degrees Celsius for at least 50 hours (1 hour at 700 degrees Celsius is basically de-greening the catalyst). Also, if there are plans to apply this to gasoline applications, the reviewer said there was a need to assess the effects of rich operation on the durability.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer observed that the project supported petroleum displacement by seeking to lower the cost and strategic material requirements of the exhaust after-treatment systems necessary for highly efficient diesel engines to meet emissions requirements.

Reviewer 2:
The reviewer said the proposed future work was very appropriate for emerging lean GDI after-treatment solutions that must work with lower exhaust temperatures associated with emerging combustion strategies.

Reviewer 3:

The reviewer stated that proposed future work appeared focused on the main questions and targets of the project. A faster transition to integrating the aging, sulfur-doping, testing and evaluation of full-size samples is warranted. The reviewer indicated that low/no PGM catalysts could help accelerate proliferation of light duty diesel in the United States, which could substantially help support the DOE's goal of reduced petroleum consumption (as diesel vehicles provide fuel economy beyond what gasoline ones can).

Reviewer 4:

The reviewer stated that the reductions in PGM and identifying new catalyst solutions are a continuous focus for automakers to improve fuel economy and keep vehicle costs competitive.

Reviewer 5:

The reviewer noted that the proposed future work was clearly relevant to reducing PGM catalysts and developing low temperature catalysts.

Reviewer 6:

The reviewer stated that the project was more aimed at reducing PGM use than reducing fuel use; although a lower cost LNT might allow more use of lean-burn operation and thereby reduce fuel use.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that this level of characterization and testing appears to have sufficient resources in this investigation.

Reviewer 2:

The reviewer stated that the PI has integrated fully PNNL's capabilities into the project. The reviewer added that even though the project showed a promising outlook, integrating a university research team and/or a catalyst supplier with good R&D capabilities (of course within some bounds of confidentiality and possibly intellectual property (IP) sharing) into the project could have accelerated the rate of the progress dramatically.

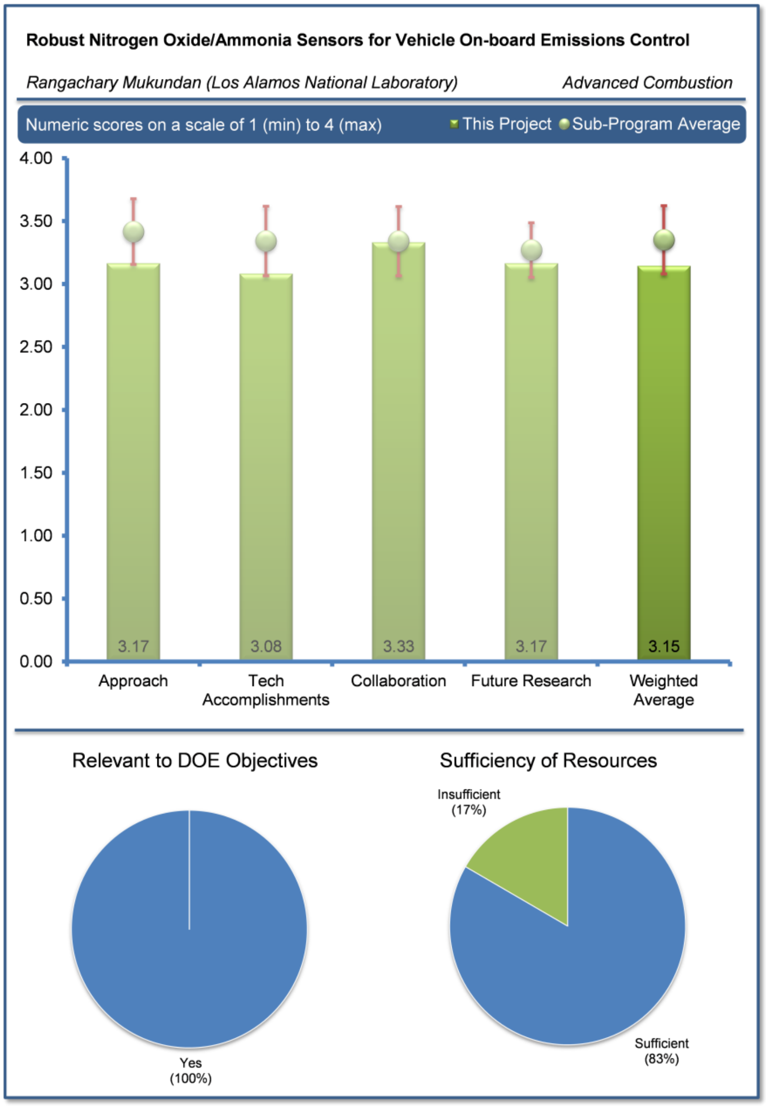
Reviewer 3:

The reviewer indicated significant work was done with modest resources.

Reviewer 4:

The reviewer stated that the funding level seemed consistent with the effort and progress.

Robust Nitrogen Oxide/Ammonia Sensors for Vehicle On-board Emissions Control: Rangachary Mukundan (Los Alamos National Laboratory) - ace079



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the approach favored a unique make of the sensor for improved sensitivity and robustness. These include dense electrodes, porous/thin film electrolyte, and controlled interface. The reviewer judged that a valuable contribution of the project is the integration of mixed potential sensors (NO_x, HC and NH_3).

Reviewer 2:

The reviewer commented that this was a project to develop an interesting set of sensor concepts, and remarked well set-up.

Reviewer 3:

The reviewer found that the project generally had a good approach. The reviewer summarized that the project takes LANL fundamentals, puts into sensor, evaluates, and if good, then goes to engine.

Reviewer 4:

The reviewer observed a nice approach to increasing the sensitivity of the NO sensors. This reviewer had some concern that the signal would depend to a certain extent on the ratio on NO_2 to NO, and whether this would be viewed as a limitation to commercialization.

Reviewer 5:

The reviewer thought that the overall approach was good but the presentation could be clearer in discussing which sensor (NO_x. HC, etc.), or which function of mixed sensor was being discussed at the moment. The reviewer commented that Slide 7 for example, seemed to be talking about both NH_3 and NO_x functions but was not clear which milestone was being discussed and seemed to jump back and forth without clarity. The reviewer commented that testing appeared to be effective in establishing appropriate conditions, including the dilution with air for comparison with atmospheric conditions. The authors had done a good job in demonstrating that the sensor tracks qualitatively total NO_x concentration at start-up and at different flow-rates in steady states regimes and that the sensor tracked quantitatively the total NO_x concentration at different EGR levels. However, according to the reviewer the sensor calibration work for total NO_x had not been tested yet in actual engine conditions and needed more attention due to the non-additive NO and NO_2 concentrations properties.

Reviewer 6:

The reviewer recommended that the barriers identified (sensitivity, stability, interference, response time) were good but should be substantiated through industry survey or input U.S. Council for Automotive Research (USCAR), or perform an OEM survey. Targets from development/OBD engineers for cost and performance (with some justification) would improve. The reviewer pointed out that identification of competitive baseline cost /performance options would also improve.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commended that the project had made very good progress. The project demonstrated quantitative correlation of NO response of optimized sensor to FTIR response during engine testing. According to the reviewer, the project also demonstrated an NH_3 sensitivity of 10 ppm in an ESL manufactured sensor.

Reviewer 2:

The reviewer observed good initial results, and commented that there were many more conditions to be considered.

Reviewer 3:

The reviewer found that the project had addressed many of the practical issues associated with stability, selectivity, sensitivity and time response. After 400 hours of testing, the NH_3 sensor showed good stability, but more testing hours were required. The reviewer thought that selectivity could be improved for HC and NO_x by using bias currents. The pulse discharge technique (PDT) shows that NH_3 selectivity could be ensured through increased pulse amplitude, while it is invariant to pulse duration. The NH_3 sensitivity of 10 ppm had been demonstrated too. The reviewer found that the work so far had been productive and convincing but it was not clear yet if all the barriers (not just some) such as selectivity, sensitivity, stability (durability), reproducibility, response time, limit of detection, and cost will be passed for mixed NO_x and NH_3 sensors. Again, a clearer presentation would help. The reviewer was looking forward to final testing and calibration under actual exhaust gas conditions to see whether damaging effects, such as temperature spikes during active regeneration or presence of other harmful gases, could be withstood or may deteriorate the sensor prematurely.

Reviewer 4:

The reviewer commented that answering the question about poisoning was important.

Reviewer 5:

The reviewer said that it was excellent to have successful engine testing results using commercially viable element and mounting for HC, NO_x, and NH_3 sensors. The reviewer commented that there was significant risk with very low full range voltage in automotive engine environment. The reviewer said that on-sensor amplification would likely be required and would have to withstand significant absolute temperature ranges and thermal shock. The reviewer commented that baseline requirements from industry and value proposition relative to competitive products or industry potential savings would make the project outstanding.

Reviewer 6:

The reviewer commented that the presentation was not clear with too much data. The best plots are response to concentration. Time plots are only useful for time response, not for concentration response. The reviewer detailed that Slide 12 showed low sensitivity of NO_x to HC between 25 and 60 ppm. At 30 ppm HC, the sensor was good to about 10% (60 vs 66 ppm NO_x give same reading). The reviewer observed that Slide 13 showed good lab results with mixed NO/NO_2, but the EGR results were troubling with EGR and off versus the sweep. The reviewer noted that with EGR on at 20 ppm, 180 mv versus 210 mv at same NO_x level. The reviewer exclaimed that this was a 70 to 400 ppm NO_x range as indicated by the sweep. The reviewer commented that there was something strange here in the exhaust. Slide 15 showed decent lab data on HC sensor. The reviewer pointed out that the sensor read 12 to 55 ppm HC depending on 50 or 150 ppm of NO_x. The reviewer commented that perhaps this is not critical. However, according to the reviewer engine results are troubling. The scatter is 150 to 400 ppm diesel at approximately 80mv response and 10-20 ppm HC at 20 mv. The reviewer said that higher levels were not so good. The reviewer concluded by commenting that the NH_3 sensor looking promising.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that the collaboration is very good.

Reviewer 2:
The reviewer found that the project appeared to have engaged university, national laboratory, and industry partners effectively and was commended for actively seeking commercialization paths for this innovative technology.

Reviewer 3:
The reviewer commented that this was a well-organized project.

Reviewer 4:
The reviewer remarked good so far. The reviewer suggested that a real sensor manufacturer needed to be recruited.

Reviewer 5:
The reviewer observed nice feedback loops and the involvement of right kind of partners. This reviewer suggested doing development work on sensor, testing in a lab, and if okay, moving to engine. This reviewer suggested that if engine exhaust showed unexpected anomalies, the project team needed to find out why and simulate it in the laboratory. The reviewer noted that engine work could get expensive, and it was not clear if LANL was engaged on improving sensor sensitivity and refinements.

Reviewer 6:
The reviewer observed good R&D effort beginning to take shape with a sensor manufacturer. The reviewer suggested that next must be OEM or Tier 1 automotive manufacturer input to confirm requirements and critique of implementation to significantly improve the product development speed and final result.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the study had begun to report on NO/HC sensor response optimization studies. The project planned to continue with a demonstration of greater than 10 times NH_3 selectivity with respect to HC. The reviewer noted that other activities were outlined, including the optimization of NO_x sensors and testing and would try to engage OEMs for validation.

Reviewer 2:
The reviewer said that the proposed work looked thorough and promising. Nevertheless, according to the reviewer, there are many barriers to consider before claiming success, including the following: selectivity; sensitivity; stability (durability); reproducibility; response time; limit of detection; and cost.

Reviewer 3:
The reviewer observed a good plan, though more conditions and aging were needed in the long run.

Reviewer 4:
The reviewer observed good next steps to develop controls and package hardware. The reviewer suggested that the project should focus on cost and value equation for the next round.

Reviewer 5:
The reviewer remarked pretty standard approaches. The reviewer suggested that sensitivity improvements should be accomplished before going into expensive vehicle testing.

Reviewer 6:

The reviewer commented that it would have been nice for these results to have been cast into a framework of what the various targets were, cost being a big one, for commercialization.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that sensors were needed for emission controls at high efficiency.

Reviewer 2:

The reviewer said that the project content was relevant. The development of low cost, robust, and accurate NO/NH_3 sensors would help improve efficiency and lower emissions. The reviewer commented that it would help validate models for the degradation of exhaust after treatment system, and would help develop better engine controls.

Reviewer 3:

The reviewer said that sensors are currently expensive. This person further noted only one supplier of NO_x sensors and possibly two suppliers of NH_3 sensors, and noted that these sensors are critical to high-efficiency closed loop control and OBD.

Reviewer 4:

The reviewer said that inexpensive constituent sensors could support fuel savings through the implementation of fuel saving technologies, which could be optimized with sensor feedback or which would require OBD for implementation.

Reviewer 5:

The reviewer remarked that improved sensors would aid in meeting emissions and performance goals leading to increased efficiency to reduce petroleum use. The reviewer commented that presumably these same sensor technologies would work just as well with non-petroleum fueled engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources seemed sufficient, but perhaps a little on the low side depending on how difficult it would be to solve sensitivity issues. The reviewer noted that the project was halfway through the program and that the obstacles might be large to take next steps.

Reviewer 2:

The reviewer commented that if the team could substantiate the value proposition with industry interest and need, substantial new funding would be needed to implement a commercially viable sensor technology. The reviewer observed good initial work to get stable linear output, and, as mentioned above, improving the full range signal would likely require on-sensor electronics development and continued engine testing for sensor stability. The reviewer concluded that the current budget did not appear to comprehend these activities in whole. The reviewer recommended an OEM/Tier 1 partner for additional funding.

Reviewer 3:

The reviewer found that the resources were sufficient.

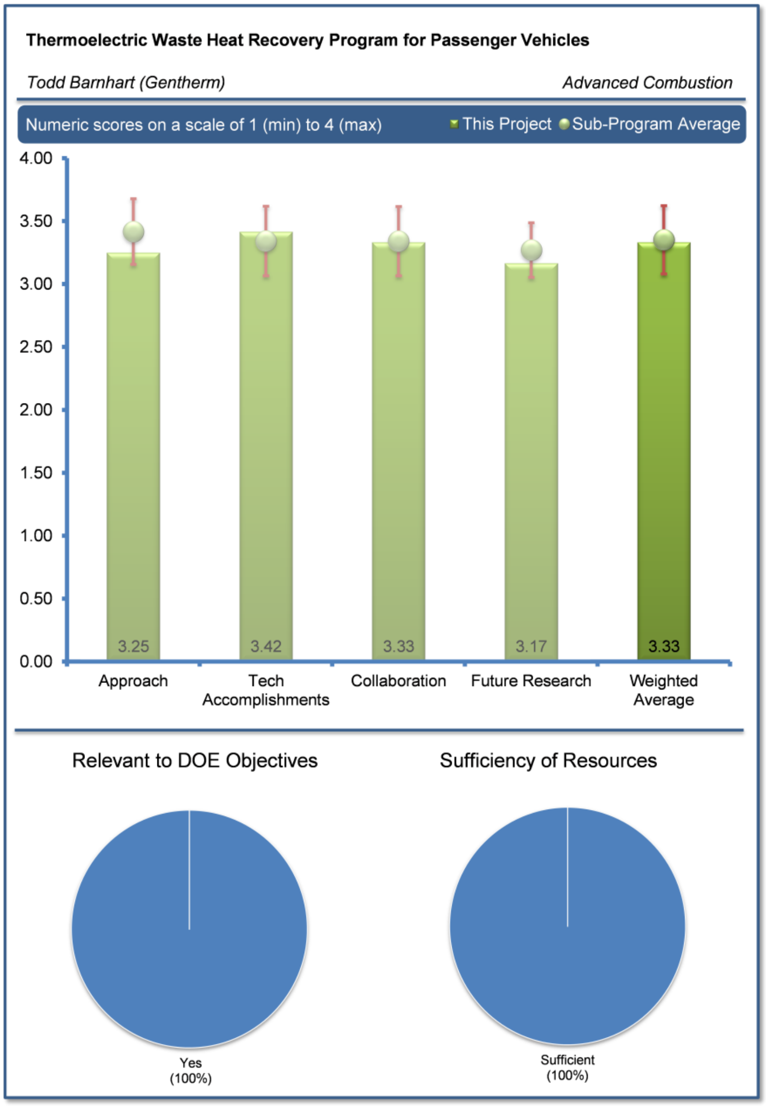
Reviewer 4:

The reviewer said that resources seemed appropriate for the projected work.

Reviewer 5:

The reviewer said that resources were sufficient for now. Expansion would be needed as the project achieves real sensor and testing conditions.

Thermoelectric Waste Heat Recovery Program for Passenger Vehicles: Todd Barnhart (Gentherm) - ace080



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the PIs had been performing the tasks as proposed.

Reviewer 2:

The reviewer found that the approach is considered excellent because the Gentherm team knows how difficult the task is in harvesting power using the hot exhaust gas as a heating medium for thermoelectric generator (TEG). According to this reviewer, the project team has demonstrated their knowledge by focusing on every critical aspect of the project, such as design and engineering of the TEG cartridges, heat transfer modeling, thermoelectric (TE) material selection, and vehicles' exhaust system integration, besides TEG performance evaluation and durability testing.

Reviewer 3:

The reviewer found that the team had a balanced approach in materials development and TEG development.

Reviewer 4:

Although this reviewer agreed that significant improvement to material properties would not come easily or quickly, this reviewer believed that this project could spend a bit more effort in monitoring pertinent materials research to understand how future breakthroughs might impact the designs. Otherwise, this reviewer would have scored this project a 4.0, Outstanding. The reviewer noted a very good focus on reducing product cost, variability, and manufacturing.

Reviewer 5:

The reviewer commented that the Gentherm work has two focus areas (i.e., DOE application and U.S. Army Tank Automotive Research, Development and Engineering Center [TARDEC] application). The TARDEC work seems like it was of low emphasis and successful, but the scope was unclear. The reviewer pointed out that in the overheads, an egregiously large radiator was shown in an image, and the reviewer would like to know if that was only with the mock-up, or if the radiator was an integral part of the Bradley. The reviewer would like more discussion about the anticipated lifetime of the TEGs. Because both are used for DOE and TARDEC it would be good to know if there will be a recurring cost of replacing the cartridges after some years of service. The reviewer commented that the abandonment of enamel coating suggests that while the life may be long, it will be finite. The reviewer would like to know what that time is in years, and what happens if there is a failure. In general, the reviewer said that there was an excellent mix of performers in the program, and all have been successful. The reviewer found that the work was properly scoped and funded, and that the project team had offloaded appropriate tasks to other team members suggesting excellent management by the PI. The reviewer pointed out that the presenter mentioned other ways to increase the improvement in fuel efficiency beyond the immediate waste-heat recovery, so maybe that should be clarified or described in private to the Merit reviewers to evaluate the approach.

Reviewer 6:

The reviewer found that the approach includes materials development, TEG design and evaluation, and vehicle integration. These subjects are nicely presented, easy to follow, and make sense.

The reviewer found that what was missing was a strong link, or any link for that matter, to fuel efficiency. For example, a lot of data were presented on ZT as a function of temperature. The PIs do not inform to what extent the ZT values presented link to FE. If, say, n and p type ZTs were doubled from the data presented (which would be an extraordinary development) the reviewer would like to know what would be the precise impact on FE. For this reviewer, the project team should always be mindful of this sort of question when developing tasks. It is fine to engage in an array of subtasks for a given year. However, according to the reviewer, unless there was a better understanding of the impact and cost/benefit ratio of pursuing those tasks on system level FE, the overarching goal of the project would not be met. This person found that the presentation was missing information that considered this link between subtasks and system level performance.

The reviewer recommended that the PIs, in future presentations, should provide data or analysis that specifically and clearly establishes a quantitative connection of their results to vehicle efficiency. Everything the project team does should be with this in mind, and not just from a broad perspective. For example, the reviewer suggested that instead of presenting figures like ZT versus time, the project team should present charts showing FE versus ZT, or FE versus TEG mass flow rate. For this person, this will provide far more useful information and establish that the PIs are keeping their eye on the ball. The reviewer pointed out that to prepare such plots may require collaborating with someone that has an accurate system level analysis; perhaps Ford or BMW have this. ANL is claimed to have it.

This reviewer envisioned that the materials effort could be eliminated and the funds directed toward expanding the system-level modeling or cost analysis – both of which are potentially show-stoppers (i.e., no matter how high the ZT, if the TEG was not efficient or the myriad of interfaces not well characterized, material gains would have little impact on FE). The reviewer found that the PIs are hedging their bets that skutterudites are the best for waste heat recovery in an automobile. The reviewer would like to know why this material system was better than half-Heuslers, which are being pursued by others in the program, or vice versa.

Finally, the reviewer pointed out that there is the matter of cost, for example as expressed as cost per watt generated by an installed TEG. The reviewer observed that it was not just the TEG but that the installation of it that will contribute to the overall cost of the design. The reviewer recommended that the PIs must present this in their presentation, or at the least inform DOE about it if it is proprietary. The reviewer noted that DOE was investing millions to pursue this technology and that DOE should have a right to such information since it would be the basis for continued funding (i.e., no agency was going to invest in a technology that is not cost effective).

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the integration of TE and heat exchanger were on target to goals. Materials selection and production appeared to be done effectively.

Reviewer 2:

The reviewer commented overall good work and good progress. Perhaps this reviewer did not understand all the work that had been done, but the reviewer got the impression that the analysis could be used more effectively to verify durability requirements and reduce design iterations.

Reviewer 3:

The reviewer noted that over the past year, a lot of data were taken to evaluate the performance of skutterudite materials (n and p type). ZT had been measured and research on stability of the materials reported. The reviewer noted that a performance evaluation of the compact heat exchanger that incorporated integral fins with the materials showed interesting levels of electricity generation. The reviewer commented that the TEG module seems to perform well over the operating cycle (e.g., seven days, with little loss of performance). The TEG design seemed to have been completed. The reviewer recommended that the PIs needed to indicate the cost of the units designed. Unless the PIs do that, there would be little hope of widespread use in an automotive system. The reviewer also recommended that some discussions on alternator down-sizing should be mentioned because this is apparently where increased FE will be derived from.

Reviewer 4:

The reviewer found that there appears to be excellent progress. The reviewer would like to know if there was still materials development work being pursued. The reviewer remarked that it seemed late in the game if so. This reviewer thought there should have already been a down-select of the n-type and p-type skutterudite compositions, and those should be close to optimized for integration into product. The reviewer commented that the mention of the phase diagram development by the Caltech partner suggested that there were still materials R&D for further improvement of ZT, which seemed out of place for this stage. Generally, the reviewer found that the accomplishments and progress were excellent. The reviewer was interested in knowing yield. In other words, the Gentherm approach was unique in that the claim that thermal expansion issues are mitigated. The reviewer asked what fractions of modules (or strings of devices along the cartridge) fail, and whether all are fully functioning. The reviewer would like to know if a cartridge has ever failed.

Reviewer 5:

The reviewer found that technical accomplishments and progress toward overall project and DOE goals are excellent. The reviewer commented that it was clearly shown in the oral presentation that Gentherm is making good progress toward the overall objective of having a 5% improvement in fuel consumption. The design of TEG cartridges and TEG configuration is excellent. The performance of TEG has been evaluated and the milestones have been met as scheduled.

Reviewer 6:

The reviewer found that technical accomplishments and progress were on track with the original plan. The team is realistic in the material performance. The reviewer noted that the TEG module approach was a flexible design with scale-up in mind. The reviewer found that the skutterudite performance is reasonable. The known issue of sublimation of Sb at high temperature was not being addressed directly. The reviewer noted that the cost model is not clear, especially on the materials and “module” cost.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer observed good partnerships and collaboration.

Reviewer 2:

The reviewer remarked that Gentherm worked well with their collaborators from other institutions and used their collaborators' expertise to overcome critical barriers such as selection of good TE materials to reduce cost, heat transfer modeling, oxidation and sublimation suppression coating with enamel, vehicles' system integration, and testing, etc.

Reviewer 3:

The reviewer remarked that the partnerships were managed well and highly focused on the assigned sub-tasks. The project team had sought out external expertise (Tenneco) to facilitate rapid progress, and to reduce overall costs to the Program. The reviewer pointed out that the TARDEC work seemed to be lagging because of the TARDEC partner, so the project team should rapidly identify a back-up plan so that progress can continue at the Gentherm pace.

Reviewer 4:

The reviewer found that the collaboration brings together a strong team from OEMs (BMW, Ford), a company proficient at system integration (Tenneco), an academic partner for materials development (Caltech) and a government laboratory National Renewable Energy Lab (NREL) for confirmation of the TEG-level and vehicle performance. The role of NREL was not clear here and more should be provided about its role, and what it is (and has been) doing.

Reviewer 5:

The reviewer found that the contributions from Caltech were not clearly described beyond a very generic statement (i.e., "deepening understanding of material structure..."). The reviewer concluded that contributions from other partners are properly summarized.

Reviewer 6:

The reviewer stated that the roles of TARDEC and the DOE project were not clear. It seems to be a separate project funded by TARDEC and not collaboration originally planned to meet VTO goals.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer concluded that this project was progressing towards a productive final year in 2015.

Reviewer 2:

The reviewer commented that the proposed future research was technically sound and clear with the prospect that there were still challenges for the project, especially when it reaches the point of mass production for commercialization. However, as shown in the presentation, Gentherm has a good plan to resolve those challenges by continuing to build up their expertise and knowledge through executing this project carefully in order to overcome technical barriers. The reviewer concluded that degree to which the project has been planned is effective and mitigates risks.

Reviewer 3:

This person remarked that the future work was clearly focusing on some of the TEG uncertainties. Vehicle level performance, confirmation testing, and in particular cost analysis are all important to move thermoelectric technology forward. The reviewer considered that perhaps it was planned, but somewhat more effort could be directed towards component reliability and overall durability testing as part of the confirmation activities.

Reviewer 4:

The reviewer noted that future work and milestones are described. However, for this reviewer the role of Caltech was still not clear. This reviewer was unsure if this was a research project; it is more development. But because a research question was asked, this reviewer would say there was really not much research done.

Reviewer 5:

The reviewer found that the future work seemed to be a simple continuation of past years' work. Unfortunately, the PIs were not presenting their results in a form where it was easy to see the benefits of gains in individual tasks (e.g., more power output or higher ZT) on FE targets. The reviewer commented that the project team needed to now start doing that and the future work should endeavor to make that link in everything the team does. This effort will be facilitated by a systems level model that bridges across scales from materials to TE couples to interfaces to heat exchangers and fin efficiency and optimal spacing, to flow rates to electricity produced by modules to reduction in alternator power and ultimately to reduction in FE. That way, according to the reviewer, the team can scope out the limits of impact of each element, craft their work accordingly and provide more useful results. When reviewers see a figure like power versus mass flow rate, reviewers wonder how FE is affected by it. The reviewer recommended that the PIs should tell the reviewers.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer concluded that this project supported the overall DOE objectives of petroleum displacement well. It is an excellent example of how we could reduce the fuel consumption of vehicles, light, heavy and military, by harvesting energy through waste heat recovery and direct energy conversion. The reviewer highly recommended that DOE have more projects like this because every watt of electrical power that can be harvested could save many problems due to shortage or high cost of fuel/energy supply.

Reviewer 2:
The reviewer found that this work would reduce the fuel utilization on automotive platforms, and also reduce the fuel needs on large platforms of the U.S. Dept. of Defense (DOD) TARDEC such as the Bradley Fighting Vehicle.

Reviewer 3:
The reviewer remarked that TEG was not the only solution for the petroleum displacement. However, it was a piece of solution on the table to be used. The reviewer concluded that the development of TEG certainly supported the DOE objectives.

Reviewer 4:
The reviewer identified that the loss of waste heat was a significant source of overall inefficiency in any petroleum fueled system and thermoelectrics were one of several potential ways to reduce this loss. Although significant barriers remained, good progress was being made.

Reviewer 5:
The reviewer commented that getting to 5% might be a real challenge. At the end of the project, the team should be asked very specifically whether the 5% goal had been reached.

Reviewer 6:
The reviewer detailed that the ultimate goal of this project is to achieve a 5% reduction in FE by incorporating a thermoelectric module in the exhaust stream of an automobile. If successful, the project would certainly be relevant to DOE’s objective of petroleum replacement. The issue here is the extent to which the activities being pursued are working to that end.

The reviewer commented that the PIs have a TEG design that appears promising. A lot of data was presented. However, according to the reviewer, none of the figures actually addressed the efficiency question. Reviewers saw graphs that showed the influence of temperature on ZT, power dissipated as a function of air flow rate and voltage as a function of current to illustrate the stability of diffusion barriers, but nothing that addressed efficiency specifically. Another concern is the efficiency target the PIs are working toward. The reviewer asked if 5% was realistic, and where this number came from. The reviewer wondered if the project team was working toward an unattainable goal (e.g., is 5% being too radical an improvement). The reviewer remarked that surely the results would be dependent on the type of automobile and drive cycle performance it would be measured against, but none of this was mentioned. Finally, according to this reviewer, cost will be an issue. The PIs should be forthcoming on cost, either in public or privately to DOE. If developmental funding is to continue, presumably the sponsors would wish to know if the model that Gentherm has developed is cost effective or ultimately too expensive. The reviewer said that this was a major concern. A strong recommendation was to cast the project team’s results in terms of the prime motivation for this project, which this reviewer commented to be efficiency. If the PIs cannot do that, the PIs are not working in the best interests of DOE.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

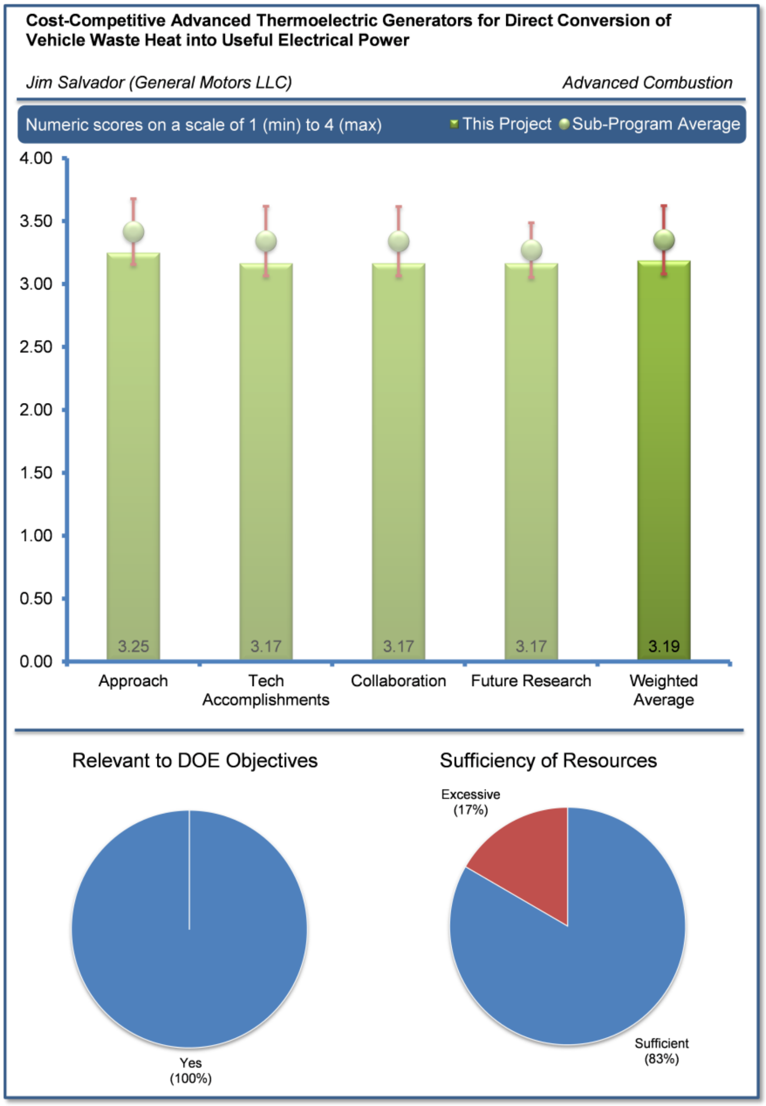
Reviewer 1:
The reviewer commented that the overall project scope had been well aligned with budget.

Reviewer 2:
The reviewer commented that the resources are sufficient for the project to achieve the stated milestones in a timely fashion. The reviewer recommended that this project continues to be funded so that our mission in reduction of fuel consumption can be achieved.

Reviewer 3:
The reviewer found that the budget seemed high. It could well be reduced and still provide useful information. The reviewer provided as an example, if the materials effort were eliminated, in the remaining period of the project, the team could develop (or use) an accurate

systems-level model that establishes a bridge across sub-tasks and a direct link to FE. The reviewer concluded that this is missing from the current work.

Cost-Competitive Advanced Thermoelectric Generators for Direct Conversion of Vehicle Waste Heat into Useful Electrical Power: Jim Salvador (General Motors LLC) - ace081



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the collaboration with many listed partners appeared to be making good progress.

Reviewer 2:

The reviewer found that the approach from the GM team was effective. It represented all effort to overcome critical barriers. The reviewer noted that we all know that the good TEG design requires not only TE materials but also how much heat it can transfer in and out effectively. The GM team has taken into account all the critical elements that are important in designing a good TEG system. According to the reviewer, these are the heat exchanger, modeling work, TE materials, TE module fabrication, TEG design and engineering, power electronics, performance testing, system integration and cost reduction scheme in TEG design.

Reviewer 3:

The reviewer remarked that the overall approach was good, although it seemed that an earlier component level validation would be helpful.

Reviewer 4:

The reviewer remarked that the team approach was focused on TEG development. Many barriers on TEG built are being addressed down to the nuts and bolts.

Reviewer 5:

The reviewer commented that the approach by the GM group appeared to be sound and well represented by the well-described team. There were some open questions about the lifetime of the modules, and overall system. The reviewer pointed out that in one response to a verbal question there seemed to be an issue with failure modes. The reviewer may have misheard, but this reviewer thought that a description of failure modes of the devices and modules would be useful. The reviewer asked if a module fails, then what happens electrically to mitigate that. The reviewer asked if the entire system needed to be disassembled so that a drop-in replacement module could be installed, and, in a similar vein, asked what the expected service lifetime of the TEGs and individual devices are, and how long the lifetime is of the TEGs that have the enamel/coating/aerogel protectant, compared to unprotected devices and TEGs. The reviewer wondered what the performance penalty is to thermal shunts from the protection strategy. It was somewhat unclear to this reviewer why flexible circuit assemblies were needed. The reviewer asked if that was to manage CTE issues. The reviewer recommended that the project team clarify if the flexible circuit adds a thermal interface penalty for dissipating heat to the heat sink.

Reviewer 6:

The reviewer commented that this project incorporates a set of tasks that the PIs believe will achieve the ultimate objective of reaching the targeted efficiency gain of 5% using a thermoelectric device to recover exhaust waste heat. The reviewer remarked that the contribution of the individual tasks to the targeted 5% goal was not well established. For example, in the entire presentation (and in the online slides) there was no graph or discussion establishing a link to FE. Rather elaborate figures were shown on the TEG prototype build, but it was not mentioned precisely what about this design would assist achieving the 5% goal. For this reviewer, the choice of skutterudites needs to be better justified in light of other options. For example, the reviewer asked why it was better than half-Heusler materials, which are being pursued by other groups in the DOE program (and, of course, vice versa).

The reviewer commented that as the PIs enter their third year of funding, and if this project is continued, it would be essential for the project team to address the targeted efficiency, how each task contributes to it, where the project team is now with the results obtained to date (e.g., the reviewer asked that if not at 5%, did the aggregate of what the team has accomplished put their results at 2%, 4.5%, etc.). In continuing their approach the project team needed to quantitatively show the link of the individual tasks to the 5% goal. The reviewer noted that in comment one of the Responses to Previous Year Reviewer's Comments – "...a closer connection is needed ....to know the actual percent improvement in Fuel Economy (FE)..." – the PI did not answer this comment. The reviewer recommended that if the PIs are unable or unwilling to quantitatively link each task to the efficiency target, the project needs a serious reorganization and redirecting of effort.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer concluded that good progress has been made. Hopefully, the hot side temperature can be improved to more than 525°C in the future.

Reviewer 2:

The reviewer found that the team has made significant progress towards TEG development. Although materials development is a still an ongoing task, the focus on TEG prototype is important. The reviewer noted that the team seems to be less certain of the role of interfaces on device performance.

Reviewer 3:

The reviewer commented that technical progress is good, although some of the design decisions are a bit questionable and are not well supported with analysis or component level testing. The reviewer noted flexible circuit board reliability would seem to be a high risk, but there was no work to understand or define the risk better.

Reviewer 4:

The reviewer indicated that the GM team has made good technical accomplishments and progress in this project. For example, the reviewer noted that the project team had particularly paid attention to how to reduce contact resistance, which is one significant source of power loss in TEG system. Other important technical accomplishments included transient thermal modeling of TEG, TEG design, module construction, module performance and durability testing. The reviewer pointed out that unlike the Gentherm team, the GM team has different TEG designs and also different approaches for solving the problem of oxidation and sublimation at operating temperature. According to the reviewer, the project team's ideas of using enamel coatings for oxidation suppression and aero gel encapsulation for suppression of sublimation at TE legs are good.

Reviewer 5:

The reviewer complimented that the GM team appears to have made significant progress towards the overall goals. The project team seems to be zeroing in on a final composition of TEG material, and a strategy for integrating the material into a modular unit for automobiles. The reviewer noted that the reported electrical contact resistivity is good, but that is known to be a somewhat dynamic property. The reviewer wondered if it would be useful to know if the contact resistivity values are from as-prepared samples, from samples that have had thermal annealing, maybe RTA, or processing. The reviewer wondered how thermally stable that value will be in service life. The reviewer also asked what the project team's definition of delamination is. The reviewer noticed that the project team used this term, but it remains unclear. The reviewer asked if delamination is a separation of the enamel. The reviewer asked is it off of electrical contact to the hot-shoe (hot-side contact). The reviewer recommended that a better description of the described burn-in process would also be helpful.

Reviewer 6:

The reviewer said that the accomplishments reviewed at the meeting involved TEG modeling, heat exchanger design, system level modeling in which the TEG is incorporated into a vehicle, prototype build, and materials advancement. The list of publications, numbering almost 30, shows 70% of these are related to materials development alone and three seem to be more review-type articles. The reviewer commented that the TE problem is certainly not, or should not be viewed as, a materials development effort alone, though the disproportionate effort devoted to materials in this project would suggest otherwise. The reviewer observed that the discussions were presented at a rather higher level than would be commensurate with a detailed review. For example, a "heat exchanger" was mentioned but the design was not presented (perhaps it is in some of the publications; if so, the PIs should not place the burden on the reviewers to dig through publications at a review meeting with the format of the AMR, to obtain them, and assess the efficacy of the design). The reviewer noted that some of the results were presented in a way that was difficult to link to the targeted efficiency gain. For example, for the transient thermal model output a graph was presented of "circuit maximum power" versus time. The reviewer would like to know the link here to efficiency. Similarly, the TEG model output includes a figure of circuit voltage with time. Again, the reviewer would like to know the link to efficiency. The prototype build notes various components of exhaust gas inlet, bottom side heat exchanger, etc. The reviewer asked what the relationship is between the inlet gas flow rate and FE or efficiency. The reviewer commented that answers to these sorts of questions will put in focus the approach and the accomplishments that come from these answers.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer remarked that compared to other teams, the GM team has the most collaboration from industry, national laboratories and academia. The project team is able to work with all collaborators well and the workloads are reasonably assigned among the team members based on their expertise.

Reviewer 2:

The reviewer commented that the PI seemed to be able to coordinate the many collaborators effectively. The reviewer acknowledged that a thermal model has been developed during this past year.

Reviewer 3:

The reviewer observed a good project team with most of the necessary expertise. The reviewer thought that it would be good to add a vehicle OEM to the list.

Reviewer 4:

The reviewer noted that GM has identified leaders in the field and has established good partnerships to facilitate progress. The project team has offloaded appropriate tasks to experts better suited to mass-production, while maintaining core expertise in-house.

Reviewer 5:

The reviewer found that as the end-user and developer of TEG, the GM team is large and well organized. The reviewer acknowledged that the role of JPL is important in assuring the success of the TEG development.

Reviewer 6:

The reviewer noted that the team includes a large number of components, 12 in all. The coordination and interrelationship between the various team tasks and teams was not clear. As example, the reviewer cited that the Jet Propulsion Laboratory is listed as modeling "heat exchangers," while Purdue is listed as "heat exchanger modeling." The reviewer would like to know what the difference is. Similarly, Molycorp is listed as "materials synthesis," Brookhaven National Laboratory is listed as "materials synthesis," and University of Washington as "TE materials research and development." It seemed to this reviewer that none of these three efforts could proceed independently of the other. The reviewer recommended that the lead PI show a clear differentiation among the team capabilities to prove little redundancy, or at the least close coordination and complementary work.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer found that future work plans were good, although some targeted reliability testing to address the flex circuit would be better.

Reviewer 2:

The reviewer commented that the GM team appeared to have a good perspective on future needs and the work requirements to conclude the present work in 2015. The reviewer observed that the tasks are realistic and the near-term goals are well-scoped.

Reviewer 3:

The reviewer remarked that proposed future work is reasonable and towards the final goals. There is not much research in the project, mostly development/engineering type of work.

Reviewer 4:

The reviewer concluded that proposed future research is technically sound and clear with the prospect that there are still challenges for the project, especially when it reaches the point of mass production for commercialization. Because the GM team has many more collaborators compared to other teams, this reviewer suggested that the proposed future research should be well thought to effectively utilize the collaborators' expertise without duplicating the work. Thus more comprehensive results can be obtained from different collaborators in a timely manner. The reviewer found that the degree to which the project has been planned is effective and risks mitigating.

Reviewer 5:

The reviewer concluded that the plan for future research is good. The path to lowering the cost is not well defined. The reviewer expressed concern that uncertainties such as long term stability and performances under cyclic conditions are still unknown.

Reviewer 6:

The reviewer strongly encouraged the PI to specify targets for his team to shoot for in their individual tasks. As it stands, it seems that the project team's objectives are only to get the highest ZT possible, or design the most efficiency heat exchanger, etc. The reviewer expressed that while it cannot be argued that tasks formulated in this way provide over-arching motivation for the individual work, the project team does nothing to put in focus objectives for each team. The reviewer cited previously-noted concerns about a tenuous link to efficiency targets of the individual or collective tasks, and remarked that none of the planned future efforts seem to address this link.

The reviewer encouraged the PI to better focus his team toward targets with specific metrics that impact overall efficiency gains. Not just get the highest ZT, or shoot for a ZT that may well be unattainable, but a ZT target that, all other things being perfect would reach 5%. The reviewer thought that some discussion of alternator down-sizing is necessary to fully address this point and how much the system the project team has thus far developed can reduce the load on the engine's crankshaft (engine testing would address this matter). The reviewer explained that this would require perhaps using a system level model to draw such a link, then identifying specific deficiencies in the ingredients to a complete package that make it currently unable for the targeted efficiency to be reached.

Finally, this reviewer commented that it was essential for the PIs to provide some cost estimates of the module and integration of it into an automobile. It is highly unlikely that GM will ever pursue a technology (e.g., even if GM reaches the 5% target) if the project team cannot do it without driving up the cost to levels that the consumer will find unacceptable. The reviewer recommended that the project team consider this matter in their next presentation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that waste heat was a major loss in a petroleum powered system and thermoelectrics are one potential method of reducing the loss.

Reviewer 2:
The reviewer remarked that TEG development was one of the available solutions to petroleum displacement. The reviewer remarked that even with a 3% FE improvement, the TEG will be an important solution to the DOE objectives.

Reviewer 3:
The reviewer commented that the GM approach will improve fuel utilization on automobiles, and provide useful electrical power for the user.

Reviewer 4:
The reviewer found that this project supports the overall DOE objectives of petroleum displacement well. According to the reviewer, the project is an excellent example of how we could reduce the fuel consumption of vehicles, light, heavy and military, by harvesting energy through waste heat recovery and direct energy conversion. The reviewer highly recommended that DOE should have more projects like this one because every watt of electrical power that can be harvested could save many problems due to shortage or high cost of fuel/energy supply.

Reviewer 5:
The reviewer noted that the 5% goal appeared to be very challenging. The reviewer recommended that DOE should really make sure that this goal is achieved.

Reviewer 6:
The reviewer confirmed that certainly, a project of this type will be consistent with DOE's overall objective of petroleum displacement if successful. This reviewer's concern is that the ingredients toward reaching DOE's targeted efficiency are not in focus. The PIs target a value of 5% for a FE improvement, apparently as a DOE specification. It is important that the PIs be clear about what the project team is shooting for. The reviewer did not observe in the presentation a justification for the 5% target. The reviewer asked if the PIs believe that the 5% target can be reached, and if not, what the project team is working towards. The reviewer strongly encouraged the PIs to scope out the performance limits before proceeding too far, and then craft the individual elements so they are consistent with those limits. The reviewer commented that 5% may not be the right limit, or even theoretically unattainable. The reviewer remarked that unless it can be proven that the 5% target is rooted in sound scientific bases given the complexity of a vehicle, the individual components of the project (materials development, synthesis, TEG design, heat exchanger development, modeling, etc.) may not be appropriate. The reviewer asked if this stellar PI team believed that 5% was achievable. If so, the reviewer asked what targets in the individual tasks need to be reached. According to the reviewer, the answer should be considered an essential element of the project team's research plan going forward.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

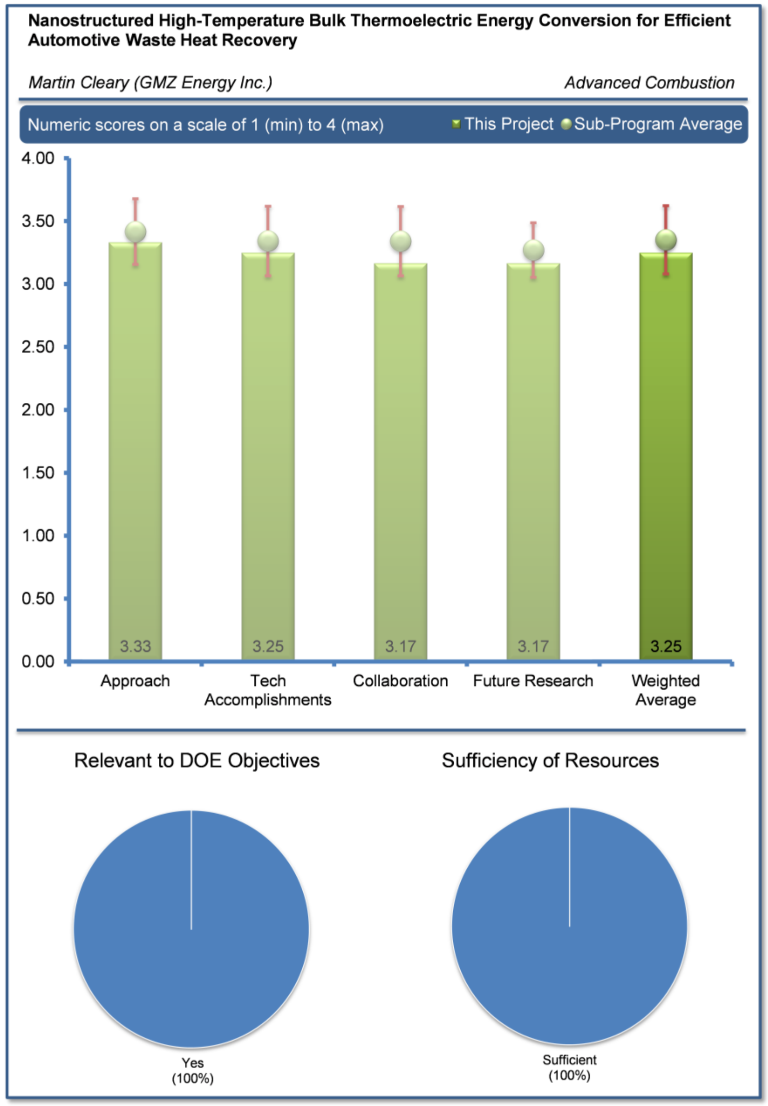
Reviewer 1:
The reviewer commented that resources for the project to achieve the stated milestones in a timely fashion are sufficient. The reviewer recommended that this project continued to be funded so that the mission in reduction of fuel consumption can be achieved.

Reviewer 2:
The reviewer said that the project plan was well aligned with resources.

Reviewer 3:
The reviewer commented that the budget seemed high though understandable given the very large team. According to the reviewer, the problem here is that the link to FE is weak, and the PIs did not make much effort to establish it for the individual subtasks the project

team is pursuing. It seemed to the reviewer that much of the work could be reduced or eliminated, but still provide value to the overarching project goal by making the link to FE. For example, if the materials effort were eliminated and a model there would still be significant value to the work. The reviewer concluded that as it stands, the value is much weaker the way the project is developed.

Nanostructured High-Temperature Bulk Thermoelectric Energy Conversion for Efficient Automotive Waste Heat Recovery: Martin Cleary (GMZ Energy Inc.) - ace082



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded that the team had a balanced approach to develop the TEG. The materials selections and the efforts to reduce the cost while maintaining the performance directly addressed the barriers.

Reviewer 2:

The reviewer concluded that the overall approach was outstanding. The reviewer found that the project is well thought out and comprehensive, yet flexible enough to accommodate learning and changes throughout the project.

Reviewer 3:

The reviewer noted that this project is entering its final year. The reviewer concluded that the project appears to have accomplished the goals/milestones as proposed, and optimization work has been conducted and tested on engines/dynamometer.

Reviewer 4:

The reviewer found that the GMZ team's approach was effective and logical, and contributed to overcoming most barriers. The project team uses nano-structured bulk half-Huesler material instead of skutterudites for high temperature. The reviewer acknowledged that the team clearly presented the reason to use half-Huesler TE material and their TEG design. The reviewer concluded that GMZ has shown in their approach that keeping the cost down is a main objective.

Reviewer 5:

The reviewer described that the goal of this project is to improve fuel efficiency of light duty vehicles by 5%, which the reviewer pointed out is DOE’s goal; TARDEC has a different objective. The project team has identified three broad tasks of scale-up, TEG packaging and durability to that end. The reviewer specified that the team is including tasks associated with materials development, TEG design and integration and vehicle modeling and component integration.

For materials, the PIs choose half-Heusler. The reviewer inquired why this was a better choice than, say, skutterudites. The module design incorporates a hermetically sealed system, which is good. However, the reviewer indicated that the design shown for the automotive TED design seemed quite complicated, if not heavy and potentially very costly. The reviewer inquired about what the PIs project as a cost for the integrated TEG (with cold plates, modules and heat exchangers) that was presented, whether it will be economically effective, and justification for engaging in a detailed investigation of such a design if its cost would be prohibitive. The reviewer commented that this highlighted a concern with the approach that broad targets are used as a basis to motivate the project, but that the individual tasks are not well linked to the broad target. The reviewer offered that perhaps a system level model would provide this link but the presentation did not indicate that.

Reviewer 6:
The reviewer found that GMZ Energy's approach is sound and the barriers appear to have appropriate focus. The reviewer detailed that GMZ's work is focused on two different set of tasks (i.e., those for the DOE, and those for TARDEC). Both applications are being addressed by the half-Heusler modules, which have less TE performance, but far superior mechanical and lifetime expectations. The reviewer suggested that more discussion about the modules would be helpful, but given the time constraints and the public forum, lack of complete transparency is understandable. The reviewer sought clarification about whether the modules are backfilled, and whether the sidewalls of the half-Heusler legs are protected against oxidation/sublimation. The reviewer would like to know what the lifetime of the assembled modules is, and how frequent are device failures. The reviewer asked if the GMZ system is installed on a vehicle, and there is a failure, is the system modular enough to accept a drop-in replacement, or is the system is so hard-wired that an entire new system is needed. The reviewer pointed out the ruggedized requirements from TARDEC, and asked whether the TEG is going to able to withstand impulse forces that might be experienced in combat.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer acknowledged that up to this point, the GMZ team is making good progress and accomplishing many technical objectives, such as low cost half-Heusler material synthesis, vehicle modeling using AUTONOMIE vehicle modeling platform, TE module performance evaluation, thermal cycling and vibration testing, etc. The reviewer concluded that the project is on schedule.

Reviewer 2:
The reviewer observed that a 200 Watt TEG had been successfully fabricated, and that a 1-kilowatt (kW) unit was being developed.

Reviewer 3:
The reviewer observed that GMZ has chosen a different TE material than most others and justified their decision. The reviewer found that the project team was progressing well though initial design and testing and on track for vehicle demonstration. The reviewer observed that component level reliability testing was more comprehensive than others.

Reviewer 4:
The reviewer found that the use of half-Heusler and the module development had been well planned. However, the reviewer expressed concern that the module performance testing seemed to lack confirmation. The reviewer pointed out that vehicle testing and especially system/device level modeling seemed to have started late in the project.

Reviewer 5:
The reviewer observed that the GMZ work began with both bismuth telluride modules and half-Heusler modules. The reviewer would like to know if an explanation can be given for why the bismuth telluride technology seems to have been dropped. The reviewer acknowledged that without the bismuth telluride lower-temperature stages, there will be a performance penalty, but would like to know what the difference is. The reviewer believed that the he materials work on the half-Heusler materials appeared to be matured, and would like to know if this was true, or whether there was more materials development ongoing.

Reviewer 6:
The reviewer found that the team has pursued activities, and made progress, in materials development and production, TEG design and module reliability, and vehicle modeling. The reviewer described that as to measuring this progress against performance indicators, especially the project team's link to the overall goal of a 5% FE improvement, the accomplishments are weaker. The reviewer expressed concern that there did not seem to be a quantifiable link between the specific work carried out over the past year and how results from that work puts the team quantifiably close to the FE target. The reviewer said that to an extent, the results reported seem removed from

fuel efficiency because the PIs did not establish it clearly. The reviewer wondered, for example, regarding the influence of packing fraction, power dissipated and the optimized fin design, what is the precise link of the optimized fin geometry to fuel efficiency. Obviously, this is a complicated question that requires linking all of the sub-system elements to engine load. The reviewer observed that the PIs have not endeavored to address it. The reviewer concluded that, as such, when the accomplishments are viewed against the overarching goal realizing a certain target (in this case 5%) FE improvement, the accomplishments are lacking.

The reviewer noted that the PI reports an "advanced assessment analysis" was carried out. This is an important effort though it was unclear what was involved with it. The reviewer also noted that the PIs reported a cost for the half-Heusler compositions being investigated, which seems to have been taken from a U.S. Geological Survey data. The reviewer wondered if this was the extent of the cost analysis. Also, TEG design appeared to be quite complex as evidenced by the photograph of the assembled TEG shown. The reviewer recommended that the PIs need to indicate the expected cost of this design. Of greater concern for this reviewer could be the tolerances in assembly, especially interface resistance. The reviewer concluded that this matter did not seem to have been addressed in the work presented.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer remarked that the GMZ team appeared to have organized a highly competent and talented group that was well-suited to make continued progress.

Reviewer 2:
The reviewer found that the project team consisted of a good mix of universities, engineering consultants, Tier 1 suppliers and an OEM.

Reviewer 3:
The reviewer remarked that GMZ had demonstrated an ability to work well with collaborators and utilize collaborators' expertise effectively. Because Honda was a collaborator, the reviewer hoped the technology would be commercialized faster for passenger vehicles. The reviewer noted that the transition of a TEG system to the U.S. Army for use on Bradley Fighting Vehicles was also an excellent application within TARDEC's program.

Reviewer 4:
The reviewer observed that added efforts from Honda helps.

Reviewer 5:
The reviewer detailed that this project is collaboration among eight institutions, and GMZ is the lead. The reviewer commented that some of the work assigned to the team members seems to be a bit overlapping. The reviewer pointed out that GMZ, Bosch and Houston are indicated as working on materials. For the reviewer, the differences among these groups and how the results are coordinated was not clear. The PIs indicated that Bosch had reduced their work, or possibly dropped out, with AVL apparently taking over as a replacement for Bosch. The reviewer requested that some clarification on what motivated Bosch to drop out should be provided. The reviewer noted that the oral presentation gave a quite different picture of Bosch's involvement. The reviewer observed that other elements seem to be in some flux, for example GMZ's need for a partner to work on the direct current (DC)-DC converter.

Reviewer 6:
The reviewer remarked that as a materials and TEG developer, this team seems to be weaker on the role of vehicle makers. There is a lack of details and planning on actual vehicle integration and involvement of the company.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer concluded that the team should really get the 5% FE improvement in its last project year.

Reviewer 2:
The reviewer commented that the future plan was very good and the team appeared to be on track to complete the planned tasks.

Reviewer 3:
The reviewer found that future work was well balanced between addressing outstanding risk issues and demonstrating performance.

Reviewer 4:
The reviewer remarked that the proposed future research was technically sound and clear with the prospect that there are still challenges for the project, especially when it reaches the point of mass production for commercialization. The project team's proposed tasks, as shown in the presentation, are to continue working on materials, device and module, subsystem and vehicle systems. The reviewer concluded that the degree to which the project had been planned was effective and mitigates risk.

Reviewer 5:
The reviewer acknowledged that the future work planned for DOE seemed considered and thoughtful. However, the reviewer found that there was not really a description of the future work planned for TARDEC, and what the TARDEC needs are.

Reviewer 6:
The reviewer commented that future work includes tasks associated with the broad categories currently part of the work presented in the 2014 review (i.e., materials, modules, heat exchanger design, and vehicle system integration). As this reviewer had noted elsewhere in this review, it was not evident what the specific targets for these sub-tasks are and how success in these efforts would realize the overall objective of a 5% FE improvement.

The reviewer stated that as noted last year, 5% did not seem to be achievable for the US06 cycle based on what GMZ reported last year. The reviewer noted that GMZ established targets in last year's presentation of between 3% and 4%. The reviewer would like to know why the project team sticks to 5% now. The reviewer strongly recommended that the PIs put more effort into quantifying the actual benchmark efficiency target in the remaining period of their effort, and work toward those targets before using more DOE funds to develop what may not be achievable. The reviewer offered that this could be accomplished by expanding the system model to identify all parasitics that contribute to degraded performance (and, thus, would be appropriate to invest with more research efforts to improve), and then identifying from this model how improving materials, interfaces, heat exchanger design, etc., would contribute to efficiency target. Alternatively (or in parallel), the reviewer suggested more vehicle testing of the type reported last year could be useful to establish guidelines on realistic FE targets for a waste heat recovery technology (TE or any other technology for that matter) could realize.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that waste heat was a major loss in efficiency for any petroleum fueled system and TE was one potential method to reduce these losses.

Reviewer 2:
The reviewer found that TEG development, especially using an alternative TE material, was important. With the predicted 3% FE improvement, the TEG was going to be a part of the solution to achieve DOE's petroleum displacement objectives.

Reviewer 3:
The reviewer found that the GMZ work would result in reduced fuel consumption and improved fuel utilization both for civilian applications as well as military (TARDEC) applications.

Reviewer 4:
The reviewer commented that this project supported the overall DOE objectives of petroleum displacement well. It is an excellent example of how we could reduce the fuel consumption of vehicles, light, heavy and military, by harvesting energy through waste heat recovery and direct energy conversion. This reviewer strongly recommended that DOE have more projects like this one because every watt of electrical power that can be harvested could save many problems due to shortage or high cost of fuel/energy supply.

Reviewer 5:

The reviewer offered that this project, indeed any project, would be consistent with DOE's objective if it realized a reduction of petroleum use. The reviewer summarized that the PIs' approach here is to use TEG modules with half-Heusler materials to recover waste heat from the exhaust stream. The result of this effort would presumably alleviate the electrical requirements that normally would be derived from an alternator, lighten the load on the crankshaft and thereby improve FE.

The reviewer summarized that the presentation noted the DOE objective of a 5% FE improvement as a goal in the work (the project team also noted the TARDEC relevance of developing a 1kW TEG for a Bradley Fighting Vehicle; this component is not specifically evaluated in this review though the tasks to achieving it are undoubtedly folded into the work related to the DOE objectives). As the reviewer previously noted, GMZ's 2013 presentation appeared to call into question the relevance of the 5% target, though the project team continues to use 5%. The reviewer commented that some clarification is needed. This target would be very specific to the drive cycle and specific model used. It seemed to the reviewer that, based on last year's presentation, a more target would be between 3% and 4%. The reviewer found that it was unclear why the project team would work towards a target that past work suggests may not be achievable.

The reviewer observed that the presentation also noted relevance in terms of materials, production of TE modules, reliability, finalizing the design, and vehicle modeling and testing. The precise connection between these activities and the efficiency target was cast only in the broadest terms. The reviewer said that this is likely the result of not quantifying or knowing how all the ingredients to a successful TE integration into an automobile would combine to influence efficiency. All of the following will have an impact: materials; TEG design; interfaces; heat exchanger and flow configuration; and temperature. The reviewer concluded that without a good handle on how the broad tasks will impact efficiency, it is unclear how specific goals or targets for the individual tasks are realistic or well thought out.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found that resources were well matched to the project plan and goals.

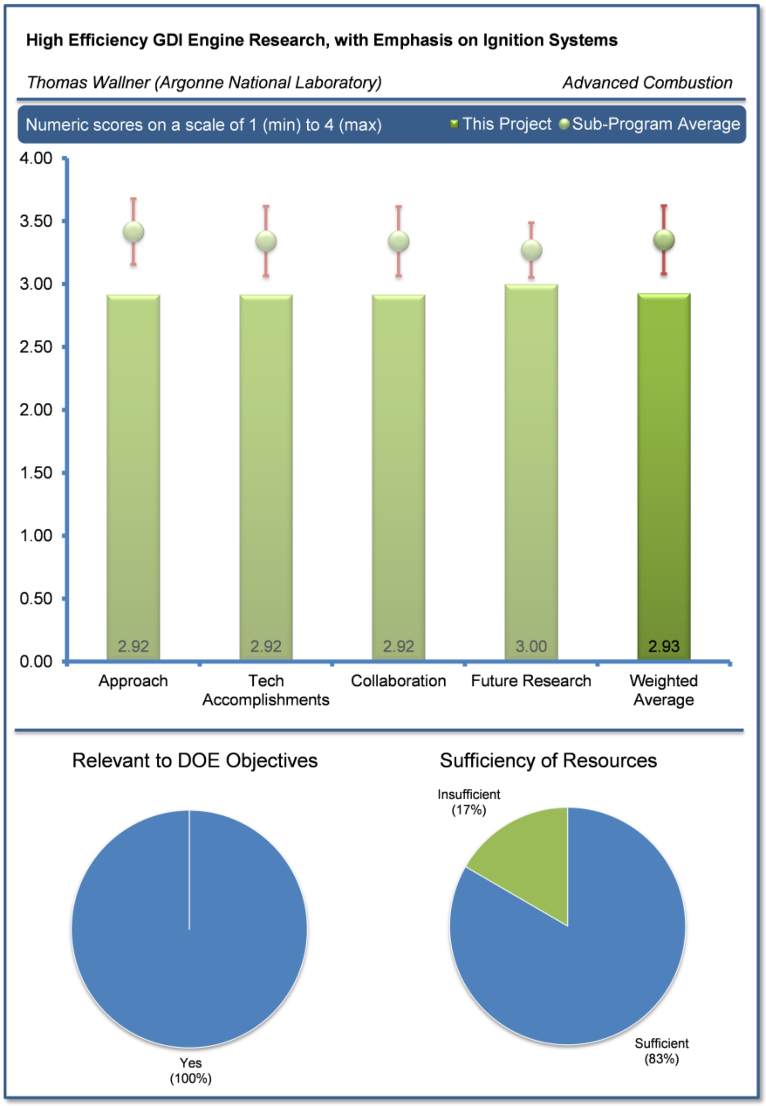
Reviewer 2:

The reviewer commented that the resources for the project to achieve the stated milestones in a timely fashion were sufficient. The reviewer recommended that this project continue to be funded so that the mission in reduction of fuel consumption can be achieved.

Reviewer 3:

The reviewer found that the budget was in line with other projects of this type. The reviewer was worried that the target FE goal may not be achievable. The reviewer suggested that more effort should be put into those aspects of the project that will help better specify what the PIs should be working toward than to simply continue on the current path. The reviewer thought that this can, at least over the next year, be done at a much reduced level compared to the 2013 expenditures by some vehicle testing along the lines of what was reported last year.

High Efficiency GDI Engine Research, with Emphasis on Ignition Systems: Thomas Wallner (Argonne National Laboratory) - ace084



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the experimental methods are creatively designed to address the critical barriers to dilute combustion. The modeling and experimental program has suitable objectives, enhancing the probability of success.

Reviewer 2:

The reviewer commented that the approach of coupling single cylinder engine test results with 3D CFD modelling is useful.

Reviewer 3:

The reviewer said that the ignition function is critical, and careful experiments and modeling will be very useful. The reviewer found that the plan to identify what features are critical and how these features interact with engine flows is very useful.

Reviewer 4:

The reviewer detailed that the PIs were using a RANS approach to correlate to cycle-to-cycle variability. This approach in CFD has been of debate in the recent literature. The reviewer would like to know if the PIs considered running an LES computation to test if the conclusions hold true.

Reviewer 5:

The reviewer summarized that the project seeks to provide robust lean-burn and EGR-diluted combustion technology and controls, relevant to boosting and downsizing engines. The project seeks to overcome limited lean and EGR-diluted operating range, lack of ignition systems for lean/dilute combustion, and absence of robust modeling tools. The reviewer suggested that the roadmap, including targets and specific milestones, may be better laid out. The reviewer expressed concern that there is a sense the project is improvising as it moves ahead. This could be better represented.

Reviewer 6:

The reviewer cautioned that there seemed to be duplication of effort between this work and ace006 by Isaac Ekoto in SNL. Both were proposing to evaluate advanced ignition systems. The reviewer detailed that this work only involved a metal engine and no optical diagnostics. The reviewer also observed that a RANS model was being used to predict cyclic variability, which may not have the necessary physics. The reviewer asked why the project is not using an LES model.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer complimented that the technical accomplishments, though incomplete, were poised to provide very useful insight into the fundamental causes of combustion instability and variability that are the chief barrier to highly-efficient dilute combustion.

Reviewer 2:
The reviewer found good progress on meeting milestones. The reviewer commented that results from analysis of cyclic variability had led to evaluation of alternative ignition concepts.

Reviewer 3:
The reviewer commented that so far, the project team had a good experimental base. The addition of optical access will be very helpful.

Reviewer 4:
The reviewer remarked that the work seemed to be progressing well, status shows it has upgraded to spray-guided DI configuration, it has completing ranking of ignition systems, performed cyclic variability study with dilute operation, evaluated various advanced spark-based ignition systems, and have begun to meet with SNL to coordinate collaboration on ignition system projects.

The reviewer suggested that cyclic variability study and the correlation between efficiency and COV, especially the mechanism for introducing the perturbation, may need to be explained better. The reviewer also suggested that authors may need to tie in the overall goals with the specific work performed, which will require maintaining visibility on the performance targets sought for the improved performance.

Reviewer 5:
The reviewer detailed that the PIs were correlating COV of indicated mean effective pressure IMEP with variation in pressure traces for 10 cycles. To better understand these results, the reviewer would like a better understanding if the predictions are an artifact of the physics or the numerical setup. The reviewer asked do these conclusions continue to hold true with greater than 10 cycles. The reviewer offered as an example, if the PIs removed the first 10 cycles, would the same conclusions be drawn when sampling cycles 10-20. The reviewer would like to know what flow boundary conditions are being used, and whether the PIs are actually modeling the flow through the intake manifold or simply specifying constant conditions at the port entrance. The reviewer asked how sensitive the computations for a given set of boundary conditions were and small perturbation to the ignition model. The reviewer would like to know how many engine cycles were used for the experimental data shown in Slide 7 and Slide 10.

Reviewer 6:
The reviewer commented that the spark duration results shown with the Altronic Ignition system seem low with respect to industry standard. The reviewer pointed out that both the single as well as the multi spark durations are in the range 0.4 to 1.2 ms. The reviewer noted that typical automotive production ignition systems result in about 1.0 to 2.0 ms for the secondary arc duration. This parameter may have a very strong influence on the dilution tolerance. The reviewer expressed surprise that doubling the ignition energy did not have much of an effect in decreasing COV in the 0% to 20% range. Data should be taken at smaller increments beyond 20% EGR to properly assess ignition system differences, and not just base it on one point at an EGR of 27%. The reviewer said that the induced ignition and injection perturbation experiments can be mined further by plotting results as a function of ignition delay (0% to 10% mbf) and also plotting just the -1 deg. and the +1 deg. data. The reviewer would like to know what new knowledge this work contributes. The reviewer observed that these kinds of studies were conducted by industry 20 years ago and effects are well understood.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed good project team collaboration, and remarked that the optical engine work will be very important.

Reviewer 2:

The reviewer observed that collaborations were mainly with the U.S. DRIVE ACEC Tech Team, several ignition system developers, and one other national laboratory.

Reviewer 3:

The reviewer commented that the partnerships appeared to be appropriate for the present project objectives, but ultimately closer collaboration with industry will be needed to transfer the understanding gained toward commercial LD engines.

Reviewer 4:

The reviewer suggested that the team could be revised to include various suppliers in the ignition area, and that the presentation mentioned that there is an effort in this direction.

Reviewer 5:

The reviewer would like to know how this project work correlated with the advanced ignition studies being proposed at SNL by Ekoto and Sjoberg.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer complimented that this proposed future research seemed like an excellent plan. The corona ignition and the optical work are of great interest.

Reviewer 2:

The reviewer commented that the proposed future work would address a critical barrier for an important LD engine technology. The potential impact is high.

Reviewer 3:

The reviewer found that project plans seemed reasonable to continue program progress.

Reviewer 4:

The reviewer summarized that the project proposes to continue to determine applicability of RANS-based 3D simulation approach for flame propagation and combustion stability under dilute (lean/EGR) operating conditions and finalize assessment of laser ignition potential. The reviewer suggested that authors need to tie in the overall goals with the specific work performed, which will require maintaining visibility on the performance targets sought for the improved performance.

Reviewer 5:

The reviewer suggested that the PIs consider running additional cycles to test their modeling approach.

Reviewer 6:

The reviewer expressed concern that the laser ignition data provided was very scant. More data and understanding of ignition with the free-air laser should be provided (e.g., how did the system respond to laser output energy). The reviewer suggested that the actual nature of the laser beam and its location in the cylinder should be provided. The reviewer commented that achieving a 20% EGR tolerance is nothing noteworthy. The reviewer would like to know what the plans are to achieve 30% EGR tolerance and with what kind of an ignition system.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked that boosted EGR engines were critical for manufacturers to achieve future efficiency goals cost-effectively, and this work may significantly impact the technology.

Reviewer 2:
The reviewer stated that the project had very relevant for dilute combustion SI engines, which may be the mainline engines of the future.

Reviewer 3:
The reviewer stated that exploring engine concepts such as lean, boosted GDI that can potentially improve FE and reduce emissions is consistent with DOE objectives.

Reviewer 4:
The reviewer remarked that advanced ignition is a key to igniting lean, highly dilute mixtures.

Reviewer 5:
The reviewer commented that the project promotes improved tools that will help in the overall fuel efficiency roadmap. Dilute combustion in SI engines offers the potential for decreasing petroleum consumption.

Reviewer 6:
The reviewer found the project to be relevant, but the impact this project might have was going to be very minimal.

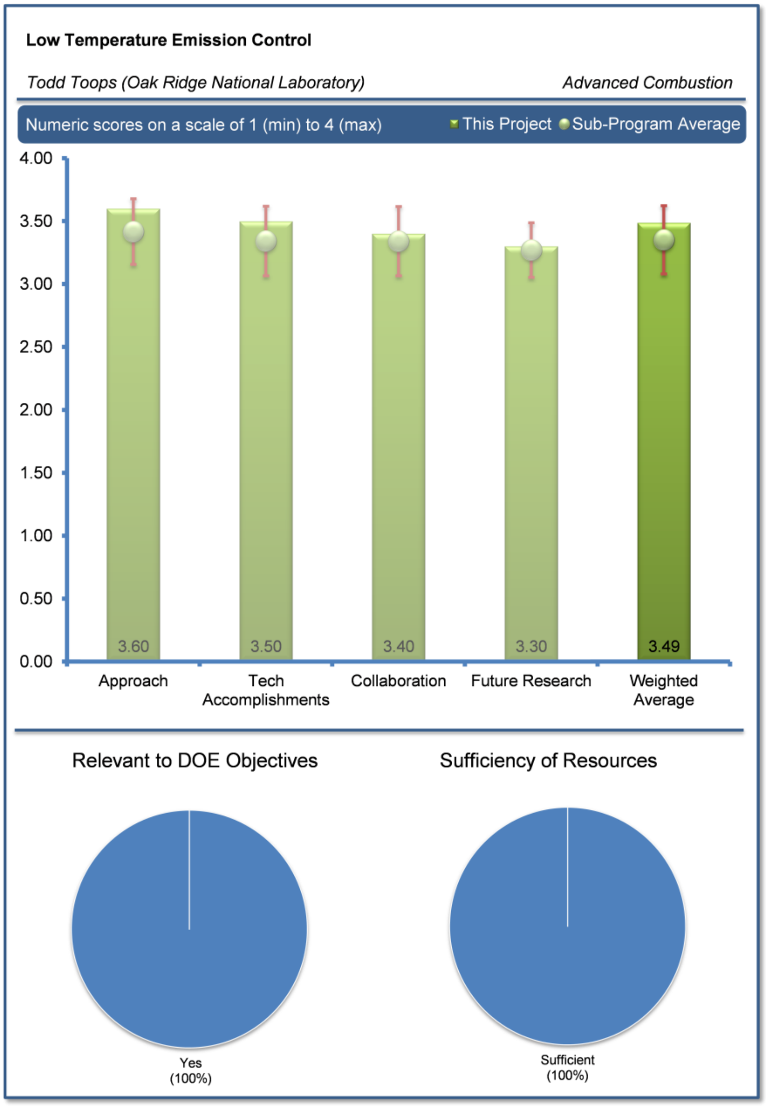
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that greater resources were needed to accelerate development in this project area, to maintain pace with industry efforts.

Reviewer 2:
The reviewer said that the resources seemed sufficient, but the project may need more if the optical work has to be paid from this budget.

Reviewer 3:
The reviewer remarked that the project’s resources were sufficient.

Low Temperature Emission Control: Todd Toops (Oak Ridge National Laboratory) - ace085



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the range of materials and range of techniques used is excellent.

Reviewer 2:

The reviewer found that the project has a fair approach to characterizing what needs to be done. Considering that this project is mostly about catalyst development and investigation, is the reviewer said it was good to see PNNL is on-board to capitalize on their strengths and know-how in this regard.

Reviewer 3:

The reviewer found that in general, this was a very good approach and consistent with the ACEC roadmaps for uncovering new materials that function at 150°C. However, according to this reviewer, demonstrating the performance of the novel materials under more realistic conditions earlier in the discovery process would minimize the amount of time characterizing a formulation that will not function in vehicle exhaust.

Reviewer 4:

The reviewer detailed that the project was investigating catalysts with good CO conversion without interference from HC or NO_x was a good first step toward developing catalysts that also light-off at low temperatures for HC and NO_x, as the exothermic release from CO oxidation provides extra heat for the HC and NO_x conversion. The reviewer commented that the project was investigating the individual and combined effects of HC and NO_x on CO light-off on Slide 13 is a great approach. The reviewer added that investigating the thermal durability of the new catalysts would be critical. The reviewer clarified that if the catalyst was intended for gasoline engines, the durability needed to be assessed under lean, stoichiometric, and rich conditions.

Reviewer 5:

This project is one of the efforts that harmonizes low-temperature combustion technologies. This is the second year since this project was migrated from the basic energy science (BES) side of program; however, according to the reviewer it still has not addressed potential challenges enough to be considered for the real-world application, such as sulfur poisoning and thermal stability.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer found that the results from the new co-precipitated CuO_x, CoOy, and CeO_2 (CCC) catalyst formulation and on CeO_2-Zr O_2 formulation appeared interesting.

Reviewer 2:
The reviewer observed very novel approaches to developing new materials. Sulfur and HC tolerance should be demonstrated early in the selection process. The reviewer pointed out that thermal durability was also a major concern that was being investigated. According to the reviewer, low temperature activity is essential for new combustion approaches.

Reviewer 3:
The reviewer observed the project team’s great progress in developing non-PGM catalysts including the Au/Cu catalyst and CCC catalyst. The reviewer also observed good work on washcoat modifications with zirconium (Zr) as well.

Reviewer 4:
This reviewer opined that advances in finding ways of improving low temperature performance are broad, and suggested that even more effort in aging and response to poisons would be useful.

Reviewer 5:
The reviewer said the project has screened many materials; however, the project needs a more systematic approach to look into new materials with some rationale behind.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that incorporating a supplier to provide guidance and advice was essential for these materials. The reviewer observed a good use of supplier and other resources in this project. The reviewer also thought the CLEERS connection is a benefit.

Reviewer 2:
The reviewer observed that the project had active collaboration with BES researchers, CLEERS, USCAR and U.S. DRIVE.

Reviewer 3:
The reviewer observed project team’s good collaboration with Johnson Matthey and University of Tennessee.

Reviewer 4:
The reviewer noted that the team included collaborators from two universities, PNNL, Johnson Matthey, and BES. The reviewer commented that collaboration did not however seem to include a strong role from Johnson Matthey, and the reviewer did not know exactly how the outcome was to be shared with other catalyst outlets on a pre-competitive basis.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer affirmed that the proposed future work was clear and consistent with the remaining challenges and the overall target path.

Reviewer 2:
The reviewer observed that the proposed future research was a fairly sound technical path forward.

Reviewer 3:
The reviewer thought the project needed a more systematic plan and deliverables.

Reviewer 4:
The reviewer commented that for catalysts planned for gasoline applications, the project needs to assess the effect of high temperature rich operation on the catalyst. The reviewer noted that some catalysts look good after lean aging but degrade after rich aging (e.g., SCR catalysts).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said improved combustion systems that reduce fuel consumption will produce lower exhaust temperatures. The reviewer affirmed that this low-temperature catalyst project would be extremely important to enable such improved combustion systems.

Reviewer 2:
This reviewer commented that improvements in this temperature range are very helpful.

Reviewer 3:
The reviewer said that this project supported USCAR/U.S. DRIVE initiatives to address the need for low temperature aftertreatment to produce viable solutions for emerging, higher efficiency combustion strategies.

Reviewer 4:
The reviewer said yes, the project did support overall DOE’s objectives.

Reviewer 5:
The reviewer noted that new combustion strategies produce higher FE while also driving exhaust temperature lower. Hence, synergistically this project supports DOE's charter.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

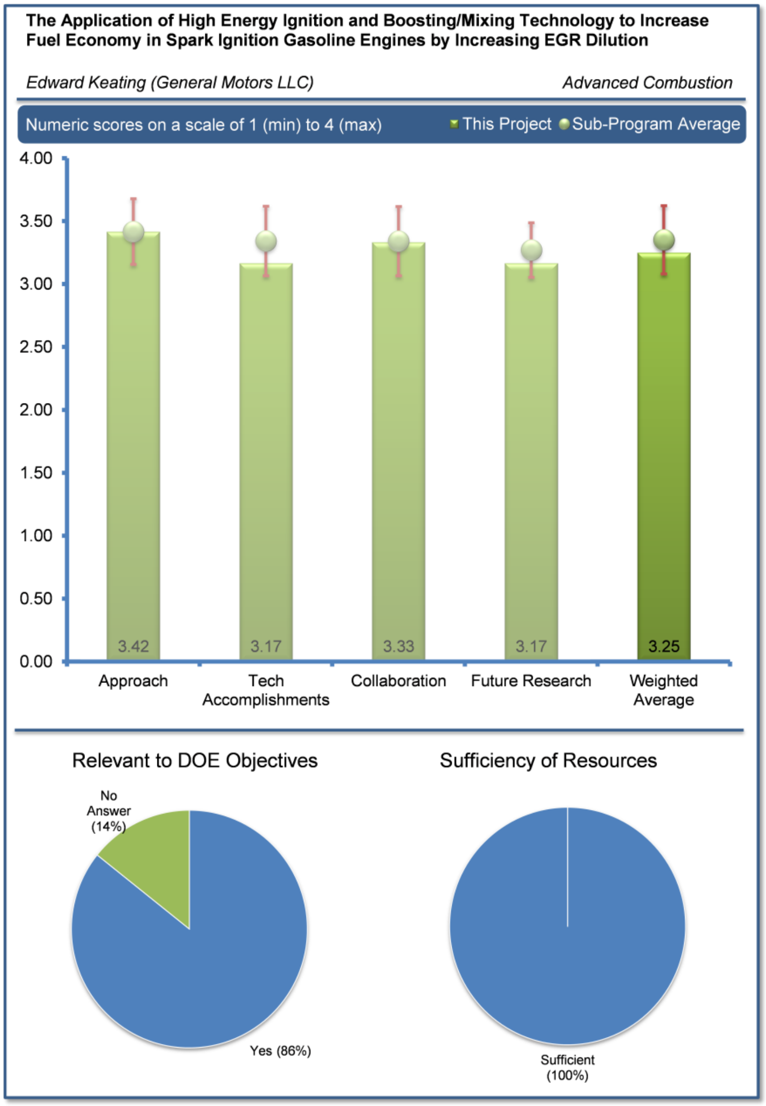
Reviewer 1:
The reviewer concluded that this project was appropriately funded and staffed with researchers with the required knowledge base.

Reviewer 2:
The reviewer said that the funding seemed sufficient for the project.

Reviewer 3:
The reviewer found that the funding level and resources applied to this project were consistent.

Reviewer 4:
The reviewer described that the catalyst technology emerging from this project would be an industry game-changer. The reviewer recommended that the project should have integrated major involvement from key catalyst suppliers (in a pre-competitive set-up) and/or a strong integration of a university catalysis R&D in the project (the role of the University of Tennessee is said to be a graduate student, but no explanation was provided on what exactly the graduate student contributed to the project.)

The Application of High Energy Ignition and Boosting/Mixing Technology to Increase Fuel Economy in Spark Ignition Gasoline Engines by Increasing EGR Dilution Capability: Edward Keating (General Motors LLC) - ace086



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that the team's approach was balanced to address the barriers and technical challenges.

Reviewer 2:

The reviewer detailed that the project was looking at all the levers to increase gasoline engine efficiency, and specifically highlighted combustion stability (mixing and hydrogen via D-EGR, spark), thermal losses, and pumping losses. The reviewer noted that much of this work had likely been done by SwRI in the HEDGE consortium, but this group is building on that on a likely future platform base.

The reviewer liked the baseline comparison low pressure loop (LPL) EGR as a real current engine baseline. The reviewer would have liked to see what D-EGR and all the bells and whistles could bring incrementally. The reviewer observed a very impressive approach with much interest.

Reviewer 3:

The reviewer commented that with the push towards engine downsizing, almost all of the companies had adopted the technology mix of turbocharging with increased EGR dilution, improved ignition, and high CR. Moreover, this technology mix offered significant improvements in engine thermal efficiency.

The current project by GM plans to build upon the technologies developed previously under the HEDGE consortium at SwRI. The two new technologies brought to the table in this project in addition to the ones mentioned above are dedicated EGR, and low surface area to volume ratio combustion chamber. While these two technologies introduce novelty, it remains to be seen whether they offer any additional performance improvements without any detrimental implications.

Reviewer 4:

The reviewer remarked nice work to demonstrate an interesting advanced concept and sort out the issues. This reviewer expressed surprise at the low fuel consumption gain target of 12% versus a naturally aspirated (NA) engine base. The reviewer commented that most people say boosted/downsized engines get 15-20%; the reviewer would like to know why this advanced technology gains less. SwRI claims very low BSFC for dedicated EGR.

Reviewer 5:

The reviewer observed an excellent approach to apply HEDGE consortium-developed dedicated EGR cylinder technology to a four cylinder GM engine for potential productive application for full value proposition analysis on midsized vehicle. The reviewer thought that it was good to baseline low-pressure EGR downsized boosted 2.0 liter (L) compared to 2.4L normally aspirated engine. The reviewer noted that the next steps are to test the proposed concept with high energy ignition. The reviewer suggested that a possible improvement is to clarify the performance (power and engine out emissions) target of the R&D engine operating on three power cylinders and one EGR cylinder and how this relates to the vehicle needs and TP emission targets. The reviewer noted that baseline engines are both more powerful than the dedicated EGR engine.

Reviewer 6:

The reviewer said that the project addressed ignition issues and barriers that can enable more advanced combustion techniques, such as higher EGR dilution and/or D-EGR. These ignition technologies should be transferable to other combustion approaches as well. There is some concern about the relative focus between the low-pressure EGR and D-EGR approaches. The reviewer was unclear how the two strategies would be compared.

Reviewer 7:

The reviewer said EGR quality (SwRI) H_2 content produced, HEDGE system, and that all dedicated EGR gets circulated in the intake. The reviewer indicated that VGT is diesel like, and that bypass system designed and implemented during the project.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented project team's solid work toward the objectives.

Reviewer 2:

The reviewer observed a good establishment of baseline and putting in infrastructure. The last year was essentially base-building with no major surprises or developments. The reviewer concluded that the next six months will be very interesting.

Reviewer 3:

The reviewer said that the GM team has determined a well thought-out plan of execution for the project. The project team has performed 1D modeling of the system in Phase 2 that was followed by dynamometer testing of the engine to establish a baseline in Phase 3. In Phase 4 the project team plans to build and test an engine equipped with D-EGR and low S/V ratio combustion chambers. The reviewer requested that the project team please correct the heading in Slides 3 and 4 from "RELEVENCE" to "RELEVANCE".

Reviewer 4:

The reviewer noted good progress to prepare state of the art baseline data and modeling data. The reviewer observed that the dedicated EGR engine test data was not available after two years of project and 60% of budget is getting tight. Especially emissions issues can present significant challenges and dedicated EGR engine emissions may be difficult to manage particularly on cold start. The reviewer noted that dilution bypass was an interesting approach with some very good possibilities to enhance catalyst light-off if managed well. The EGR cylinder can provide excess O_2 to and heat to light-off the catalyst more quickly. The reviewer said that other schemes may be possible such as cylinder deactivation on the EGR cylinder.

Reviewer 5:

The reviewer said that the technical accomplishments were impressive. The reviewer noted that there seems to be lack of plan to address the role of various models and designs of vehicles. The reviewer noted that EGR performance was a system issue, and improvement in one specific vehicle may not directly translate to other vehicles. The reviewer recommended that the limitation needs to be addressed.

Reviewer 6:

The reviewer said that good progress was made on the engine design and build. A modest improvement in FE was demonstrated with the low-pressure EGR approach. The reviewer noted that a major limitation with the project was the lack of information on the D-EGR approach. A lot of the D-EGR research was performed under a SwRI consortium (HEDGE) that is not public, but this project is public. The reviewer suggested that it would be better if this project produced publications on the activities related to D-EGR because this is a public project (no publications or presentations listed to date for the project).

Reviewer 7:

The reviewer commented low-pressure EGR loop added in Phase three, and a 3.2% improvement to baseline FE but performance not equal. The reviewer noted two spark plugs per cylinder. The reviewer described the EGR bypass valve as "innovative."

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that SwRI was the lead organization on the base approach–dilution of SI engines with EGR and all the auxiliaries. The reviewer complimented that having SwRI as an engaged partner with a leading OEM on combustion will ensure success. The reviewer cannot recommend any additional collaboration.

Reviewer 2:

The reviewer noted that GM has partnered with SwRI, who bring to the table expertise gained through previous HEDGE consortium efforts.

Reviewer 3:

The reviewer observed project team’s close relations with SwRI to take advantage of their prior work.

Reviewer 4:

The reviewer said that the project’s necessary partners are engaged and seemed to be working well.

Reviewer 5:

The reviewer said that the project’s role of the sole collaborator is clear.

Reviewer 6:

The reviewer observed that the project team had only SwRI as a partner.

Reviewer 7:

The reviewer acknowledged the project team’s collaboration with SwRI, but said no university or national laboratory collaborations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer found that the plan looked excellent. The reviewer noted that the rubber hits the road this year, and observed the following approach to be very logical: run the engine; analyze the results; fix the deficiencies; and repeat.

Reviewer 2:

The reviewer observed a solid plan for future research.

Reviewer 3:

The reviewer noted that the project’s future work will focus on D-EGR approach.

Reviewer 4:

The reviewer commented that the project was on track to complete the planned tasks.

Reviewer 5:
The reviewer commented that a four-valve single plug is the path of the future, and low pressure EGR loop added.

Reviewer 6:
The reviewer remarked that some additional projections of power and emissions from modeling may improve forward of barriers and directions for future work. The reviewer suggested that exhaust aftertreatment possibilities should be outlined based on projections from modeling, planned control schemes and the HEDGE data.

Reviewer 7:
The reviewer commented that D-EGR appeared to be a technology that introduces new challenges for engine control across all speed-load conditions. The current method of using an 11-point steady-state operation as the test matrix might hide the technical challenges that one would face in transient operation of the engine. The reviewer said that it might be well worth the effort to finally demonstrate the operation of the engine using one of the transient cycles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that the project aims to achieve 12% fuel efficiency improvement while meeting the EPA emission regulations. The reviewer acknowledged that the project is already through Phase-1 work, and the GM team has demonstrated an approximately 3% FE improvement. According to the reviewer, should the technology mix to be tested in latter phases result in further FE improvements, the project team could significantly reduce the nation’s petroleum fuel consumption. The reviewer noted that an added benefit is reduced GHG emissions.

Reviewer 2:
The reviewer said that this project’s technology may enable significant FE gain.

Reviewer 3:
The reviewer commented that potential OEM production pathway for HEDGE Consortium dedicated EGR concept being evaluated for performance and value for potential savings of 12% FE.

Reviewer 4:
The reviewer confirmed that improvement in FE through new EGR design will have direct impact on DOE's petroleum displacement objectives.

Reviewer 5:
The reviewer found that this project supported the petroleum displacement goals of DOE and specifically that this project addressed barriers associated with more fuel efficient engines that utilize dilute gasoline combustion.

Reviewer 6:
The reviewer commented that diluted charges enabled highly-efficient gasoline engines. High energy ignition is a leading approach to enable these engines. The reviewer said that compression ignition was another way, and both need to be evaluated.

Reviewer 7:
The reviewer said that global barriers were not identified by the project team.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

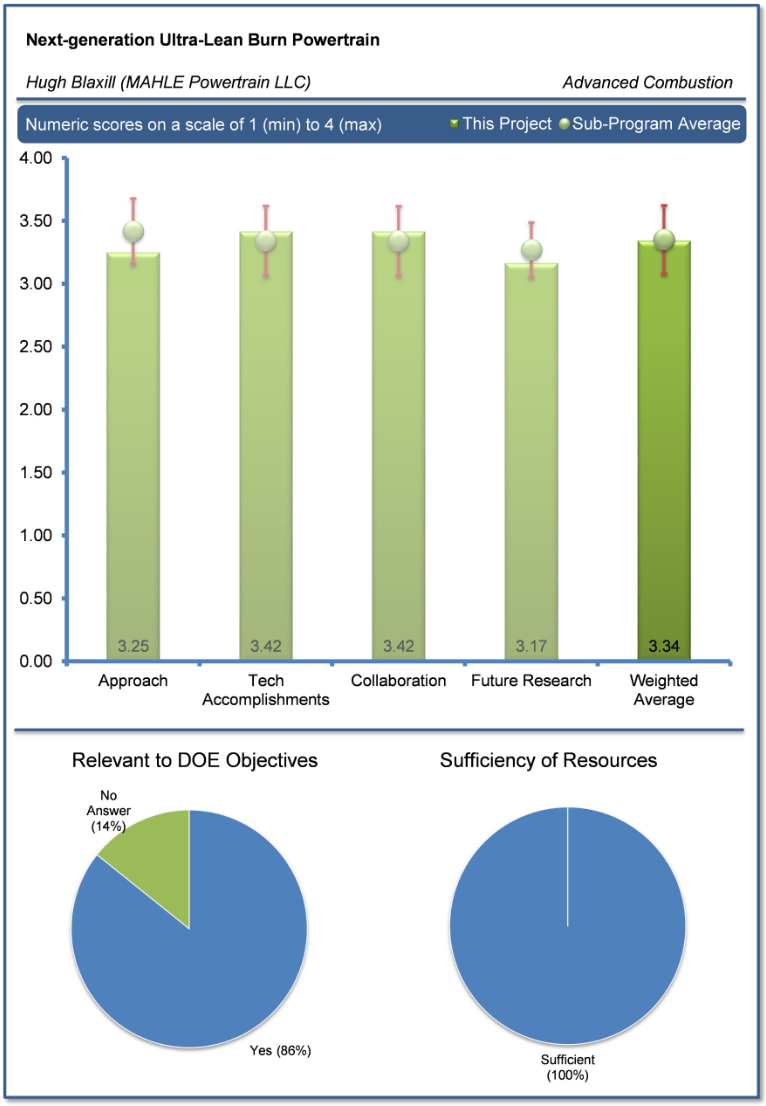
Reviewer 1:
The reviewer said that project’s resources seemed to be appropriate to the work level.

Reviewer 2:
The reviewer found that it looked like there was plenty of money left for the project team to run and optimize the engine.

Reviewer 3:

The reviewer concluded that project team’s allocated funds are sufficient, and recommended inclusion of a transient engine test.

Next-generation Ultra-Lean Burn Powertrain: Hugh Blaxill (MAHLE Powertrain LLC) - ace087



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer detailed that Mahle proposes to develop a fueled pre-chamber sparkplug that can serve as an improved igniter under ultra-lean engine operational conditions. This in turn will significantly improve the engine efficiency and further reduce the aftertreatment burden to reduce emissions.

Reviewer 2:

The reviewer said that the approach was impressive, and that early publications looked quite optimistic. The reviewer was delighted to see this work progress, and commented that the technical plan looked good. The reviewer noted a nice mix of single cylinder, simulation, multi-cylinder, and simulation.

Reviewer 3:

The reviewer found that the team had a balanced approach to addresses the technical barriers and challenges.

Reviewer 4:

The reviewer detailed that PFI was the main fueling mechanism, and that design optimization was in Phase 1, and that Phase 2 is design validation with 3D simulations.

Reviewer 5:

This reviewer expressed skepticism about pre-chamber designs because they tend to increase heat transfer losses and require an internal pumping work. The reviewer commented that perhaps the analysis would show how these issues could be overcome.

Reviewer 6:

The reviewer acknowledged that the goals were appropriate, and noted the following: achieve 45% thermal efficiency with comparable or lower emissions on a light-duty SI engine; achieve 30% drive cycle FE improvement over comparable gasoline engine on a light-duty SI engine; and achieve a cost effective system with minimal changes to existing engine. The reviewer observed that the testing approach was good and typically employed for effective combustion projects (i.e., optical engine, single cylinder metal engine, simulations, multi-cylinder engine, and mini-map to project cycle efficiency and emissions). The reviewer found that the technology approach (turbulent jet ignition [TJI]) shows good initial promise to achieve goals.

Reviewer 7:

The reviewer noted that this project addressed barriers associated with enabling lean gasoline combustion. The project addresses ignition and emissions aspects of lean gasoline. The reviewer remarked that the approach to utilize pre-chamber combustion with resulting jet ignition to the cylinder charge is not new but is nonetheless worth pursuing.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed single cylinder work yielding good results and direction, and an impressive extraction of information. The reviewer also noted interesting nozzle diameter results and analyses, and excellent incremental efficiency improvements. The reviewer observed CFD modeling and blowback to pre-chamber.

Reviewer 2:

The reviewer detailed that Mahle has developed a fueled prechamber igniter and further optimized its operation through computer simulations and tests performed on a single-cylinder engine. The net result is the demonstration of an overall efficiency of 46% that surpasses the DOE goal of 45%. Also, the project team demonstrated extension of lean ignition limit to a Lambda value of 2.0 with a NO_x emission level as low as 20 ppm. The reviewer found that these were very impressive achievements that point to the fact that the present development can enable a true lean-burn gasoline engine in the very near future. Referencing Slide 22, the reviewer inquired about why indolene and propane were used as pre-chamber fuel, and how the TJI concept compared with other fueled pre-chamber concepts pursued elsewhere.

Reviewer 3:

The reviewer observed good data so far. The reviewer noted that HC goes up when lean enough for NO_x. The reviewer asked if the project team could control it at such a low exhaust temperature. The reviewer asked if the NO_x was low enough to meet SULEV30 without a NO_x catalyst. The reviewer pointed out that it was essential to consider realistic losses for the boost system, and that a low exhaust temperature may require a difficult boost system and may lose a lot of the apparent efficiency gains.

Reviewer 4:

The reviewer observed an excellent result to meet the goal of 45% thermal efficiency on light-duty SI engine at some test points with NO_x emissions comparable to or below existing SI engines. The reviewer had some question about limited data points presented at 45% being possible across the map, and how the turbocharger emulation was included in thermal efficiency. In some TJI design cases lower NO_x was also accompanied by somewhat higher HC emissions than SI engine for some design configurations. The reviewer remarked excellent work to characterize pre-chamber activity and performance through testing and modeling. The reviewer noted that 30% predicted drive cycle FE improvement over comparable gasoline engine vehicle still needed to be done. The reviewer noted that value analysis to confirm claimed cost effectiveness of the system, and still to do relative to base and competing concepts. The reviewer commented that the system required a head, piston, combustion chamber modification and two sets of injection systems/controls. The reviewer pointed out that some DI only concepts (without PFI) achieving similar results.

Reviewer 5:

The reviewer observed very good progress shown on the understanding and modeling of the TJI system. The explanation of jet penetration into the cylinder was nice and demonstrated significant accomplishments in the understanding of the process. The reviewer observed that low NO_x emissions were demonstrated and clearly showed a benefit of this approach; however, HCs increased at those AFRs. Efficiency improvements were noted, but it was difficult to ascertain the efficiency of this approach relative to other lean gasoline combustion approaches. The reviewer suggested that the efficiency metrics/goals in the U.S. DRIVE ACEC Tech Team Roadmap needed to be adopted by this project to better show results compared with other combustion approaches. The reviewer pointed out that a lot of industry input went into those goals/metrics; so, it was best to use them. The reviewer observed that the major limitations associated with this approach that had not been addressed by the project included durability (to coking/clogging) and transient operation/control (especially with respect to NO_x and HC emissions). The reviewer recommended that the project needed to address these issues in the next stages, and also that PM emissions data were needed.

Reviewer 6:
The reviewer would like to know if initiated CFD model correlation. The reviewer noted that orifice optimization was the key to good flame front generation; over penetrate results in quench at the wall. The reviewer pointed out that NO_x in ppm made the lambda effect more exaggerated.

Reviewer 7:
The reviewer acknowledged that the technical accomplishments of the team were very significant. There seemed to be a slight lack of balance between modeling and testing. The reviewer mentioned that some of the testing results shown were clearly off-scale. The reviewer thought that a balanced approach should be using various filters to capture both low temperature initial injection and the combustion process.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that the project team and collaboration were well coordinated.

Reviewer 2:
The reviewer acknowledged that Mahle is partnering with Delphi to leverage their expertise on ignition systems and fuel injection systems. Moreover, Mahle is using a Ford engine as the platform for testing. The reviewer concluded that the partnerships are ideally suited for the proposed development.

Reviewer 3:
The reviewer pointed out a solid relationship with Ford and the project team.

Reviewer 4:
The reviewer noted that the project had an excellent demonstration of interest and support from Tier 1 and an OEM through direct support, or materials/work in kind.

Reviewer 5:
The reviewer commented that this was clearly a Mahle project with what appeared to be little technical input from Ford. CFD modeling from Delphi plus hardware and direction is probably sufficient collaboration to ensure success to access commercial feasibility.

Reviewer 6:
The reviewer noted the collaborations with Ford and Delphi, but it appeared to this reviewer that most the resources and work was being done at Mahle.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer concluded that the project team's plans for future work were good, and that the project was on track to achieve the original goals.

Reviewer 2:
The reviewer indicated that the proposed future work entailed further optimization through modeling and further tests. This would be followed through tests on a multi-cylinder engine. The reviewer remarked that these were logical extensions of the current developmental program.

Reviewer 3:

The reviewer observed a logical plan given the overall technical approach. The multi-cylinder engine (MCE) results will certainly be interesting. The reviewer noted that new challenges were anticipated and that the team seemed well-equipped to manage upsets.

Reviewer 4:

As previously mentioned, the reviewer encouraged the project to look closely at heat losses and internal pumping work, and also at after-treatment capability and booting needs.

Reviewer 5:

The reviewer noted a good plan to prepare optimized design and evaluate capabilities on MCE across several test points. All criteria and non-criteria emissions are of interest. This reviewer specifically highlighted HC, CO, NO_x, PM, as well as CO_2/MPG exhaust temperatures for after-treatment considerations, and engine performance to compare to baseline and other combustion concepts. The reviewer suggested that although out of scope for the current project to perform cold work, some potential cold start strategies and concepts to address other possible vehicle system level challenges such as transients, idle, and torque/power performance.

Reviewer 6:

The reviewer suggested that the project's next steps needed to address durability (to coking/clogging) and transient operation/control (especially with respect to NO_x and HC emissions).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that the TJI igniter developed in the current program was likely to serve as an enabler for lean-burn combustion in transportation engines. This mode of combustion not only improves the engine efficiency but also reduces the pollutant emissions to very low levels so that aftertreatment may not be necessary. The reviewer concluded that the improved efficiency was in line with DOE's goal to reduce U.S. petroleum consumption.

Reviewer 2:

The reviewer remarked that ultra-lean burn was an attractive approach to deliver high gasoline efficiency with low NO_x emissions. Certainly, work in this field was important and attractive.

Reviewer 3:

The reviewer commented that the project was relevant to FE needs and thus petroleum reduction.

Reviewer 4:

The reviewer commented that potential new combustion technology to provide 30% FE improvement for light-duty applications can significantly reduce petroleum use.

Reviewer 5:

The reviewer stated that improvement of FE via fuel injection system improvement would have a direct impact on DOE's petroleum displacement objectives.

Reviewer 6:

The reviewer said that the project could potentially enable lean gasoline engines which, if commercialized, could significantly reduce U.S. gasoline/petroleum consumption.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer concluded that the team adequately leveraged complementary capabilities.

Reviewer 2:

The reviewer said the project's resources seemed to be appropriate.

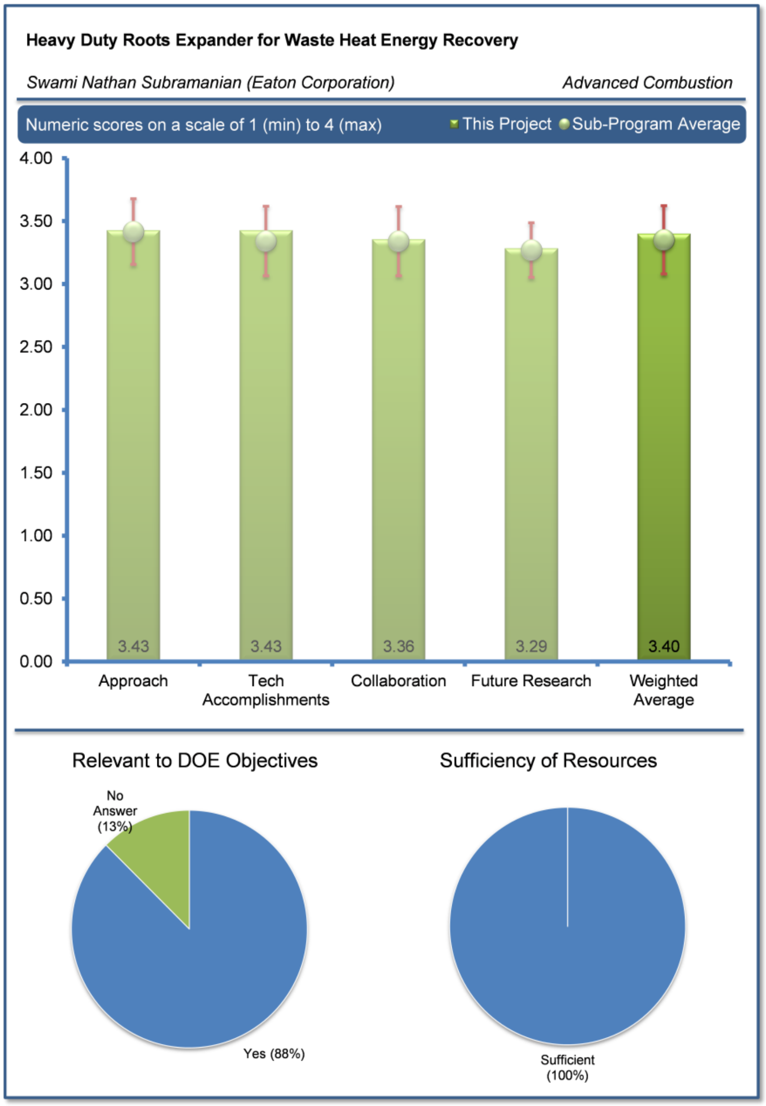
Reviewer 3:

The reviewer commented that the big money spending was coming and that the team built the basic knowledge with relatively low spending on the single-cylinder engine to address issues and keep within budget.

Reviewer 4:

The reviewer commented that resources were sufficient; however, it was unclear why Mahle was only contributing 20% of the total project funding. Most other industry-led projects had a 50/50 government/industry funding model. The reviewer asked if Mahle was committed to this approach, and if so, inquired about matching DOE's funding level.

Heavy Duty Roots Expander for Waste Heat Energy Recovery: Swami Nathan Subramanian (Eaton Corporation) - ace088



Reviewer Sample Size

A total of eight reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the approach followed by Eaton to develop a Roots expander for WHR followed a well-thought out plan based on sound engineering principles. This system, once it came to fruition, offered fuel efficiency improvement up to 6% with minimal penalty elsewhere (i.e., cost, durability or emissions impact). Moreover, the roots expander being developed offers low impeller speed, and improved resistance to dual phase working fluids that may result from improper working fluid expansion. The reviewer pointed out that though there were other efforts in the industry to develop WHR systems for on-highway trucks (that by Cummins, for example) the present development was primarily focused on developing one using the unique Roots expander.

Reviewer 2:

The reviewer observed that Organic Rankine Cycle (ORC) WHR was a hot topic and that this program directly addressed many of the issues and opportunities. It was well conceived to build and demonstrate a system for HD trucks.

Reviewer 3:

The reviewer commented that this project addressed barriers with the recovery of waste heat from engine systems to improve overall system fuel efficiency.

Reviewer 4:

The reviewer applauded excellent detailed requirements to design approach for a potential new product from SuperTruck activity. The project is a well-defined spin-off from SuperTruck activity with current goals to improve HD engine efficiency (improvement >5 %) through WHR systems without NO_x and PM penalty. The reviewer noted that the specific focus is a productive design for cost effective, highly durable waste heat recovery system ORC system by roots expander.

Reviewer 5:

The reviewer said the project approach involved ORC to improve expander efficiency in water-based ORC system.

Reviewer 6:

The reviewer observed a typical approach of modeling and bench testing using engine inputs, design and optimization on the bench, and installation on the engine.

Reviewer 7:
The reviewer remarked that the approach to use root extender for waste heat recovery was good. The team seemed to be unaware of the pros and cons of other waste heat recovery option for vehicles.

Reviewer 8:
The reviewer remarked that the approach was technically sound. However, the reviewer was not sure why a John Deere engine was selected with 13 mode cycle to prove the benefits. The reviewer pointed out that the John Deere engine was mainly for off-highway application, while 13 mode cycles were only used for on-highway application for certification cycle. There is disconnection here. The reviewer suggested that the program should be clear where the WHR system would be mainly applied–off-highway or on-highway, where these two applications could have different characteristics with different types of engine calibrations and hardware requirement. The reviewer concluded that due to the high cost of this system, one stone just could not hit two birds.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer observed the project team's solid results to date. Good analyses seemed to have considered the major issues and identified likely solutions.

Reviewer 2:
The reviewer commented that the team had shown excellent progress in designing a three-stage Roots expander, a test bed to measure its performance, and has further developed an appropriate control scheme and a plan for integration on a HD John Deer engine. The analysis is based on a nine-point mode estimates approximately a 5% fuel efficiency improvement. The reviewer concluded that all along the project, various barriers regarding materials, material compatibility, sealing, and etc. were addressed appropriately. Though the system was overly designed and might lead to a higher cost, it easily lends itself for future optimization through the use of a fewer number of stages.

The reviewer found that other than the physical hardware that has resulted, the knowledge base that resulted from the project – fluid properties of the working fluid, choice of working fluid, control schemes, and etc. – are of long term value. The reviewer noted that a notable exception in this program are inclusion of metrics for added cost and weight resulting from this WHR system. These are factors that have a bearing on transformation of technology to practice.

Reviewer 3:
The reviewer commented on the project team's impressive analyses and optimization. The team was preparing nicely for engine testing with design, procurement, and packaging. The reviewer added that 2014 progress was key to the project.

Reviewer 4:
The reviewer detailed that the project demonstrated with water as working fluid. This worked, but not as good as ethanol. The reviewer added that flow paths were optimized.

Reviewer 5:
The reviewer observed outstanding progress to develop a first prototype productive design for truck OEMs with 6% FE improvement projected, a flexible design for effective use on multiple applications, and cost effectiveness. The reviewer specified a less than 2-3 year payback projected, and consideration for safety of working fluid, which had been a concern. The reviewer detailed that the project evaluated different roots expander ORC WHR system architectures theoretically for optimized system considering heat exchanger layouts on system performance and leading to specifications of roots expander and other required WHR system components. The reviewer added that the project prototyped optimized expander with CFD analysis, bench testing, calibration, and validation durability. The reviewer also noted that valid metrics were presented to demonstrate activity and results, and that the first tests should also focus on road, Class 8.

Reviewer 6:

The reviewer commented that the project demonstrated good progress and was on track. The design and experimental results looked good to date. Furthermore, according to the reviewer the working fluid research is important not just for Eaton but the community in general. More results are needed on system evaluation under transient conditions. The reviewer recommended not only drive cycles, but other simulated transients that may show the optimal and non-optimal conditions where the heat recovery could be performed. More information on cost was also needed; even if exact costs cannot be listed, approximate the percent of engine cost metrics that could be shared. The reviewer pointed out that the control model did not appear to be very sophisticated. The reviewer would like to know if there were plans to develop a model on another platform besides Excel/Visual Basic. The reviewer preferred more appropriate engine control platforms.

Reviewer 7:

The reviewer found that the team had demonstrated the feasibility of recovering heat using the Root extender approach. However, there seemed to be a lack of understanding of how big the system should be in order to achieve the 5% FE improvement. The reviewer noted that the system shown was too small, and that the cost benefit of a large system and the effect of added weight were not addressed.

Reviewer 8:

The reviewer observed that analytical results showed great benefits in Slide 12, which was overly optimistic, and specifically at C speeds. The reviewer would like to know what assumptions were used. The reviewer noted that the expander efficiency at 60% shown in Slide 23 seemed high. The reviewer wondered if the John Deere engine mainly used at C speeds. The reviewer pointed out that for on-highway applications, the engine was hardly seen at such high speed. The reviewer asked how the 6% net FE in Slide 12 was calculated. The reviewer detailed that final FE should be calculated over weighted modes rather than averaged modes.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer judged that the team and collaborators were well organized.

Reviewer 2:

The reviewer said that Eaton had teamed with a number of component manufacturers whose expertise was required for integration of the overall system. The project team had used an off-highway HD engine as the platform to demonstrate the operation of the system being developed. The reviewer pointed out that though this test engine was not an on-highway HD engine, the technology was being tested lends easily for adaptation for on-highway applications. Per the presenter, adaptation for on-highway applications was being pursued outside of this project by Eaton.

Reviewer 3:

The reviewer observed a strong connection with an engine manufacturer, although the reviewer thought it would be nice to also have an on-highway OEM involved.

Reviewer 4:

The reviewer commented that Eaton and AVL were the main partners with what appeared to be good collaboration. The reviewer found that having the “loose” collaboration with Deere (engine only) was troubling, and that the team should try to partner with them or others more involved in engine issues.

Reviewer 5:

The reviewer observed that the project team had a good list of collaborators, although mostly industry.

Reviewer 6:

The reviewer judged the project team’s collaboration to be very good, and asked that the project team please add on-road application partner or on-road test application.

Reviewer 7:
The reviewer remarked that the project team working with John Deere was excellent. However, the reviewer guessed that applications with this WHR system should be for on-highway applications. According to the reviewer, it was hard to justify investment in this kind of expensive system toward off-highway application.

Reviewer 8:
The reviewer pointed out that the project had collaborated with John Deere, and inquired about OEM and off-highway collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the project's future work plan was good.

Reviewer 2:
The reviewer remarked that there was a solid plan to complete the analysis, build, and demonstration by the project team.

Reviewer 3:
The reviewer concluded that the team was well-poised to move forward. The future work was going to be the key to the program's success.

Reviewer 4:
The reviewer said that the tasks proposed for future research to be conducted in 2014 and 2015 were logical extensions of the developmental effort pursued so far. The reviewer commented that though not included in the promised scope of work, if possible, demonstration and testing of the WHR system on an on-highway truck engine using a transient cycle would be beneficial to correctly assess the net fuel efficiency benefit. The reviewer commented that a long-term operation of the system, say a 200-500 hour continuous operation, would yield information about the long-term durability of the system.

Reviewer 5:
The reviewer remarked that an on-road application by the project team would demonstrate flexibility and performance of design and confirm emission impact.

Reviewer 6:
The reviewer judged project's future work to be good, and suggested that transient operation needs be included in the experimental plan with a focus on defining what how different time scales of engine load changes affect the heat recovery efficiency gains.

Reviewer 7:
The reviewer remarked that the technical direction was clear and that the path to make further improvement was clear too. However, it was not clear what kinds of cycles were to be used for the program. The reviewer wondered if it was a 13-mode, if a John Deere engine would be the best choice.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that project's improvement of engine efficiency supports the overall DOE objectives of petroleum displacement.

Reviewer 2:
The reviewer observed a strong FE impact by the project.

Reviewer 3:
The reviewer stated a potential new product from SuperTruck R&D activity with possibility for 6% fuel savings using waste heat.

Reviewer 4:
The reviewer commented that the proposed development, though aimed towards on-highway trucks, has ramifications towards off-highway and other transportation sectors as well. The reviewer added that the 5-6% FE benefit resulting from this system can easily lead to significant petroleum derived fuel savings. The reduced U.S. GHG emissions resulting from this technology are an added bonus.

Reviewer 5:
The reviewer remarked that ORC WHR is on the 55% BTE roadmaps of all the major HD OEMs. The reviewer added that work is needed and the project will move the application forward.

Reviewer 6:
The reviewer stated that improving heat recovery can improve system efficiency and reduce petroleum reduction, so this project was potentially enabling that approach.

Reviewer 7:
The reviewer remarked that WHR is a solution to improve FE and directly related to engine efficiency. Improving the overall engine efficiency certainly supports DOE's objectives of petroleum displacement.

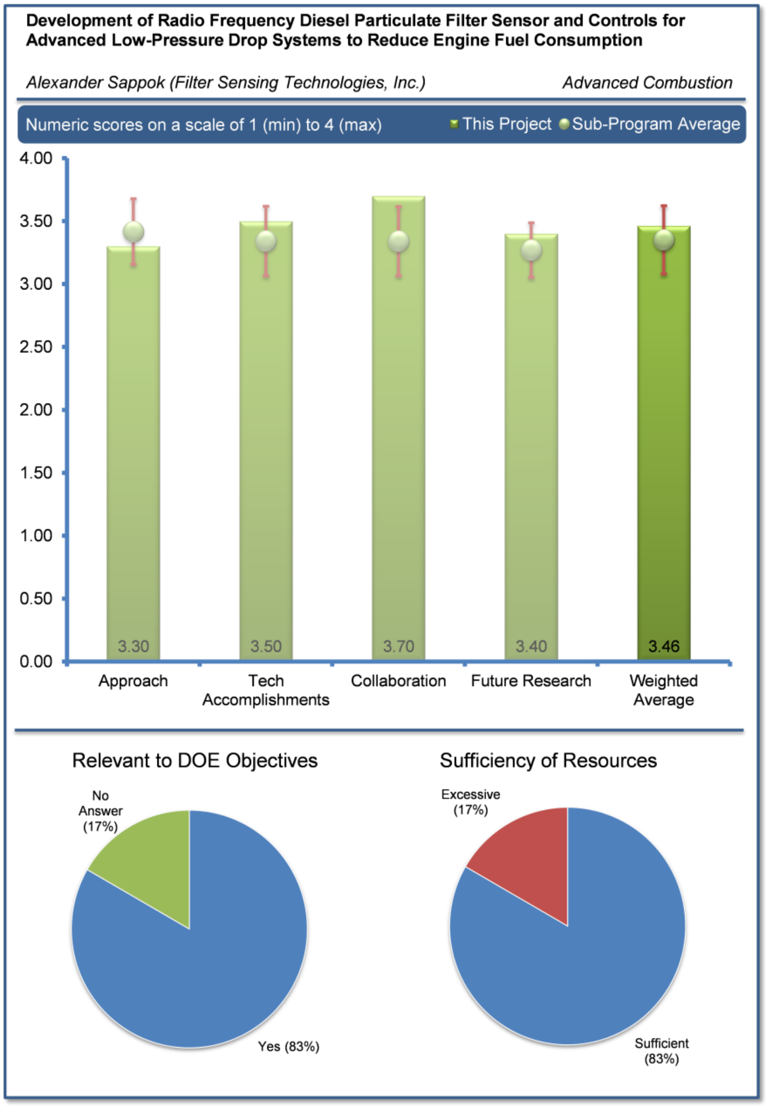
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer concluded that the allocated budget was commensurate with the activities proposed in this project. However, if funding were the limitation, the reviewer asked to please look into adding additional funds to conduct transient tests using an on-highway HD engine. The reviewer remarked that such tests would help determine the true potential of this technology.

Reviewer 2:
The reviewer commented that the project seemed to be appropriately funded.

Reviewer 3:
The reviewer said that there seemed to be plenty of money available for the project team to move forward.

Development of Radio Frequency Diesel Particulate Filter Sensor and Controls for Advanced Low-Pressure Drop Systems to Reduce Engine Fuel Consumption: Alexander Sappok (Filter Sensing Technologies, Inc.) - ace089



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed a very well laid out program with great collaboration by the project.

Reviewer 2:

The reviewer applauded the outstanding approach to leverage basic, inexpensive radio frequency (RF) technology, including management of key challenges to demonstrate sensor and controls, Proof of Concept, identify and implement a commercially viable sensor package, and define and simplify controls based on first target application use considering the end user application value proposition.

Reviewer 3:

The reviewer remarked that this project was a very interesting concept, and that the program plan was a solid approach to development and toward commercialization.

Reviewer 4:

The reviewer commented that in a typical diesel engine as the DPF soot loading increases the back pressure increases, leading to low engine efficiency. Currently, by measuring the back pressure (heating) regeneration cycles are initiated to burn off the deposited soot. Filter Sensing Technologies (FST) proposes to develop an advanced system based on radio waves that accurately measures in situ soot loading. However, the reviewer opined that FST fails to show that the current system of backpressure measurement is inadequate so that one needs to develop the advanced system. In practical engines, simplicity, low cost and robustness are of prime importance.

Reviewer 5:

The reviewer inquired about a radio frequency sensor for DPF control. This person further reported measurement of PM and ash as well as changes in dielectric properties on the filter measurement, and one-year payback.

Reviewer 6:

The reviewer commented that the overall layout of this project was well thought-out and technically sound, in terms of RF sensor development. RF sensors seemed to provide more information on soot loading than the pressure drop signal typically used in production vehicles, such as uneven soot distribution in the filter as shown in Slide 24. The reviewer said that localized high concentration soot may cause damage to filter so that today's engine regenerates more frequency than appears to be needed as indicated by the pressure drop. However, the reviewer was not clear if this extra information was used as part of the control strategy.

The reviewer described that as the method has been presented, RF sensor signals appeared to be used to measure the overall soot loading on the filter. The reviewer said that it could be more accurate or direct measurement of soot loading. However, it was essentially providing the same information as the pressure drop signal. This reviewer was interested in knowing if the soot distribution information can be reliably derived from the RF sensor and used as a feedback control signal.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented the project team's comprehensive presentation demonstrating very good progress.

Reviewer 2:
The reviewer applauded that a system development into a miniature unit that could be readily deployed on commercial trucks was commendable. Also, the project demonstrated the operation of this unit on various engine platforms. However, according to this reviewer, the benefits accruing from the use of this advanced unit over a system where back pressure measurement is used in tandem with model based control would strengthen the case for the current development.

Reviewer 3:
The reviewer commented very nice project work, and elaborated that the progress in the design and application was very impressive, especially for a small company.

Reviewer 4:
The reviewer applauded outstanding results. Sensor and controls concept demonstrated, testing facility commissioned, commercially viable sensing element and controls package developed with sensor element integrated in existing exhaust temperature sensor application. The reviewer noted that simplified controls with initial calibration scan provided by device that was developed and tested in a laboratory and fleet environment.

Reviewer 5:
The reviewer remarked that it appeared an impressive team had been assembled to perform the tasks. Significant progress had been made with sensor related development, integration and measurement. With two-thirds of the time used and 58% of the work completed, the project was behind schedule time wise.

The reviewer opined that fleet test fuel saving (Slides 13-14) were not as convincing as it was presented. The reviewer commented that it was not clearly demonstrated that reduced regeneration frequency was the direct result of using RF signals. It could be that the control model was more aggressive. The reviewer wondered if the pressure drop signal in combination with the control model produced the same regeneration event. When claiming improvement over the current technology, it is more convincing if a direct comparison is made. The baseline used for comparison (refuse truck with 2009 Volvo/Mack engine) does not represent the state of art.

Reviewer 6:
The reviewer observed that the ash loading performance was up to 40 gram (G)/LT, the tip in transient tests response was slow, and the correlation with ash-loading measurement was excellent. The reviewer inquired about addressing soot and ash together, thus reducing regeneration events on DPF to save fuel-payback in one year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that FST had collaborated with various partners in developing and modularizing their system. The project team had shown the performance of their system on a number of partner platforms.

Reviewer 2:
The reviewer observed a good summary of the project team's collaborators and their specific contributions. The reviewer pointed out Detroit Diesel, and the New York City Sanitation Department.

Reviewer 3:
The reviewer observed an outstanding example of collaboration to insure requirements are properly gathered and reviewed from potential end-user and OEMs, hardware manufacture and controls are user friendly/cost effective. The reviewer remarked that the project team enlisted and clearly defined partner roles according to expertise. The project leveraged sensor manufacturer, OEM vehicle manufacturer, fleet, controls specialist and sensor specialist companies.

Reviewer 4:
The reviewer commented that several key relationships had been developed leading to good program progress by the project team.

Reviewer 5:
The reviewer remarked that collaboration and coordination with the industry partner or subcontractors has been good. The reviewer suggested that for the future tasks, it would be valuable to work closely with the engine manufacturers. The reviewer expressed uncertainty if the manufactures listed on Slide 19 will be partners of this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the project was properly focusing on developing optimized calibrations and controls to quantify performance relative to baseline (ΔP + Model) in a wide range of engine and vehicle applications. The clear focus on first most valuable application and durability performance is excellent.

Reviewer 2:
The reviewer commented that it would be interesting to see if there is a fuel savings through more effective scheduling and control of regeneration relative to a situation where manufacturers have done more work optimizing their regeneration algorithms. But this is an important question to answer and this project should be able to do that. The reviewer guessed that this technology would be beneficial.

Reviewer 3:
The reviewer detailed that the proposed work intends to demonstrate the sensor on a variety of vehicle platforms. Possibly the benefits associated with the advanced sensor would become apparent.

Reviewer 4:
The reviewer commented that the project team needed more trucks/manufacturers.

Reviewer 5:
The reviewer observed a very good project plan given the funding scale. According to the reviewer, it would be nice in the future work to see more fleet testing in a wider range of applications, including light-duty diesels.

Reviewer 6:
The reviewer remarked that the proposed future works were sound only because the project had reached this stage. The system level evaluation provides an opportunity to quantify the actual savings, which could validate the technology. The reviewer also noted that a more careful proof of concept should have been done at an early stage of the project.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer detailed that this project aimed to develop a sensor to measure the soot loading of a DPF on a diesel engine. This facilitates a more intelligent and optimized way to regenerate DPF, thereby avoiding unnecessary regeneration cycles. The reviewer concluded that as approximately 6% of total fuel is spent on DPF regeneration, the fuel penalty associated with regeneration could be reduced.

Reviewer 2:

The reviewer acknowledged that the ability to regenerate the DPF reliably is key for a number of diesel applications. This could be very useful to many retrofit programs.

Reviewer 3:

The reviewer recounted a low-cost production sensor that can be easily calibrated and applied to a DPF application can ensure optimized regeneration cycles. DPF filling predictive models and pressure drop measures can be enhanced to insure the fuel consumed on regeneration events is minimized.

Reviewer 4:

The reviewer stated that this is a yes with a question mark. The reviewer said that it was not quantified how much extra fuel was used for the purpose of regeneration. While reduced regeneration frequency does reduce fuel usage, it was not clear that reduced regeneration frequency was the direct result of using RF sensor. The reviewer found that it was questionable to what extent this project supported DOE objectives.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the project's resources seemed to be about the right funding.

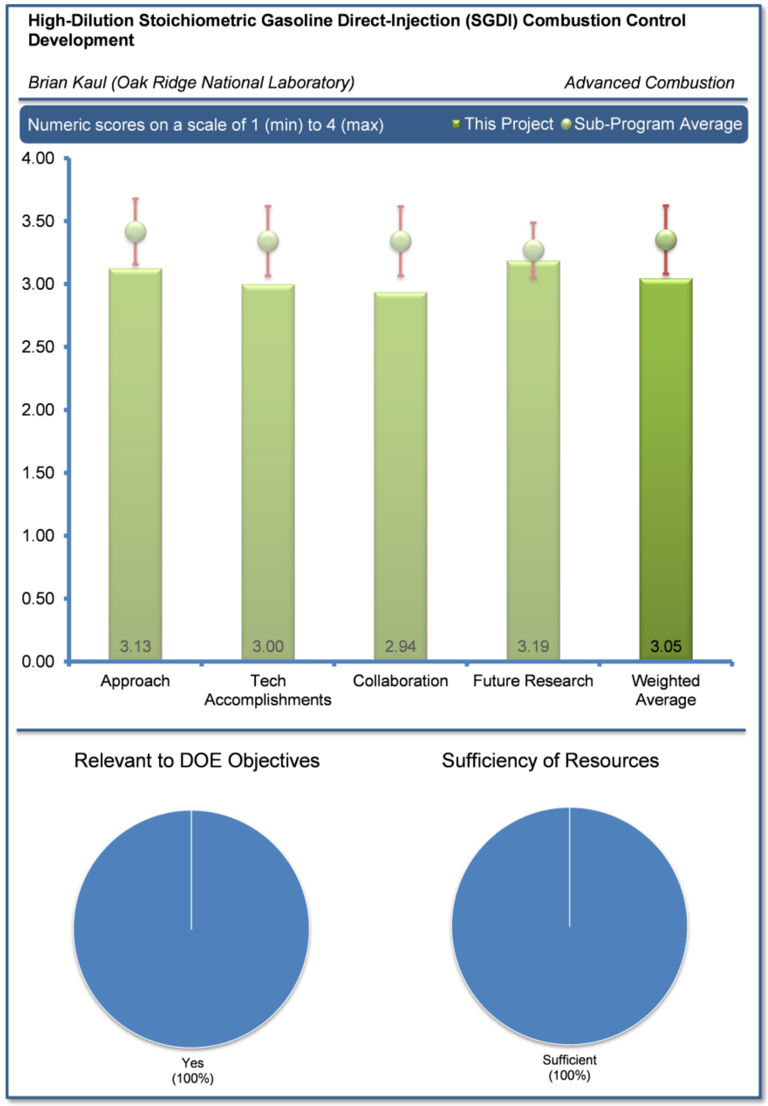
Reviewer 2:

The reviewer found that project funding seemed to be adequate for the remaining tasks.

Reviewer 3:

The reviewer commented that it appeared that FST had been awarded projects from other sources for the same effort.

High-Dilution Stoichiometric Gasoline Direct-Injection (SGDI) Combustion Control Development: Brian Kaul (Oak Ridge National Laboratory) - ace090



Reviewer Sample Size

A total of eight reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer exclaimed that it was about time someone did this work. The reviewer remarked that it was an exciting chance to do something about the stability limit.

Reviewer 2:

The reviewer commented that the project addresses a specific, critical barrier for dilute SI combustion in a focused manner. The importance of advanced controls is often overlooked, but is of equal importance to (and is an essential to the success of) combustion system development.

Reviewer 3:

The reviewer remarked that the approach of symbolization of chaotic time series to discretize the data and identify trends should enable development of better control systems for dilute SI systems.

Reviewer 4:

The reviewer observed that this was the first time this program had been reviewed. The reviewer remarked that the investigators were addressing an important problem and the project team was learning a lot about addressing the problem as they proceed. The reviewer fully expected that their approach would take on a sharper focus as the project moves forward. For example, the project team might be able to specifically identify and rank the phenomena that the deterministic causes of cyclic variability. This could have broad implications, from control system development to design changes in the engine.

Reviewer 5:

The reviewer remarked that stability limits directly impacted the FE effectiveness of dilution strategies. Being able to operate closer to the limit is beneficial. The reviewer asked if cylinder pressure was required for optimal control, and inquired if crankshaft speed or some other feedback mechanism could be used.

Reviewer 6:

The reviewer said that the project sought to characterize cyclic variability for external EGR operation. The project will evaluate effects of varying engine control inputs with the goal to develop next-cycle control methodology to reduce cyclic variability and implement next-cycle controls on engine. The reviewer noted that the project could give more clear indications on the roadmap control strategy pursued. The task is rather challenging and for this reviewer, it is unclear if the technical barriers leading to predictability will be overcome.

Reviewer 7:

The reviewer commented that the second bullet under Project Objective was not clear. The reviewer asked how downsizing and boosting had made the part-load effects of EGR (viz., increased efficiency) important, and wondered if it should be the other way around. This is because a large fraction of the part-load losses have been recovered via downsizing and boosting. The reviewer acknowledged that the approach addresses the combustion instability problem of high dilution engines, which needs to be successfully developed to increase engine efficiency and reduce petroleum usage. However, the approach seeks to only manage and minimize the combustion variability of an existing engine design, by adjusting fueling level of a cycle that is anticipated to suffer from the harmful effects of a previous cycle. The reviewer remarked that it remained to be seen if in the net a thermal efficiency gain is achieved. The reviewer noted that very precise experiments would be needed to verify the effect.

The reviewer commented that having said that, this project is still useful for controlling the engine in such a way so as to operate at the “edge of stability,” and the concept of next-cycle controls can have applicability over the entire engine operating range irrespective of whether or not EGR is used.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer observed good progress by the project team on milestones.

Reviewer 2:

The reviewer commented good project progress for a first year review.

Reviewer 3:

The reviewer commented that the formulation of the strategy and analysis is an important first step in demonstrating improved controls. Although in the relatively early stages, the indicators showed promise for the future work.

Reviewer 4:

The reviewer noted good progress by the project team on a difficult problem. The project team has created a good test bed and the necessary infrastructure to do some great work.

Reviewer 5:

The reviewer commented that the project is in the initial phase of development and has limited progress reported. The project evaluated analysis methods for identifying deterministic components of variations. The reviewer said that symbol-sequence statistics were used to identify recurring non-random trajectory of events. The results showed a decrease of COV at 11% and 17% of EGR. The reviewer commented that the benchmarks however, remove the bad cycles to recalculate the statistics. This does not appear meaningful. The reviewer observed that high EGR leading to longer time-constant instabilities were reported. These results are what would be expected.

Reviewer 6:

The reviewer commented that the project’s framework that has been established to identify and affect a control strategy seemed to be sound. It remains to be seen the extent to which the project team’s control approach will demonstrate benefits in performance.

Reviewer 7:

The reviewer found that the ability to discern patterns in the seemingly random data with the symbolic analysis was very interesting. The reviewer noted that the correlation of combustion instability to the EGR path-length was also very interesting. However, it seemed like that correlation would be strong when operating in a misfire-type situation and therefore easy to discern. However, according to the reviewer, when operating at a COV of about 3% the correlation may not be as strong and the usefulness of the technique may be severely diminished. The reviewer pointed out that Slide 4 stated that cylinder balancing was completed, but these results were not included in this review. The reviewer inquired if this was because these results were available too late to be included in the AMR presentation and meet the deadline.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed solid collaborations by the project team with Ford and National Instruments. The reviewer expected opportunity for more as more people realized the possibilities.

Reviewer 2:
The reviewer noted that some industry collaborations with Bosch and Drivven were mentioned by the project team.

Reviewer 3:
The reviewer commented that the project was collaborating with Bosch and National Instruments on a high-EGR control system development but no details were given showing their contribution, except in a generic way.

Reviewer 4:
The reviewer commented that the project team's collaboration with Bosch and National Instruments is strategically important, but a stronger connection to industry controls expertise would link this project more closely with technology development efforts leading to commercialization and avoid wasted or redundant effort.

Reviewer 5:
The reviewer would like to see more collaborators involved in the project (e.g., an OEM).

Reviewer 6:
The reviewer commented that sufficient project collaboration exists with Bosch, a Tier I supplier and National Instruments. The reviewer added that the project may benefit from collaboration, or at least input, from an OEM's controls experts.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer observed a well laid-out plan for future work by the project team.

Reviewer 2:
The reviewer commented that the project plans to demonstrate a next-cycle control of the engine, having impact over limiting COV. The reviewer continued that it will address differing dynamics of lean-burn versus external EGR.

Reviewer 3:
The reviewer remarked that the future research is targeted at addressing an appropriate barrier to dilute SI combustion. Ensuring that the engine hardware (i.e., combustion chamber, injectors and ignition system) is capable of demonstrating of the efficacy of the control strategy will also be important to the success of the project.

Reviewer 4:
The reviewer said that it will be interesting to see the final answer from the project team on whether a net gain in thermal efficiency can be gained during a relevant experiment.

Reviewer 5:
The reviewer complimented excellent start. As the project addresses these issues, you will want to extend to transient and cold start operation. The reviewer asked if the project team could only make awful combustion into bad combustion, or if the project could also make bad combustion into good combustion. And, asked the reviewer, if doing so allows the project to run in significantly better regions than one could without this methodology.

Reviewer 6:

The reviewer commented that the proposed work was good, but the reviewer was a little skeptical as to the size of benefit that would be realizable. Clearly from a condition with multiple misfires, this approach would show an improvement. However, production engines are not calibrated to misfire. The reviewer asked how much closer ‘to the edge of stability’ could engines be pushed, without miss-fire, but having a recognizable pattern to recognize. This reviewer was not sure. Again, according to the reviewer, this is a worthy endeavor, and the data will speak for itself. The reviewer hoped there was something here.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer acknowledged that many engines are stability limited under some conditions. Any ability to move those limits back should be helpful.

Reviewer 2:

The reviewer said that the control systems are important to pushing the limits of dilute/lean SI combustion, improving the efficiency of these systems.

Reviewer 3:

The reviewer said that the development of advanced control strategies to extend SI dilution limits should make this approach more feasible for commercialization of this technology.

Reviewer 4:

The reviewer commented that combustion instabilities at the dilution limit have a deterministic structure combined with stochastic noise. Cooled EGR enables fuel efficiency gains with boosted downsizing, but is limited by cyclic variability.

Reviewer 5:

The reviewer said that high dilution engines, either lean or EGR, are part of the strategy to increase engine efficiency and reduce petroleum usage.

Reviewer 6:

The reviewer remarked that EGR and stability are limiting factors to engine efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found that the project’s resources were sufficient. However, the reviewer said that the resources may need to be increased in fiscal year 2015 to ensure that the combustion hardware is suitable for the controls demonstration.

Reviewer 2:

The reviewer said that the project’s resources were sufficient.

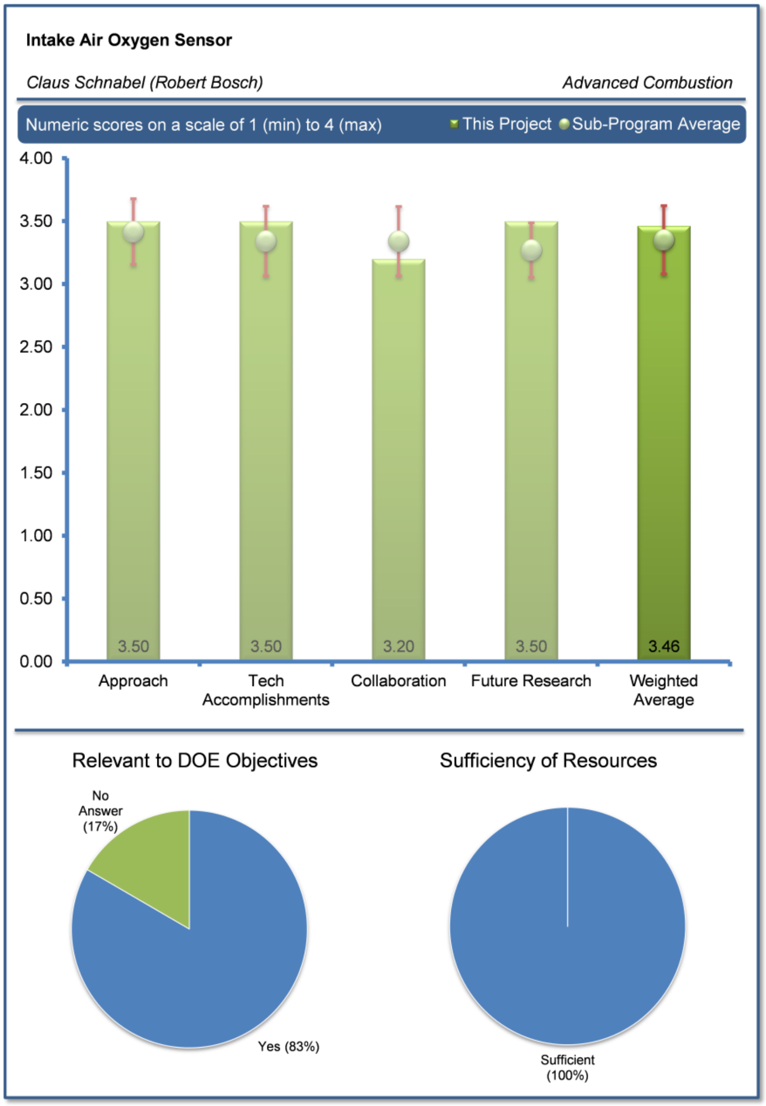
Reviewer 3:

The reviewer found that funding seemed appropriate for the planned project work.

Reviewer 4:

The reviewer remarked that project resources were sufficient provided planned work could be completed in the next fiscal year.

Intake Air Oxygen Sensor: Claus Schnabel (Robert Bosch) - ace091



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted a well-thought out process for identifying the needs, and identifying critical performance criteria

Reviewer 2:

The reviewer noted a very solid approach reflecting Bosch's long experience in automotive sensor development.

Reviewer 3:

The reviewer said that the approach was reasonable with staged development and distribution of responsibilities. Proper starting point, gaps analyses, adaption, testing, scale-up, and controls all logical and proven approaches.

Reviewer 4:

The reviewer commented that in this project, Bosch intended to develop an oxygen sensor that could be deployed in the engine intake air duct. Such a sensor would facilitate accurate measurement of EGR fraction, especially under low-load and low-speed conditions. The reviewer noted that this in turn would facilitate high efficiency engine operational modes that use EGR. The reviewer observed that a cooled EGR estimation algorithm had been developed as a part of this project. The reviewer remarked that it would have been nice to share this information in the form of a publication.

Reviewer 5:

The reviewer said that this project was well designed in terms of oxygen sensor development, installation on the engine as well as integration with cooled EGR control. The target set for the accuracy of the sensor is quite high, which may be difficult to meet or verify in actual engine operation.

The reviewer pointed out that as internal EGR or residual gas fraction varies from cycle to cycle and cylinder to cylinder, at some point, more precise knowledge on external EGR rate does not offer added benefit for final in-cylinder EGR prediction. The reviewer concluded that it is therefore sensible to work with cooled EGR partners, Clemson and ORNL, to define the accuracy of EGR rate needed for the modeling and control, which in turn defines the accuracy of the intake O_2 sensors. The reviewer remarked that once a realistic accuracy is defined, more efforts could be put in to make the sensor durable and low cost.

Reviewer 6:
The reviewer said cooled EGR application was needed for this O_2 sensor, and noted an EGR estimation algorithm. The EGR control is based on the O_2 feedback, and models GT power. Water effects/pressure effects/O_2 level are sensitive. The reviewer noted the potential to ignite with HC vapors in exhaust.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer remarked that the project team nicely designed tests and analyses given solid results leading toward production.

Reviewer 2:
The reviewer said that the project followed a well-defined pathway for the development of the intake O_2 sensor. With the intension of developing the sensor for all potential diesel and gasoline applications, the team had considered all elements that could potentially affect its performance.

Reviewer 3:
The reviewer observed an excellent identification of issues and risks, and several accuracy challenges. The reviewer commented engine sensitivity to control strategy to determine needs. The reviewer observed a nice assessment of manufacturing feasibility, impressive prototype development, and impressive progress on failure modes, seals, protection tubes, etc.

Reviewer 4:
The reviewer pointed out that Bosch has plenty of expertise in O_2 sensors, which has been well applied in this project. The technical accomplishments presented fit well with the project and DOE goals. The reviewer noted that the team was about halfway through the project, and all major issues had been touched on. The reviewer said that what was not very clearly defined was how the progress on certain matrices was measured, such as those in Technical Risk Assessment (Slide 11).

Reviewer 5:
The reviewer noted very good progress. However, it was not clear to this reviewer what was new in this development. It seemed like the project team was developing an expanded range of sensor capabilities by using technologies that already exist within the company. Clarification of what is new would have helped this reviewer make an assessment of whether it is appropriate for the federal government to support this work.

Reviewer 6:
The reviewer expressed concern that the risk of fire seemed major. The reviewer commented that this is for SI, not diesel, but it could be adapted to diesel.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that Bosch had formed an excellent team and was leveraging complementary capabilities very well.

Reviewer 2:
The reviewer pointed out that the project team had excellent partnerships and assignment of tasks, and that each member was dealing with strengths.

Reviewer 3:
The reviewer pointed out Clemson and ORNL as collaborators with the project team.

Reviewer 4:
The reviewer commented that Bosch was presumably working with a number of customers even though it was not shown in this talk.

Reviewer 5:
The reviewer remarked that project's collaboration and coordination with partners seemed to be lacking or not shown. Hopefully, this situation will change for the future tasks.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said there was a high probability of project success leading to production.

Reviewer 2:
The reviewer said that, so far, the proposed future work was a logical progression of the developmental work performed.

Reviewer 3:
The reviewer commented that the project's future work plan seemed achievable, focused on risk areas, and will achieve project objectives.

Reviewer 4:
The reviewer remarked that the proposed future works were sound and logical. The system level evaluation provided opportunity to quantify the benefit of technology. The reviewer remarked that hopefully, more close collaboration with cooled EGR partners would occur during this phase of the project.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that relatively accurate information on intake oxygen could potentially improve cooled EGR control strategy, and thus improve the FE which supports the DOE objective.

Reviewer 2:
The reviewer commented an important tool for high EGR levels, which in turn are necessary for low emissions with high efficiency.

Reviewer 3:
The reviewer commented that advanced controls were essential to efficient engine operation. This project gets to the heart of a key one – air and EGR control.

Reviewer 4:
The reviewer detailed that the proposed development of intake oxygen sensor facilitates the metering of EGR under low-load and low-speed conditions, which are primarily used under typical driving conditions. This in turn would lead to the development of highly efficient downsized engines that use turbocharging and EGR.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that the team leveraged complementary capabilities excellently.

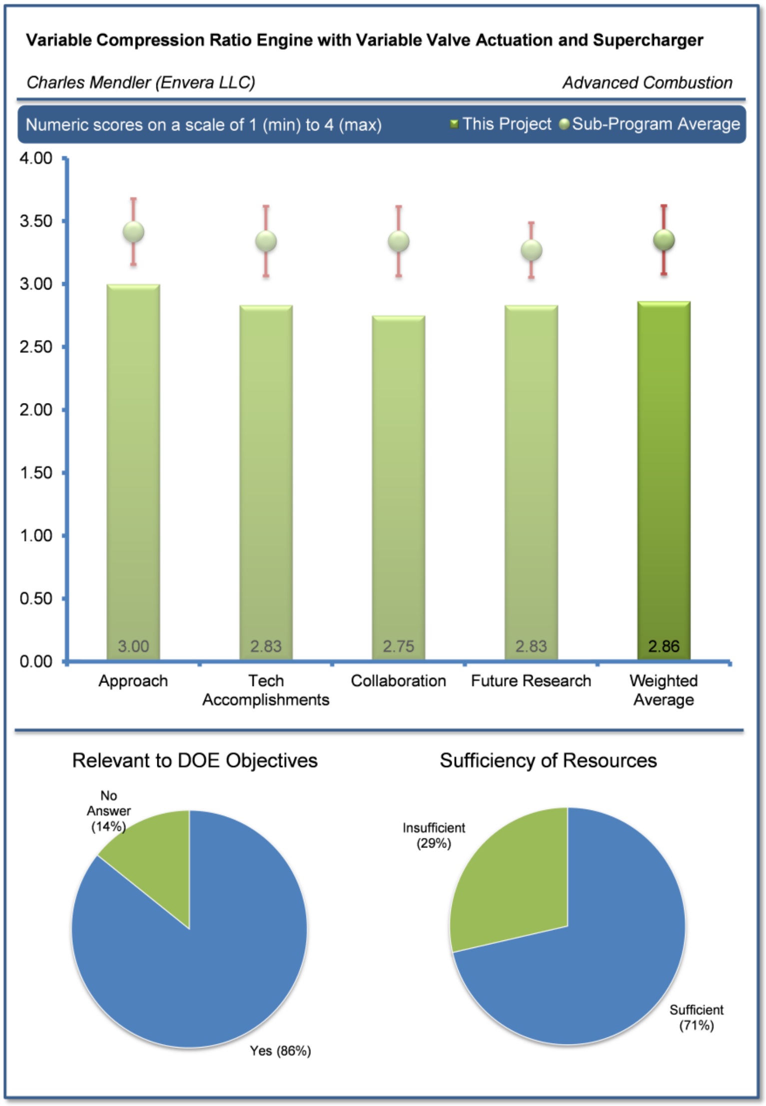
Reviewer 2:
The reviewer found that project's resources seemed to be properly funded.

Reviewer 3:
The reviewer said that project's funding seemed to be adequate for the remaining tasks.

Reviewer 4:

The reviewer remarked that the project partner funding seemed low, but Bosch funding and capability seems quite adequate to help out if needed.

Variable Compression Ratio Engine with Variable Valve Actuation and Supercharger: Charles Mendler (Envera LLC) - ace092



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that the project team's approach to address the technical barriers was well planned and balanced.

Reviewer 2:

The reviewer commented that combining with VVA was interesting; and observed the Atkinson cycle enabled with VVA, a 40% improvement in pickup truck, and GT power modeling to match supercharger.

Reviewer 3:

The reviewer said that this was a very interesting concept for VCR. The reviewer did not see how the project would convincingly demonstrate 40% FE benefit without more effort on system integration. The reviewer remarked that controls, after-treatment, vehicle implication like shift schedule, were all important and did not seem to be addressed. Perhaps the objective should have been more component or subsystem oriented.

Reviewer 4:

The reviewer remarked that VCR combined with VVA and supercharging was an interesting combination much discussed in the literature. The reviewer found that goals seemed achievable given the expected flexibility of the system. The feasibility, design, and build approach was quite standard. However, according to the reviewer, the system seemed quite complex so there will be significant challenges.

Reviewer 5:

The reviewer detailed that pressured by the requirement for improved mileage, most of the engine manufacturers have adopted a combination of turbocharging, plus GDI and high levels of dilution, for knock mitigation. Usually, the high levels of dilution have been instituted via increased levels of EGR. The reviewer detailed that the present project proposes an alternate pathway for knock mitigation – that of using variable compression ratio (VCR), which allows one to use low CR at high loads and high CR at low loads, thereby improving the engine efficiency overall. The reviewer noted that the other technology that is proposed is VVA to institute Atkinson/Miller cycle, is somewhat proven.

The reviewer commented that while the technology to vary CR is innovative and commendable, it relied on moving the crankshaft position vertically. This introduces new difficulties of sealing oil containment while allowing for crankshaft traverse, reliably transmitting the shaft power to transmission, having the needed time response for transient engine operation, and added cost and weight.

The reviewer noted that the benefits from the proposed VCR technology must surpass those from EGR or lean-burn technologies to be viable. The reviewer remarked that maybe the present project will shed some light as progress is made.

Reviewer 6:

The reviewer remarked that VCR device with Atkinson cycle is possible to meet targets of the project (i.e., part-load brake thermal efficiency of 31%, over 25% FE improvement on SI engines without sacrifice to power and emissions, and enhanced alternative fuel capability with regard to R&D).

However, according to the reviewer, there is some data in the literature indicating real FE improvements of 7% with Atkinson cycle (Honda 2009 SAE)[1] and system development of certain VCR systems is mature and on the shelf for manufacturers to implement as needed (MCE-5 in Europe)[2].

The reviewer noted that mature MCE-5 technology, similar to the current project, has not been adopted in Europe beyond demonstration vehicles at PSA in 2010. The reviewer noted that the R&D approach for this project could be improved by taking a look into the potential mechanisms which are either available now (and full complete ready systems like MCE-5) or more practical devices which do not require as significant base engine changes, such as the Honda system, FEV, Hyundai patents, Ford patents for Connecting Rod/Piston based devices, and implementing one of these devices in the test program, therefore avoiding a long and expensive engine development and providing a clearer pathway to production.

The reviewer suggested an additional recommendation for improvement is to identify an OEM or Tier 1 with interest to partner to develop a VCR technology. Because base engine changes are required and are one of the largest barriers to production use of this technology, the OEM/Tier 1 integration partner interest will demonstrate the need/interest in the marketplace and expedite integration to a base engine design. Additionally, the OEM partner with interest can provide leverage with their existing engine controls for more practical controls integration of a very complex activity.

The reviewer said that VVA 2-step mechanisms are in production, and tailoring the device to the Atkinson application is a valuable exercise for enabling fuel saving technologies.

The reviewer noted that a cost effective variable speed supercharger was the original option for this project and may be highly desirable for other fuel saving projects.

Reviewer 7:

The reviewer noted that combining three advanced technologies, VCR/VVT/supercharging, into one system sounded very attractive. However, how the market could accept such an expensive system was not clear at all. The reviewer found that more challengingly, the engine system control remained a daunting task with so many unexpected hurdles to overcome.

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[1] SAE 2009-01-106; testing in an otherwise conventional production 2.0L, 4-cylinder engine, the Honda dual piston mechanism was able to adjust the engine from a CR of 9.6 to 14.2 and back again. Combining the high compression ratio with the Atkinson cycle, the engineering team demonstrated a 7.4% improvement in FE in operation over the Japanese 10-15 cycle. As part of the study, the team also demonstrated switching durability of the dual piston mechanism of more than one million cycles.

[2] The VCRi engine principle. The MCE-5 engine provides continuous and reactive compression ratio control with a range between 7:1 and 20:1 to each cylinder of the engine. The MCE-5 engine block integrates power transmission and compression ratio control through a combination of a rod-crank mechanism, long-life gears and exclusive actuators. The result of 12 years of intensive R&D, MCE-5 VCRi is a technology with extremely low residual functional or industrial risks. The MCE-5 VCRi engines exist in single-cylinder, in four-cylinder with two-stage turbocharging and in direct gasoline injection versions. MCE-5 VCRi demo cars are currently running. http://www.mce-5.com/english/pop_up/atouts_strategiques/It_s_ready.html.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented good progress by the project team on the build of the engine –, stress analysis on VVA, and that the supercharger appeared to be developed already – but that it must be matched to the engine design needs.

Reviewer 2:
The reviewer said that the project team had good results so far--mainly selecting options and getting hardware together as planned.

Reviewer 3:
The reviewer commented that the technical accomplishments of the team are significant. The added weight and volume seemed to be a concern and the benefits may need to be addressed at the vehicle level. The reviewer found that the answer was positive but less convincing. Technical data and analysis are lacking and needed to support the claims.

Reviewer 4:
The reviewer remarked that the project work has had some setbacks, but fundamental structural issues were being addressed. VVA improvements seemed to be within Eaton's normal commercial responsibility given the commercial status of the technology. The reviewer commented that the delay in crankcase casting delivery was troubling. Troubleshooting seemed to be causing delays, but we are early in the project with time to recover.

Reviewer 5:
The reviewer said that the integration of the device on a production engine was a good accomplishment. However, OEM support would improve the prospects of the project's success and the integration of the technology in an engine should it prove effective. The reviewer acknowledged good progress on new VVA lost motion Atkinson application, and little activity on supercharger except gathering requirements.

Reviewer 6:
The reviewer summarized that following a predetermined scope of work, the Envera/Eaton team has shown excellent progress in Phase 1 of this project. Specifically, the project team has developed a conceptual design to incorporate VCR, been working to improve their VVT mechanism to incorporate late intake valve closing, and planned to use GT power modeling to guide the selection of boosting hardware. However, according to the reviewer, the main envisioned impediment to this VCR technology is reliable transmission of shaft power from a shaft that translates vertically. The reviewer commented that the presenter had not revealed details claiming it (VCR power takeoff coupling) to be proprietary. The reviewer concluded that in absence of its details it is difficult to judge the feasibility of this concept.

Reviewer 7:
The reviewer commented that not too much progress was reported except some preliminary analytical and design findings. The reviewer would like to know why, in Slide 32, the conventional V8 engine had better BSFC at high loads starting at 240Nm. With such an expensive investment, BSFC should be better over entire operating range.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that the team leveraged complementary capabilities to ensure progress of the project.

Reviewer 2:
The reviewer found that the project team's collaboration with Eaton was well managed.

Reviewer 3:

The reviewer observed solid interaction with Eaton. The reviewer suggested that a partner would be needed for controls and vehicle integration most likely.

Reviewer 4:

The reviewer noted that the collaboration between the two partners was certainly impressive and can address the expected mechanical troubleshooting. The reviewer expressed concern about the team's ability to calibrate such a complex system. The reviewer suggested that the project team consider bringing in calibration expertise, at least to help guild the large number of variables to address here.

Reviewer 5:

The reviewer pointed out that for this level of engine integration, OEM interest and high level controls support is warranted, but not in the team.

Reviewer 6:

The reviewer commented that working with Eaton was good, but it was concerning if no OEM was involved, at least from a technical advisor point of view. The reviewer expressed concern that the system may be developed in such a way that nobody would accept it due to the high cost and a highly complicated system.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer found that the project was on track to achieve the planned goals.

Reviewer 2:

The reviewer commented that the project's proposed future work was a logical extension of the program followed so far.

Reviewer 3:

The reviewer observed that the team was plugging away at the complex issues. The project plan seemed reasonable, but the reviewer suggested that contingencies were needed to manage any slippage.

Reviewer 4:

The reviewer remarked a good plan by the project team for hardware build and test, but seemed weak on system integration and ultimately a FE demonstration.

Reviewer 5:

The reviewer suggested that the focus on the current device should be re-evaluated for best pathway. Other devices are more appealing to manufacturers because they do not require base engine block changes or have been fully developed and could be purchased for testing. The reviewer suggested that one of these pathways should be considered for the device selection to simplify the hardware aspect to get into the performance demonstration phase more quickly, and to ensure OEM interest for the selected approach.

The reviewer recommended that other research, such as the Honda paper and MCE-5 work, should be summarized to ensure that the state of the art is considered in the R&D approach going forward.

Reviewer 6:

The reviewer was hopeful that a "go/no-go" decision could be really used. The reviewer views that this could be a very high risk project with no clear return path of investment.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer said that improvement of engine efficiency supported the overall DOE objectives of petroleum displacement.

Reviewer 2:
The reviewer said that improvement of engine performance had direct impact on fuel consumption and FE. It supports DOE's objectives of petroleum displacement.

Reviewer 3:
The reviewer commented that high FE for petroleum reduction supports DOE’s objectives.

Reviewer 4:
The reviewer commented that the project team projects a 40% FE improvement which surpasses that of the DOE goal of 25% improvement. While FE improvements are certain, due to various factors, they might not be as high as the project team projected. However, the reviewer found that the present project supports DOE's mission of petroleum displacement and GHG emission reduction.

Reviewer 5:
The reviewer noted that VCR devices applied to engines with Atkinson have high projected benefits. The reviewer said that VCR device development (or integration) and associated valvetrain/supercharging and controls are important steps to achieve projected gains.

Reviewer 6:
The reviewer said that the three technologies are often discussed as attractive means to drop FC. The reviewer said that we need to get a better peak in the box.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said the project’s resources were sufficient.

Reviewer 2:
The reviewer said that no provision by the project team for the significant effort of system integration, control system, and calibration to support the system demonstration FE objectives.

Reviewer 3:
The reviewer said that project’s resources were insufficient to implement a system with the hardware and controls complexity involved. The base engine development and integration and the controls efforts require significant budgets assuming a baseline control system and calibration data/approach are available. The reviewer recommended that additional partners and funding could improve risk.

Acronyms and Abbreviations

Acronym	Definition
1D	One Dimensional
3D	Three Dimensional
ACEC	Advanced Combustion and Emissions Control
AEC	Advanced Engine Combustion
AFCI	Advanced Fuel Cycle Initiative
AFR	Air to Fuel Ratio
AKI	Anti-Knock Index
ANL	Argonne National Laboratory
APS	Advanced photon source
AMR	Annual Merit Review
Au	Gold
AVFL	Advanced Vehicle/Fuel/Lubricants
BES	DOE Basic Energy Sciences
BMEP	Brake Mean Effective Pressure
BP	Bandpass
BSFC	Brake-specific fuel consumption
BSG	Belt-Driven Starter-Generator
BTE	Brake Thermal Efficiency
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CCC	Co-precipitated CuO_X, CoO_y, and Ceo_2 catalyst
CFD	Computational Fluid Dynamics
CI	Compression Ignition
CLEERS	Cross-Cut Lean Exhaust Emissions Reduction Simulations
CNT	Carbon Nanotubes
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COV	Coefficient of variance
CPU	Central processing unit
CR	Compression Ratio
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CSC	Cold Start Concept
CT	Computed tomography
Cu	Copper
CZ	Ceria-zirconia
D-EGR	Dedicated-Exhaust Gas Recirculation
DC	Direct current
DI	Direct Injection

Acronym	Definition
DISI	Direct Injection Spark Ignited
DOC	Diesel oxidation catalyst
DOD	U.S. Department of Defense
DOE	Department of Energy
DPF	Diesel particulate filter
DSNY	City of New York Department of Sanitation
DTBP	Di-t-butyl peroxide
E85	85 percent Ethanol blend with gasoline
ECN	Engine Collaboration Network
ECU	Engine control unit
EGR	Exhaust Gas Recirculation
EHN	2-ethylhexyl nitrate
EHR	Exhaust heat recovery
EPA	U.S. Environmental Protection Agency
ERC	Engine Research Center
FACE	Fuels for Advanced Combustion Engines
FE	Fuel Economy
FGM	Flamelet generated manifold
FMEP	Friction mean effective pressure
FST	Filter sensing technologies
FTP	Federal Test Procedure
FTIR	Fourier Transform Infrared Spectroscopy
FY	Fiscal year
GDI	Gasoline Direct-injected
GDCI	Gasoline Direct Compression Engine
GFR	Glomerular filtration rate
GHG	Greenhouse gas
GM	General Motors Corporation
GPF	Gasoline Particulate Filter
GPU	Graphics Processing Unit
GSA	Advanced probing technique
GTDI	Gasoline Turbocharged Direct Injection
H_2	Hydrogen
HC	Hydrocarbon
HCCI	Homogeneous Charge Compression Ignition
HD	Heavy-Duty
HECC	High efficiency clean combustion
HEDGE	High-Efficiency Dilute Gasoline Engine
HPC	High Performance Computing
HV	High voltage
ICE	Internal Combustion Engine
ICT	Institute of Chemical Technology
IMEP	Indicated Mean Effective Pressure

Acronym	Definition
IP	Intellectual property
ISFC	Indicated Specific Fuel Consumption
ITE	Indicated Thermal Efficiency
K	Potassium
Kn	Knudsen Number
L	Liter
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LD	Light-Duty
LES	Large Eddy Simulation
LEV	Low Emission Vehicle
LIF	Laser-induced fluorescence
LLNL	Lawrence Livermore National Laboratory
LNT	Lean NO_x Trap
LPL	Low-pressure loop
LTC	Low Temperature Combustion
LTGC	Low Temperature Gasoline Combustion
MBC	Model based controls
MCE	Multi-cylinder engine
MD	Medium-Duty
Mg	Magnesium
MIT	Massachusetts Institute of Technology
mJ	Milijoule
Mn	Manganese
MOU	Memorandum of Understanding
MPG	Miles Per Gallon
ms	Milliseconds
MSU	Michigan State University
MTU	Michigan Technological University
N_2	Nitrogen
N_2O	Nitrous Oxide
NA	Naturally aspirated
NH_3	Ammonia
NIST	National Institute of Standards and Technology
NMOG	Non-methane organic gases
NO	Nitric Oxide
NO_x	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
NREL	National Renewable Energy Laboratory
NSC	NO_x Storage Catalyst
NSF	National Science Foundation
NSR	NO_x Storage Reduction
NVO	Negative Valve Overlap

Acronym	Definition
O_2	Oxygen
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer
OH	Hydroxide
ORC	Organic Rankine Cycle
ORNL	Oak Ridge National Laboratory
OSC	Oxygen storage capacity
OSU	Ohio State University
PAH	Polycyclic aromatic hydrocarbon
PCCI	Premixed Charge Compression Ignition
PDT	Pulse discharge technique
PFI	Port Fuel Injection
PFS	Partial fuel stratification
PGM	Platinum group metal
PI	Principal Investigator
PM	Particulate matter
PN	Particulate number
PNA	Passive NO_x adsorber
PNNL	Pacific Northwest National Laboratory
POD	Proper orthogonal decomposition
PPC	Partially Premixed Combustion
ppm	Part per million
Pt	Platinum
PWM	Pulse width modulation
R&D	Research and development
RANS	Reynolds-Averaged Navier Strokes
RCCI	Reactivity Controlled Compression Ignition
RCM	Rapid compression machines
RF	Radio frequency
SACI	Spark assisted compression ignition
SAE	Society of Automotive Engineers
SCR	Selective Catalytic Reduction
SCRF	Selective catalytic reduction on filters
SEM	Scanning electron microscope
SI	Spark-ignition
SIDI	Spark-ignition direct-injection
SNL	Sandia National Laboratories
SULEV	Super Low-Emission Vehicle
SUV	Sport utility vehicle
TARDEC	U.S. Army Tank and Automotive Research, Development and Engineering Center
TCR	Thermochemical recuperation
TDC	Top dead center
TE	Thermoelectric

Acronym	Definition
TEG	Thermoelectric Generator
TRD	Transmission radiation detector
TWC	Three-Way Catalyst
UC	University of California
UConn	University of Connecticut
UHC	Unburned hydrocarbons
UM	University of Michigan
USCAR	U.S. Council for Automotive Research
U.S. DRIVE	U.S. Driving Research and Innovation for Vehicle Efficiency and Energy sustainability
UW	University of Wisconsin
UWM	University of Wisconsin-Milwaukee
VCR	Variable compression ratio
VCT	Variable camshaft timing
VTO	Vehicle Technologies Office
VUV	Vacuum ultraviolet
VVA	Variable Valve Actuation
WHR	Waste Heat Recovery
WSU	Washington State University
XAFS	X-ray absorption fine structure
XPS	X-ray photoelectron spectroscopy
Zr	Zirconium
ZT	Thermoelectric Figure of Merit

5. Fuel and Lubricant Technologies

As transportation accounts for two-thirds of the nearly $1 billion the U.S. spends daily on foreign oil, it is vital to increase our use of alternative fuels. Increasing the fuels available to drivers reduces price volatility, supports domestic industries, and increases environmental sustainability.

Reaching VTO's goals will help the country meet the Renewable Fuel Standard's goals for use of biofuels in the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007. These goals require the use of 36 billion gallons of renewable fuels annually by 2022.

To reach these goals, VTO supports activities to:

- Research fuels' effects on combustion: Improves understanding of how fuels from new sources can affect advanced combustion systems.
- Research lubricants: Works to develop lubricants that can improve the fuel economy of vehicles in the current fleet.
- Research natural gas: Works to support the development of natural gas engines and renewable natural gas projects.
- Research biofuels and their effects on combustion: Works to determine the impact of biofuels' properties on engines' efficiency, performance, and emissions. Activities include examining ways to increase alternative fuel vehicles' fuel economy, investigating the potential effects of upcoming blends, and improving the quality of current and future biofuel blends, especially biodiesel and E85.

The Fuel and Lubricant Technologies subprogram supports research and development (R&D) to provide vehicle users with cost-competitive options that enable high fuel economy (FE) with low emissions, and contribute to petroleum displacement. This is accomplished through exploitation of fuel properties to enable advanced combustion, development of efficiency-improving lubricants compatible with new and existing engines and vehicles, and fit-for-service evaluations of low-carbon alternatives to petroleum-based fuels. Future transportation fuels will be produced from refinery feedstocks derived increasingly from non-conventional sources including heavy crude, oil sands, shale oil, coal, and renewable resources such as biomass, vegetable oils, and waste animal fats. The impact of changes in refinery feedstocks and processes on finished fuels is an area of interest in terms of impacts on engines, emissions regulations, and end uses. Additionally, new lubricants will require increasingly sophisticated additive packages and higher-quality base fluids that can deliver higher efficiency with better engine protection.

Subprogram activities are intended to: (1) enable future advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; (2) develop efficiency-improving lubricants including products compatible with legacy vehicles (i.e., enabling lubricant retrofits); and, (3) reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. These activities are coordinated with and supportive of the U.S. Environmental Protection Agency’s fuels- and emissions-related activities, as mentioned in their strategic plan.

The major subprogram goals for Fuel and Lubricant Technologies are:

- By 2015, expand operational range of low-temperature combustion to 75% of light-duty Federal Test Procedure (FTP).
- By 2015, demonstrate-cost effective lubricant with 2% FE improvement.

Different fuels meeting the same specifications can have widely varying impact on engine performance and emissions.

The Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) mandates the use of enormous amounts of renewable fuels (36 billion gallons annually by 2022). Current ethanol markets are not able to absorb the volumes mandated; use of intermediate blends may be required. In addition, future feedstocks for fuel production are expected to come from alternative fossil sources. Understanding the impact of these fuels and fuel blends on current and advanced combustion engines is critical to increasing their use. Technical issues that need to be addressed include: lack of data and tools for predicting fuel and lubricant property effects on engine operation; fuel and lubricant effects on emissions and emission control systems. This subprogram is developing data and tools, in collaboration with many partners in industry, academia and government impacting new and old vehicles, as well as small non-road engines.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Kevin Stork (U.S. Department of Energy) – ft000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer said yes, and commented that the program was relatively unchanged from last year.

Reviewer 2:
The reviewer said yes, and summarized that the presentation reviewed effects from natural gas, development work in higher octane and cetane fuels, and other future fuels. The reviewer noted a lube effort regarding predictive modelling, engineered surfaces, and opportunities for retrofit-able technologies.

Reviewer 3:
The reviewer commented that the program mainly focused on end-use fuels research and development (R&D) with emphasis on internal combustion engine (ICE) combustion and integration of lubricant program. The reviewer remarked that this program is comprehensive. The reviewer perceived that including a big picture of the whole program would be very helpful to make a connection between current projects, past and future direction. This should help to better understand the overall strategy.

Question 2: Is there an appropriate balance between near-, mid- and long-term research and development?

Reviewer 1:
The reviewer said yes, and commented that beyond octane and cetane, fuels offer a long-term challenge/opportunity.

Reviewer 2:
The reviewer said yes, and clarified that some goals are stretch targets, but for large gains, things must be invented.

Reviewer 3:
The reviewer remarked that the presentation did not include a clear distinction between near-, mid- and long-term goals.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer said yes. Of particular interest for this reviewer were the 2% fuel economy improvement from oil additives versus Mobil 1, reactivity controlled compression ignition (RCCI) fuel development, biofuels and alternate fuels, and increased availability of medium-duty (MD) natural gas engines.

Reviewer 2:
The reviewer said yes, and elaborated that the program manager has clearly identified major challenges. In particular, the reviewer commented that the connection with ICE combustion program is excellent to ensure challenges are well integrated with other programs.

Reviewer 3:
The reviewer noted that funding was addressed, and increased over previous years.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer said yes. The reviewer pointed out that the presentation described the methodology for tools development, and that more details would be in subsequent presentations.

Reviewer 2:

The reviewer noted that Slide 13 showed the strategies to address challenges for the lubrication program. The reviewer said that a similar slide for fuel program would be very helpful.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:

The reviewer said yes, and observed that not much had changed.

Reviewer 2:

The reviewer noted nano-technologies, ionic liquids, and replaced zinc dialkyl-dithio-phosphate (ZDDP) with materials better suited to catalysts/aftertreatment.

Reviewer 3:

The reviewer said no, and the presentation mostly focused on the importance of the program.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer responded yes, clarifying that the projects directly supported Vehicle Technologies Office (VTO) objectives of petroleum displacement and increasing fuel efficiency in vehicles.

Reviewer 2:

The reviewer said yes, and remarked improved economy via reduced frictional losses.

Reviewer 3:

The reviewer commented that some octane ratings were incompatible with current engines (e.g., ethanol content greater than 10-15% is not compatible with current generation of cars).

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO’s needs?

Reviewer 1:

The reviewer said yes, and gave as examples higher-octane fuels, higher compression ratios for future engines, ethanol and charge cooling effect, and renewable and reduced carbon fuels.

Reviewer 2:

The reviewer said yes.

Reviewer 3:

The reviewer stated that looking into the defined projects and after listening to most of the projects’ presentations in this program, this reviewer can confirm that the area is focused on VTO’s needs and that all the projects support VTO needs. Some projects have focus on fundamental aspects and some have focus on practical aspects, but all are in the direction to address VTO's needs.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:

The reviewer pointed out new standards for biodiesel.

Reviewer 2:

The reviewer commented that scalability/implementation appear to be issues to overcome once technology is proven.

Reviewer 3:

The reviewer said that the program covers a good range of projects dealing with fundamental to practical aspects of fuel effects on ICE combustion. There is more concentration on fundamental understanding in this program. The reviewer commented that while fundamental understanding is critical, it is important that those fundamental projects do not lose sight of practicality. This reviewer heard a presenter say that this is a fundamental study and we do not care about practicality for now. So for this reviewer, it is important to ensure the fundamental projects are well-linked to practical projects or at least have a clear roadmap for this interaction.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:

The reviewer said yes, and gave as examples RCCI and lean lifted flame combustion (LLFC) related projects clearly indicated novel approaches which can potentially lead to very promising outcomes.

Reviewer 2:

The reviewer said yes, and commented very interested in ionic liquids.

Reviewer 3:

The reviewer suggested to expand the operating range of RCCI operation.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:

The reviewer said yes, and cited as examples Clean Cities and many others.

Reviewer 2:

The reviewer said yes, most of the projects include strong partnerships including fuel/engine original equipment manufacturers (OEMs), national laboratories and academia. In addition, the program has an excellent collaboration with the ICE program.

Reviewer 3:

The reviewer agreed that the program appeared to have collaboration.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:

The reviewer said yes.

Reviewer 2:

The reviewer said yes. The reviewer commented more synergy with fuel economy standards, greenhouse gas (GHG) emissions, and biofuels strategies (referenced on Slide 9). The reviewer also cited fuel properties for future engines.

Reviewer 3:

The reviewer said not enough information to judge.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:

The reviewer said not that come to mind.

Reviewer 2:

The reviewer reported that an inquiry was raised regarding the possibility of pursuing GHG emission reductions as aggressively as criteria pollutant emissions.

Reviewer 3:

The reviewer commented that given that there are limited funding resources, it would be good to come up with a strategic plan for this program that identifies which fuels have higher priority. This reviewer explained that there is a large range of oxygenated fuels, biodiesel, and petroleum-based fuels. For example, natural gas seems to have high priority in fiscal year (FY) 2015. The reviewer suggested that having a roadmap will be helpful.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:

The reviewer said no. This reviewer particularly liked mention of co-development of engines and fuels. The reviewer specified high-octane fuels and advanced combustion development.

Reviewer 2:

The reviewer said not that come to mind.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer suggested conclusive comparative studies to help define a roadmap to determine the future focus of the Fuels Technologies program for future fuels.

Reviewer 2:

The reviewer inquired about the best way to use natural gas in transportation and cited heavy-duty (HD) trucks, marine, and rail. The reviewer also added the removal of barriers to natural gas use.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer said no.

Reviewer 2:

The reviewer said natural gas refueling infrastructure, HD range issues, and storage.

Reviewer 3:

The reviewer noted that the program may encourage and demand more collaborative efforts among the projects, so the loops are well-connected as some of the projects just focus on fuel and some mainly do experimental engine study.

Reviewer 4:

The reviewer commented that fuel, combustion, and control/calibration are the three key elements that determine final outcome for fuel economy and emissions from an ICE engine/vehicle. The reviewer said that defining integrated projects in this area will be critical to bridge fuel R&D program to VTO’s needs.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer said no.

Reviewer 2:

The reviewer recommended supporting precompetitive biofuels work, and advanced deployment of natural gas engines. The reviewer also commented pursuing lubes work with new base oils, VI improver that are less sensitive to temperature variation, and advanced lube additives.

Project Feedback

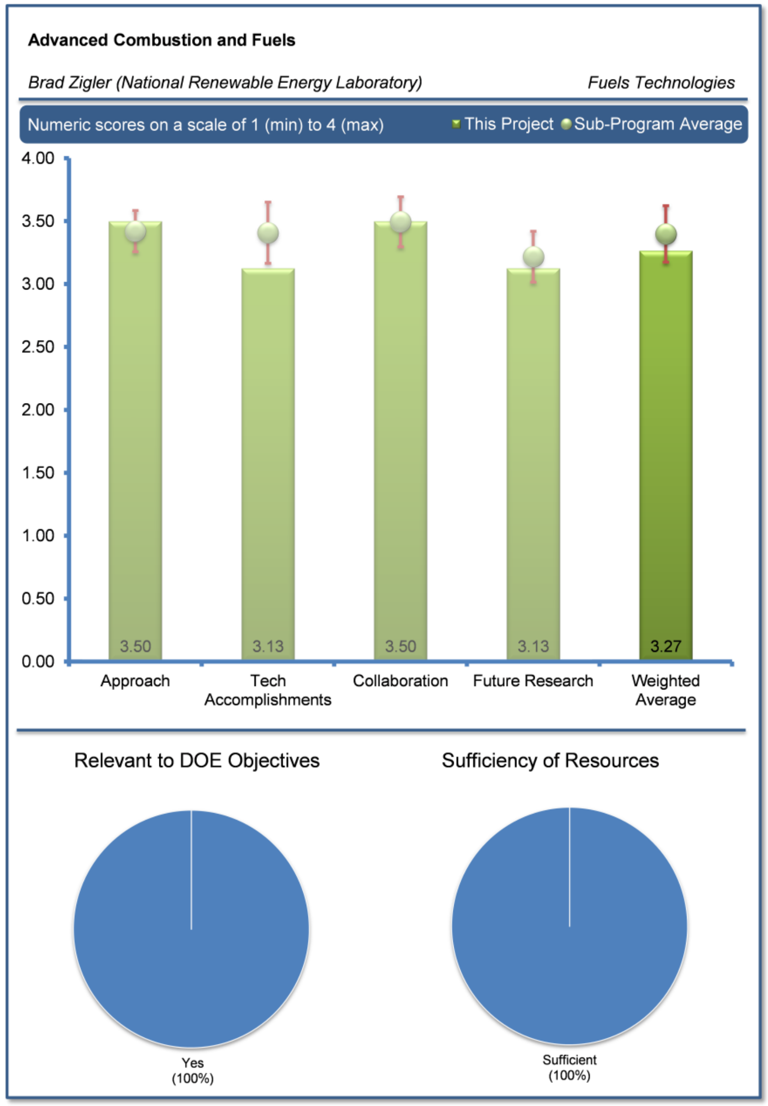
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Advanced Combustion and Fuels	Brad Zigler (National Renewable Energy Laboratory)	5-9	3.50	3.13	3.50	3.13	3.27
Performance of Biofuels and Biofuel Blends	Bob McCormick (National Renewable Energy Laboratory)	5-12	3.63	3.50	3.38	3.50	3.52
Fuel Effects on Mixing-Controlled Combustion Strategies for High-Efficiency Clean-Combustion Engines	Chuck Mueller (Sandia National Laboratories)	5-15	3.63	3.50	3.63	3.25	3.52
Advanced Lean-Burn DI Spark Ignition Fuels Research	Magnus Sjoberg (Sandia National Laboratories)	5-19	3.60	3.60	3.20	3.20	3.50
Fuel Effects on Emissions Control Technologies	Todd Toops (Oak Ridge National Laboratory)	5-23	3.50	3.50	3.67	3.50	3.52
Gasoline-Like Fuel Effects on Advanced Combustion Regimes	James Szybist (Oak Ridge National Laboratory)	5-25	3.38	3.50	3.50	3.25	3.44
† Engine Friction Reduction Technologies	George Fenske (Argonne National Laboratory)	5-28	3.17	3.00	3.50	3.00	3.10
Ionic Liquids as Anti-Wear Additives for Next-Generation Low-Viscosity Fuel-Efficient Engine Lubricants	Jun Qu (Oak Ridge National Laboratory)	5-30	3.67	3.83	4.00	3.50	3.77
Demonstration/Development of Reactivity Controlled Compression Ignition (RCCI) Combustion for High Efficiency, Low Emissions Vehicle Applications	Rolf Reitz (Wisconsin Engine Research Consultants LLC)	5-33	3.50	3.88	3.38	3.25	3.64
High Compression Ratio Turbo Gasoline Engine Operation Using Alcohol Enhancement	John Heywood (Massachusetts Institute of Technology)	5-36	3.50	3.60	3.40	3.40	3.53
Fuel Properties to Enable Lifted-Flame Combustion	Eric Kurtz (Ford Motor Company)	5-40	3.14	3.21	3.50	2.86	3.19
Boric Acid as a Lube Additive	Ali Erdemir (Argonne National Laboratory)	5-45	3.25	3.25	3.75	3.13	3.30
Lubricant Formulations to Enhance Engine Efficiency in Modern Internal Combustion Engines	Wai Cheng (Massachusetts Institute of Technology)	5-48	3.25	3.13	3.25	3.25	3.19
Development of Modified Polyalkylene Glycol High VI High Fuel Efficient Lubricant for Light-Duty Vehicle Applications	Arup Gangopadhyay (Ford Motor Company)	5-51	3.38	3.25	3.63	3.13	3.31
† Can hard coatings and lubricant anti-wear additives work together?	Jun Qu (Oak Ridge National Laboratory)	5-54	3.33	3.33	3.33	3.33	3.33

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† CFD simulations and experiments to determine the feasibility of various alternate fuels for compression ignition engine applications	Sibendu Som (Argonne National Laboratory)	5-56	3.33	3.33	3.33	2.83	3.27
Overall Average			**3.42**	**3.41**	**3.50**	**3.22**	**3.40**

† denotes poster presentations.

Advanced Combustion and Fuels: Brad Zigler (National Renewable Energy Laboratory) - ft002



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that the project had a good mix of experimental and modeling work.

Reviewer 2:

This reviewer pointed out that expansion of the capabilities of the ignition quality tester (IQT) instrument should help determine the cetane number of samples only available in small quantities, as well as develop data needed to validate kinetic mechanisms.

Reviewer 3:

The reviewer explained that this project focuses on solving problems that cut across fuels technologies and advanced combustion, but characterizes conventional and alternative fuels and fuels designed for advanced combustion. The reviewer went on to say that it simultaneously builds a database on fuel behaviors and demonstrates linkages between combustion simulation and experimentation.

Reviewer 4:

The reviewer observed that the approach mainly centered on using IQT. While the current approach is very good, further expansion to complete the fuel and combustion modeling loop would add to the value of this project. For example, it is great to see the outcome was used in *iso*-cetane (HMN) mechanism. Given the base engine is the same as Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL), there should be enough opportunities for joint works to complete the fuel and combustion loop. The reviewer suggested that including at least one slide for showing this loop would add to the value of presentation in future AMRs. The reviewer also noted that it was unclear what the main use of the CONVERGE model for IQT was.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer praised the project's good progress and noted the technical paper going into print from the work with the IQT and simulations. The reviewer commented on how the project serves to validate reduced mechanisms and explores emerging fuel compounds and formulation. This reviewer observed that the extension to gasoline and gasoline direct injection (GDI) combustion is a bit of a stretch, in that the structure of the reaction environment in the IQT may not reflect that which is occurring in the GDI engine environment. The basic ignition information is still valuable, the reviewer offered, but there is a discrepancy between the IQT test environment and structure, and that which is expected to occur in a lube oil droplet initiation of autoignition in a wall-guided GDI engine.

Reviewer 2:

The reviewer noted that there was good progress in expanding IQT capabilities, including reducing size of samples needed for measurements, testing fuels under conditions where the negative temperature coefficient (NTC) regime occurs, and obtaining fundamental combustion data needed to refine kinetic combustion models.

Reviewer 3:

The reviewer brought to light that this project provided a critical understanding for characterizing fuel ignition delay. This is particularly important for new fuels such as biodiesel, for which little information is available. The results from this project help to develop reduced-order chemical kinetic mechanisms and also develop low-order models of ignition delay for combustion control applications. Given the current focus of internal combustion engine (ICE) program on low-temperature combustion (LTC) engines, it is necessary to ensure that IQT testing covers all the fuels which have been exploited in LTC engine studies. The reviewer offered that it is critical to ensure proper separation of chemical kinetics ignition delay and spray physical delay in measurements and analysis.

Reviewer 4:

The reviewer expressed that the milestones are weak, and that the project status updates need real, performance-based~~,~~ milestones. The reviewer added that it took many years, but it appears that modified IQT can now be considered a useful kinetic tool.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that the project includes strong involvement with industry, academia, and other national labs. Providing the data from this project in a common database platform such as Cross-Cut Lean Exhaust Emissions Reduction Simulation (CLEERS) or others can leverage further collaboration opportunities and expand the application of the results from this project.

Reviewer 2:

The reviewer reported that there was a broad team including labs, universities and industry, through the Advanced Engine Combustion (AEC) Memorandum of Understanding (MOU) and Coordinating Research Council (CRC) relationships.

Reviewer 3:

The reviewer affirmed that there were mostly collaborations with other national laboratories and universities, including Colorado School of Mines (CSM) and the University of California-Berkeley. Some collaboration with industry through Project 18 under Advanced Vehicle/Fuel/Lubricants (AVFL-18) of the CRC on improved surrogate diesel fuels.

Reviewer 4:

The reviewer remarked that although a combustion MOU is valuable, the reviewer did not consider it a collaboration, and asserted that collaboration means actually working together. The reviewer went on to express that collaboration with CSM is very valuable for modeling support, and that working with other labs in kinetics such as ANL and Lawrence Livermore National Laboratory (LLNL) is a valuable collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer confirmed that the plans seem reasonable, and thought that it will be interesting to see if the IQT can provide meaningful data for the low-speed pre-ignition (LSPI) issue.

Reviewer 2:

The reviewer stated there is a solid plan in place to complete the goals of the project by the due date. Looking into a range of oxygenated fuels, such as those with a different research octane number (RON) will be important. The reviewer suggests that if possible, studying surrogate fuels from Sandia National Laboratories (SNL), specifically Principal Investigator (PI) Mueller, could be rewarding in order to make a link between different U.S. Department of Energy (DOE)-funded programs. The reviewer concluded that injector characterization seems an important factor to separate spray physical delay from chemical kinetics delay.

Reviewer 3:

The reviewer observed that it is probably not necessary to spend a lot of time developing the ability to test with less than 25 milliliters (mL) of a fuel. LSPI work needs to close the loop with another group doing engine sampling. The reviewer would like to see more about how the project team chooses fuels and compounds to study in the IQT and engine.

Reviewer 4:

The reviewer acknowledged that the project expanded the experimental capabilities, but difficulties in linking to engine work, especially in LSPI, will remain. Moving to the CID 510 sounds promising as a means of expanding experimental capability, but even with that device, there may remain challenges in linking these results to GDI and LSPI issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that this project combines research to support fuel technology and combustion technology applications that can reduce fuel consumption and displace petroleum with biofuels.

Reviewer 2:

The reviewer indicated that this project supports DOE objectives of petroleum displacement by creating a knowledge platform for fuel ignition properties to further utilize advanced and renewable fuels in combustion engines.

Reviewer 3:

This reviewer remarked that the project contributes to the kinetic community for mechanism development and provides screening of new biofuel components.

Reviewer 4:

The reviewer explained that expanded capabilities of IQT instrumentation help to obtain data needed for refining mechanistic models which are needed for design of advanced engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources appear adequate to meet objectives.

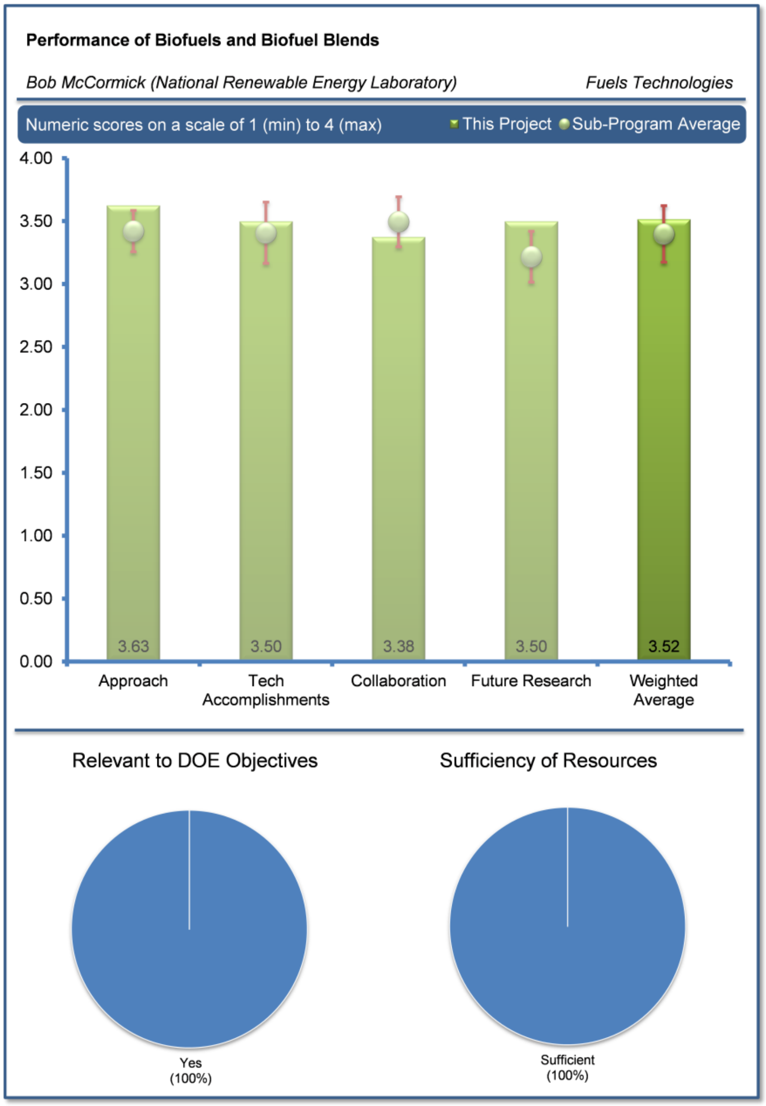
Reviewer 2:

The reviewer expressed that there is a good funding level, but that it needs to be kept stable year-to-year to maintain continuity in these efforts.

Reviewer 3:

The reviewer found that sufficient equipment exists to complete the goals of this project.

Performance of Biofuels and Biofuel Blends: Bob McCormick (National Renewable Energy Laboratory) - ft003



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded a nice approach to a useful, though narrow, research topic.

Reviewer 2:

The reviewer explained that the project examined combustion of partially oxygenated fuel blending components from pyrolysis and other processes. It answered questions about oxygenate levels that are compatible with American Society for Testing and Materials (ASTM) standards for fuel quality and performance, and performed combustion and emissions testing, and performing durability studies - including designed oxygenates and residual oxygenates left over from process technologies.

Reviewer 3:

The reviewer expressed that the National Renewable Energy Laboratory (NREL) is well qualified to perform this research.

Reviewer 4:

The reviewer indicated that this project has carried out a comprehensive study looking into solubility, storage (gum formation), and emission characteristics for range of biofuels and their blends.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer pointed out that there is a lot of detailed data, which will help when the results can be a bit more integrated into a broader set of conclusions.

Reviewer 2:

The reviewer offered that both removal of oxygen from biomass, and looking into candidate fuels compatible with distribution infrastructure, are challenging but rewarding. This project shows promising results to address and assess this challenge. The results from this study can be potentially used to find optimum compositions for biofuels for ICE operation. The reviewer also voiced that given that the project ends in September 2014, it is surprising that two major milestones (diesel engine testing and GDI engine testing) are scheduled for the last month of the project.

Reviewer 3:

The reviewer observed that the project has examined gasoline property impacts of residual oxygenates, and showed mostly no impacts of critical fuel quality tests. The project has also examined diesel fuel property impacts of residual oxygenates, and showed impacts are modest for low blend levels (i.e., 5% by weight or less). The reviewer went on to describe how the project looked at diesel performance and emissions, but noted that the project focused on regulated emissions. The reviewer asked about the effect of unregulated emissions. The reviewer asked what the fate is of the furanics, and said that the project will be looking at these questions, but will need to be aware of the analytical challenges.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer applauded strong involvement including academia, the NREL consortium, and other laboratories. The reviewer went on to suggest that more involvement from industry will be advantageous.

Reviewer 2:

The reviewer said that the correct industry people are involved and participating.

Reviewer 3:

The reviewer commended the good collaboration so far, and went on to say that it would be ideal to get more biomass treaters involved if possible.

Reviewer 4:

The reviewer pointed out the close collaboration with other entities in the state of Colorado, and compliance entities, but noted that the present team seems primarily a regional team. The reviewer offered that other universities, for example, Iowa State University, have experience in production and processing pyrolysis oils.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer reported that there is a solid plan to move forward, and that testing of real pyrolysis-derived fuels will be important.

Reviewer 2:

The reviewer recounted that the project will look at unregulated particulate matter (PM) and particle number impacts of residual oxygenates in GDI and compression ignition (CI) engines, including advanced as well as combustion processes. The reviewer mentioned that the project will explore some very interesting impacts of oxygen location in cyclic compounds on PM, and that it will explore impact of furanics on gum formation. The reviewer concluded by noting that the project will examine practical pyrolysis oil samples to compare with model compounds studies pursued to date.

Reviewer 3:

The reviewer cautioned that it seems there may be too much work to be done before concluding this project in less than three months, and offered that the results from this project should open many future research opportunities.

Reviewer 4:

The reviewer suggested that there needs to be discussion on the blending of social acceptance and infrastructure incorporation of any future fuel. Without all parties being involved, even the most brilliant idea will not be adopted.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer emphasized that the research is very relevant for alternative fuel sources as part of DOE's goals.

Reviewer 2:
The reviewer explained that the work can directly support displacement of petroleum through use of biofuels.

Reviewer 3:
The reviewer expressed that this project directly supports DOE objectives of petroleum displacement by analyzing biofuels and their blends for application in combustion engines.

Reviewer 4:
The reviewer stated that the project involves feedstocks other than petroleum sources.

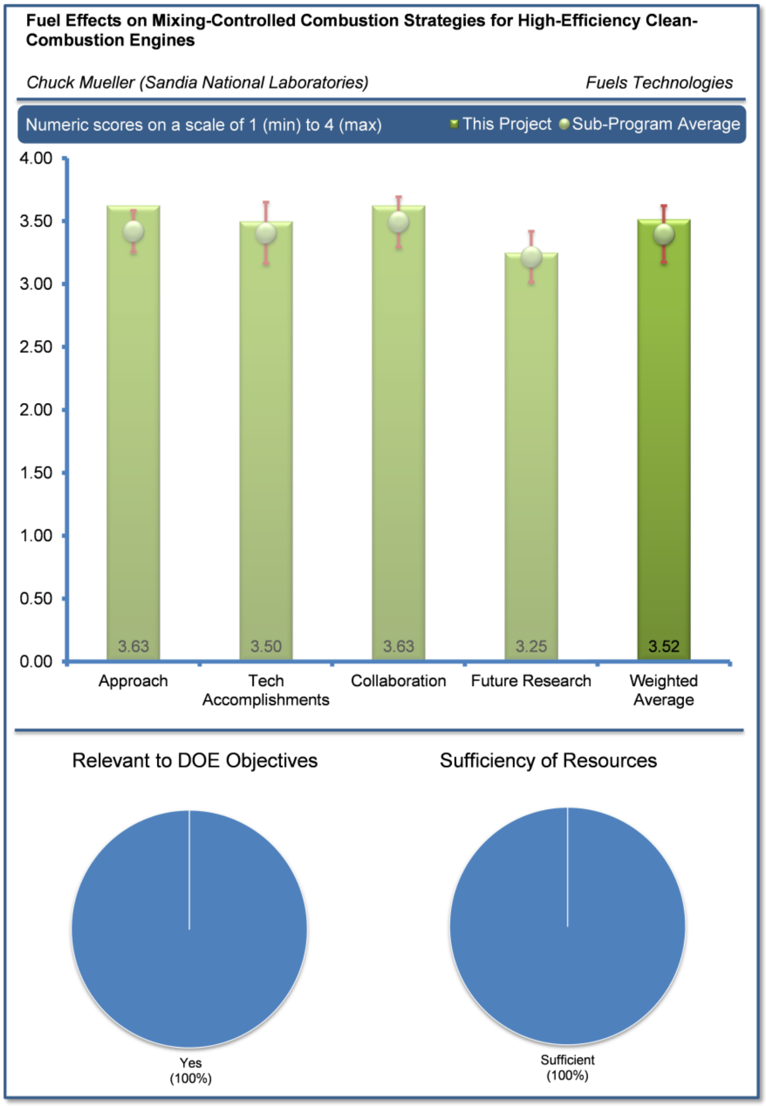
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that funding has been sufficient and is tapering off due to the end of this project.

Reviewer 2:
The reviewer asserted that adequate resources seem to be available to conclude this project.

Reviewer 3:
The reviewer remarked that funding is sufficient for the level of work, but to the reviewer, it sounded like the current funding is ending. The reviewer hoped a similar level of funding can continue, as there is much work to be done.

Fuel Effects on Mixing-Controlled Combustion Strategies for High-Efficiency Clean-Combustion Engines: Chuck Mueller (Sandia National Laboratories) - ft004



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer emphasized that the work on surrogate fuels is excellent and authoritative, and supports the development of predictive engine simulation. Mixing controlled combustion is critical in current and future technology CI engines, so continuing to evolve our understanding can have a huge impact. The reviewer wondered how the purity in the surrogate fuel blend agents (e.g., contaminants) will influence the outcomes from the surrogate mixtures. The reviewer recounted that the project has highly detailed measurements on the fuels being modeled with the surrogate, and mentioned component composition and fidelity, but inquired about the purity needed to ensure good results and consistency.

Reviewer 2:

The reviewer noted the good mix of experimental work and tool development, and liked the focus on surrogate fuels because it allows modeling to be done. The team seems to have identified and mitigated problems with purity of surrogate compounds.

Reviewer 3:

The reviewer remarked that this project uses a sophisticated approach that integrates fuel chemistry studies, optical engine investigation, potential metal engine testing, and future modeling collaboration. The reviewer went on to point out that the surrogate fuels from the project will provide a strong basis for future engine and combustion studies, so the research results from different scholars will be comparable. This is an important initial step to address the technical barrier of developing predictive tools for fuel effects on combustion and emissions.

Reviewer 4:

The reviewer indicated that the project combines development of advanced computational algorithms with the most sophisticated engine experimental, diagnostic, and observational data collection. It includes addressing a long-neglected need for predictive tools based on fuel parameters and combustion properties through the development of surrogate fuels for identifiable target fuels of interest.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that publication and reporting are strong from this program. There is valuable work on diagnostic development for in-cylinder laser-induced incandescence (LII). The reviewer asserted that surrogate fuel formulation will be useful to many research efforts, including simulation. The reviewer applauded the project for making substantial contributions in understanding fuel effects, and disseminating those results.

Reviewer 2:
The reviewer reported that one major accomplishment is the design of new diesel surrogate fuel for engine and combustion-vessel (CV) testing. This is an essential step for kinetic modeling and developing robust engine combustion control strategies. The reviewer offered that finding the relation between lift-off length and mixing combustion control (soot formation control) is very important. The reviewer added that the optical engine results for soot formation can help modeling efforts in this field by validating computational fluid dynamics (CFD) modeling results. The reviewer suggested an area of improvement to further expand this work given that there is variability in fuel properties even versus time, it would be beneficial for the research community if the PI can develop a guideline how those variations can be included. For example, as additive properties to the surrogate fuel, so the variation effects can be included systematically for combustion modeling and development of engine combustion control strategies. The reviewer understands this is a very challenging area.

Reviewer 3:
The reviewer noted that the research has identified clear relationships between lift-off length at the end of pre-mixed burn and combustion effectiveness and emissions, which have been largely ignored by other research in the field. The project has also developed sets of surrogate fuels for experimental testing and new advanced diagnostic techniques. However, it was not clear to the reviewer the extent to which this research has application beyond the concept of leaner lifted-flame combustion, most of which has apparently been spun off to a separate research project. The practical application of this appears to be quite limited due to its being dependent on tightly specified and standardized fuel parameters, which may be different for different vehicles.

Reviewer 4:
The reviewer noted that the presentation talks about understanding fuel effects, but does not really explain how an overall analysis will be done. The reviewer needs to know more about analysis and compelling trends mentioned on Slide 10.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that through the AEC MOU and CRC efforts, this program has direct connection with industry. The reviewer noted direct collaboration with Caterpillar and Ford, and other national laboratories. The project has some work ongoing and more starting with university involvement.

Reviewer 2:
The reviewer did not think that a combustion MOU should be considered a collaboration, and suggested that it would be better to highlight real collaborations with individual members and others.

Reviewer 3:
The reviewer acknowledged substantial collaboration with a long list of major institutions, including engine makers, fuel makers, other DOE laboratories, etc. Extensive coordination with related project led for Ford Motor Company on LLFC.

Reviewer 4:
The reviewer said that the project includes strong involvement/collaboration from industry, academia and other national laboratories.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that the project will continue work on surrogates, including connection to simulation and predictive engine modeling. The team will also continue to develop an understanding of fuel effects and will explore new methods for enhancing mixing in-cylinder.

Reviewer 2:
The reviewer stated that the future plan is logical. The reviewer suggested important research opportunities. Developing surrogates for biodiesel fuels can be very helpful for the research community because there is large variability among fuel properties of biodiesel fuels. This should be challenging, but very rewarding to connect a large number of independent biodiesel fuel combustion studies. The reviewer also suggested that collaborative work to utilize newly designed surrogate fuels from this project with chemical kinetic mechanisms (for example from LLNL) for combustion modeling and integration with metal engine testing could make an excellent accomplishment for this project.

Reviewer 3:
The reviewer cautioned that ducted chamber work should not be undertaken until there has been more analysis and modeling done. Research would be more valuable if more direct collaboration with kinetic and CFD modelers was established.

Reviewer 4:
The reviewer commented that the presentation suggested various areas of continued research on promising diagnostic and analytical tools. The slides on proposed future work are somewhat unclear on which research would be done under this project and which would be done under the related project (by many of the same team members) on LLFC. The reviewer claimed that the one new direction of future research, the "Ducted Combustion Chamber" for LLFC, was explained vaguely - it is not clear to this reviewer what would constitute the duct walls or how such walls would exist or survive within a combustion chamber, let alone within one with a reciprocating piston.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer mentioned that this project supports DOE objectives of petroleum displacement by creating fundamental basis for surrogate fuels to foster future internal combustion engine research, which can lead to more fuel-efficient combustion engines.

Reviewer 2:
The reviewer noted that it can lead to displacement of petroleum with new fuels and improved efficiency.

Reviewer 3:
The reviewer acknowledged that the research provides a thorough understanding of achieving dilute combustion in a diesel platform, and sets out parameters for achieving efficient combustion.

Reviewer 4:
The reviewer remarked that the project aims to develop advanced diagnostic and evaluative tools that could be used to identify optimal fuel blends or engine configurations to substantially enhance fuel efficiency and reduce emissions. It also enhances understanding of combustion effectiveness as related to fuel parameters and to lift-off in general. It also investigates a specific combustion strategy – LLFC – that is a promising area of research, but it is not clear how practical its implementation would be in a world of multiple fuel blends in the market, but could conceivably point to some areas of ultimate fuel property standardization if the benefits are substantial enough.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

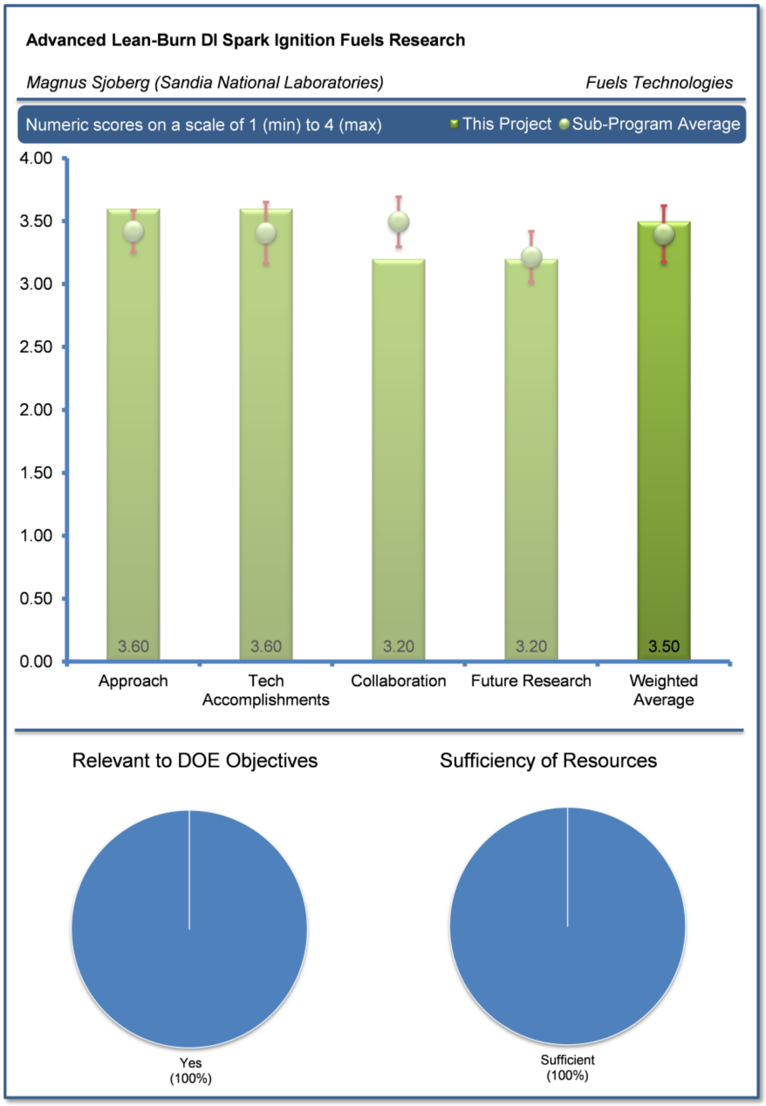
Reviewer 1:
The reviewer commented that the funding is sufficient and level, which is helpful in maintaining program quality and continuity.

Reviewer 2:
The reviewer summarized that resources are adequate for project goals.

Reviewer 3:
The reviewer said that adequate resources seem to be available to the PI.

Reviewer 4:
The reviewer observed that the project has achieved numerous milestones to date but some of the key objectives, such as target and surrogate fuels, have been pursued for a number of years and remain to be completed. Such completion appears to be slated for the coming year although the reviewer pointed out that presentation language is not completely clear on that.

Advanced Lean-Burn DI Spark Ignition Fuels Research: Magnus Sjoberg (Sandia National Laboratories) - ft006



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that combining metal engine and optical engine testing with modelling is very good. From the presentation it sounded like there are efforts underway to fill the need for CFD collaborators.

Reviewer 2:

The reviewer acknowledged that the approach to combine metal and optical engine experiments to develop an understanding of the impact of fuel properties on advanced spark ignited engines has proven to be very successful.

Reviewer 3:

The reviewer said that the project is studying direct injection spark-ignited (DISI) combustion using spray-guided combustion for lean operation. The project is seeking to develop a fundamental understanding of spray-guided spark ignition (SI) combustion and fuel impacts on spray-guided DISI (particularly ethanol, but also monitoring emerging biofuels). The reviewer recounted how the team is combining metal engines, optical engines, and simulation to better understand ways to mitigate barriers to effective and efficient combustion. The reviewer concluded by saying that the research engine combines metal and optical configurations using the typical SNL single-cylinder research engine (SCRE) configuration. This approach yields fundamental understanding with authoritative measurements.

Reviewer 4:

The reviewer highlighted that the work provides valuable comparison of stratified and lean burn DISI strategies with a number of injection and ignition strategies.

Reviewer 5:

The reviewer explained that the project uses a mainly experimental approach based on metal engine and optical engine results to provide an understanding to optimize combustion for stratified and well-mixed combustion in DISI engines. Analysis of optical engine results for characterizing combustion regime (for example, tail versus head ignition) and relation to heat release rate (HRR) and cyclic variability is excellent. The reviewer mentioned that there is enough room for using CFD models to provide a more in-depth analysis of dilute DISI engines with ethanol-blended fuels. It is good to see that CFD modeling is part of the future plan and this should also help in tackling the barrier of predictive tools for fuel property effects on combustion and engine efficiency optimization.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the project is on schedule and that it studied fuel blend impacts on stratified operation. The project is considering the role of ignition location on combustion variability and flame development. In addition, the project team considered well mixed dilute combustion and novel ignition systems. The team observed benefits of ethanol on smoke emissions, but also recognized critical importance of ignition location (i.e., the fact that tail ignition suppresses soot formation) for gasoline. The reviewer acknowledged that high ethanol content helps allow tail or head ignition. These observations are highly valuable for understanding how to control critical engine operating and configuration parameters. Yields well supported interpretation of impacts of control parameters and fuel. The reviewer concluded by saying that the publication rate from the project is very good.

Reviewer 2:

The reviewer stated that the results provide outstanding fundamental understanding for running lean-burn DISI engines at optimum operation. Given all the results are presented for 19-21% exhaust gas recirculation (EGR) and O_2, it raises a question how the dilution level will impact the findings from this study.

Reviewer 3:

The reviewer commended the project on very good progress on meeting milestones. This person pointed out that over the past year progress was made on determining the role of ethanol and gasoline mixture proportions on soot emissions for stratified operation over a range of loads. The project showed that highly stratified operation is not suitable for gasoline for the system tested. The project team was also able to statistically quantify the relationship between the in-cylinder flow fields, spark-plasma development, and combustion variability. The project also determined the role of ethanol and gasoline mixture proportions on the stability of stratified ignition for wide ranges of spark timings.

Reviewer 4:

The reviewer applauded technical accomplishments in both DISI with spray-guided stratified charge combustion system and in the area of DISI with well-mixed dilute combustion system, and stated that they have been very good. Milestones in the project continue to be met including determining the role of ethanol and gasoline mixture proportions on soot emissions across load ranges for stratified engines.

Reviewer 5:

The reviewer felt the project team did not give a good understanding of the research in this presentation and thus the reviewer would need to check publications to understand better.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that collaboration and coordination in this project continue to be excellent. The researchers are working with the 15 industry partners through the AEC MOU along with LLNL, General Motors Company (GM), and several universities, which brings together a great deal of expertise to help make this project a success.

Reviewer 2:

The reviewer stated that the project includes involvement from a large number of industry partners through the MOU, two universities, and another national laboratory.

Reviewer 3:

The reviewer noted that the project has connections to industry through the AEC MOU, and connections to GM for hardware and various collaborators. The reviewer observed the missing element to date is a connection to a simulation partner.

Reviewer 4:

The reviewer commended the good set of collaborators, and suggested that the researchers should consider adding a CFD collaborator.

Reviewer 5:

The reviewer pointed out collaborations with one original equipment manufacturer (OEM) – although the reviewer thought it was not clear if the OEM just provides hardware – several universities, and one national laboratory. As with most of the projects that claim collaboration through the AEC MOU Working Group, it is not clear if the interactions only consist of the questions asked during the twice per year presentations, or if they are more extensive.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer explained that the project will continue the study of fuel blend effects in stratified operation, complete swirl-stabilization studies, expand from lean and dilute operation to partial stratification, as well as work further on diagnostics and simulation. This is a very productive study and the future work plan is more than satisfactory. The reviewer emphasized, however, the need to link with a CFD partner soon. This person commented that it would be very interesting to compare these ethanol studies, particularly the sooting behavior relative to ignition location and oxygenate content, with studies of butanol (iso-butanol in particular). This could permit the study of oxygen content and octane number individually, because the oxygen and octane are currently varying simultaneously.

Reviewer 2:

The reviewer expressed support for the proposed plans to devote more attention to 0% ethanol blend with gasoline (E0) to 30% ethanol blend with gasoline (E30) blends.

Reviewer 3:

The reviewer asserted that future work identified for the remainder FY 2014 and FY 2015 will be to continue several ongoing projects including studying the effects of fuel blends E0 to E30. The efforts identified for future work will continue to address the barriers of this project.

Reviewer 4:

The reviewer affirmed a logical plan for the continuation of the project.

Reviewer 5:

The reviewer would like to see a more holistic evaluation of the combustion strategies, such as ability to be fuel-robust, the ability to work with conventional aftertreatment, and more information about operating ranges and limits.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer mentioned that pushing engine efficiency to higher levels, which this project can enable, will displace petroleum through reducing consumption.

Reviewer 2:

The reviewer explained that research will help with development of unthrottled lean combustion, which should be more efficient than stoichiometric combustion.

Reviewer 3:

The reviewer asserted that exploration of concepts to improve fuel economy and reduce emissions supports DOE objectives.

Reviewer 4:

The reviewer observed that determining fuel characteristics that enable advanced combustion engines to operate as efficiently as possible helps to meet the DOE goal of petroleum displacement through efficiency gains.

Reviewer 5:

The reviewer indicated that this project directly supports DOE objectives of petroleum displacement by further utilizing renewable fuels and increasing fuel efficiency in lean-burn combustion engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer recounted that funding should be sufficient for the project to complete the tasks and milestones for this fiscal year. It is not clear if adequate funding is available for the future work that is proposed.

Reviewer 2:

The reviewer offered that the project has a good level of funding and looks stable/increasing.

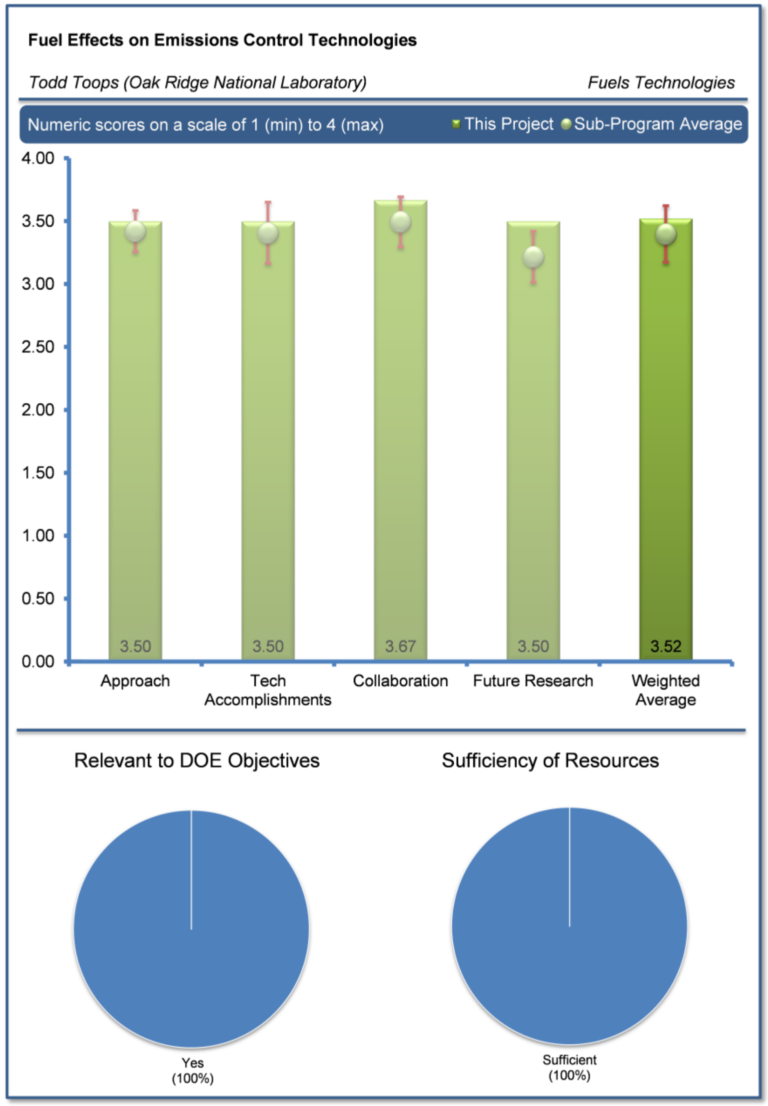
Reviewer 3:

The reviewer stated that funding seems sufficient to meet objectives.

Reviewer 4:

The reviewer claimed that sufficient experimental facility exists, and adding CFD capability through collaborative efforts will be advantageous.

Fuel Effects on Emissions Control Technologies: Todd Toops (Oak Ridge National Laboratory) - ft007



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer affirmed that the approach to provide in-depth characterization of particulate matter, hydrocarbons, and emission control devices to better understand fuel and lubricant effects has proven to be very successful.

Reviewer 2:

The reviewer indicated that it is unclear how topics are selected and retired for each year's work. ORNL has developed rapid techniques and special sampling and analysis to move work faster and to lead to more knowledge.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that the project has made excellent progress in each of the five research areas on addressing the technical barriers. In addition, all of the FY 2014 milestones have either been achieved or are on schedule to be completed this fiscal year.

Reviewer 2:

The reviewer pointed out the good results for each topic, but found it hard to relate some of them to the big picture, and suggested that the significance of the results needs to be pounded home.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commended the project on a very good set of collaborators including laboratories, universities, catalyst companies, and Manufacturers of Emission Controls Association (MECA).

Reviewer 2:

The reviewer pointed out that this project has several collaborators and partners including national laboratories, universities, additive manufacturers, and OEMs including GM, Ford and Cummins. The partners work on emissions control opportunities with biofuel, fuels and lubricant formulation impacts on GDI particulate emissions and compatibility of new fuels and lubricants with emission control devices and provide excellent coordination for a successful project.

Reviewer 3:

The reviewer suggested that it is probably best to remove the reference to Mobil 1 as the baseline for motor oil. Mobil 1 is a fine motor oil but there are many variations with different additive packages, so other researchers cannot actually tell much from this. The reviewer went on to point out that the researchers should be simply looking for a current, state-of-the-art, GF-5 oil. It is not a problem to use Mobil 1 and mention it verbally, but putting in writing that Mobil 1 is the goal or the baseline can be considered an endorsement that Mobil 1 is the best. Partners at Shell, BP, and other companies also make excellent motor oils that can outperform Mobil 1 in certain conditions. The reviewer summarized that the presentation should please remove the reference to Mobil 1 unless the project team wishes to give more details on it, and refrain from using it for future goals. It may be better to say state-of-the-art light-duty (LD) motor oil with a high-temperature, high shear (HTHS) viscosity of x.x cP.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer recounted that future directions have been identified for each of the five research areas and have been discussed with the industry partners. The work will continue to address the barriers of inadequate data and predictive tools for fuel effects on emission control systems as well as the long term impact of fuels on emission control systems.

Reviewer 2:

The reviewer observed that the project has a very broad range of research, which perhaps suffers because too many topics are being covered to allow in-depth study and analysis.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer highlighted the fact that the research is generally supportive of developing and understanding emissions control with advanced engines, lubricants, and fuels.

Reviewer 2:

The reviewer agreed that the objective of the project is relevant to petroleum displacement since the objectives are to identify concerns of changes in fuels and lubricants including renewable fuels and investigation of unique characteristics of fuel that will enable increased fuel efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

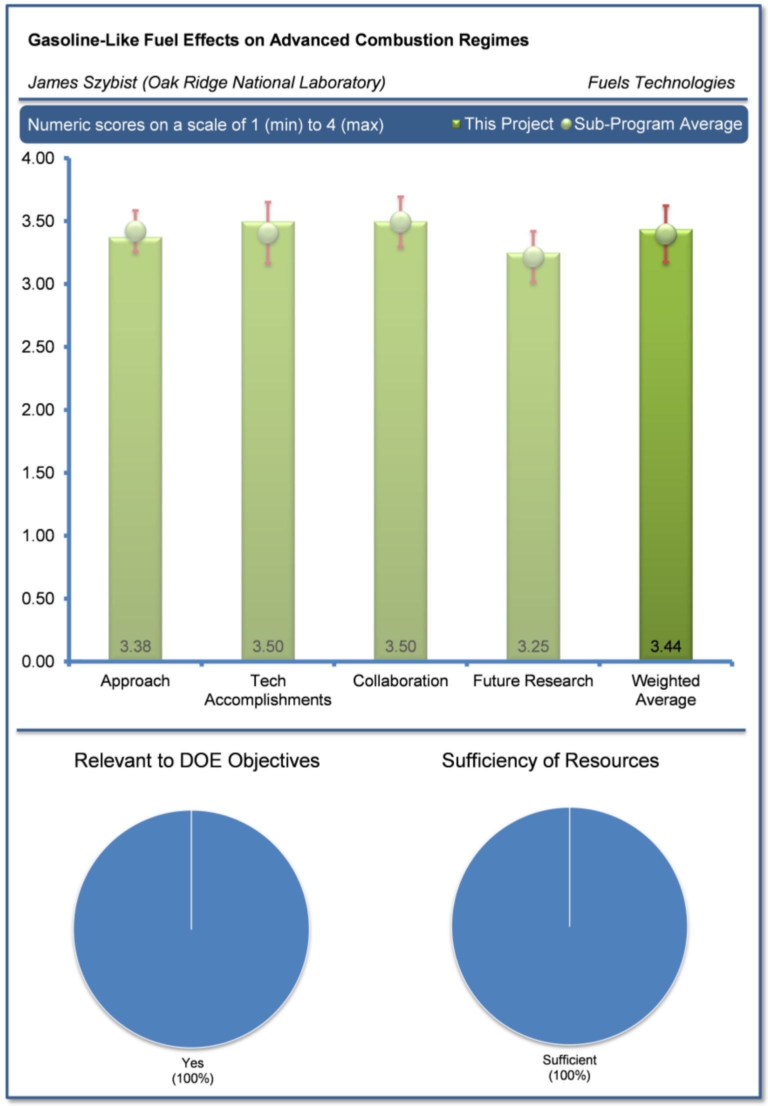
Reviewer 1:

The reviewer affirmed that funding is sufficient to complete work in FY 2014. It is unclear what resources will be available for the proposed future direction.

Reviewer 2:

The reviewer stated that resources are sufficient for this level of effort, but it might be better to focus and go deeper with a smaller set of topics.

Gasoline-Like Fuel Effects on Advanced Combustion Regimes: James Szybist (Oak Ridge National Laboratory) – ft008



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work – the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded a very good set of experiments making useful comparisons to understand fundamental limits in the systems.

Reviewer 2:

The reviewer described the project balancing Corporate Average Fuel Economy standards and Renewable Fuel Standards (RFS) using commonly available oxygenates is a good approach. It would be nice to also include a conventional petroleum super premium in baseline testing. The reviewer wondered how the combustion chamber was optimized for a high compression ratio.

Reviewer 3:

The reviewer observed that the approach of using the same engine platform for each of the four combustion modes studied is very good, and coupling experimental work with Autonomie simulation is good. The reviewer had some concerns over choice of fuels studied. The regular gasoline did not contain any ethanol – which is not representative of the 10% ethanol blend with gasoline (E10) primarily used in the United States. The reviewer said that a comparison of E0 to 24% iso-butanol fuel blend to E30, where fuel composition as well as octane number changes, seems like an apples-to-oranges comparison.

Reviewer 4:

The reviewer explained that the project investigated fuel effects for different promising advanced combustion modes including reactivity controlled compression ignition (RCCI), boosted homogeneous charge compression ignition (HCCI), and partially premixed combustion (PPC). The approach/results look like a collection of highlights for different modes, rather than a systematic approach for comparison of fuel effects on these advanced combustion modes (particularly including apples-to-apples comparisons). The reviewer noted that Slide 19 shows the plan for comparison for PPC and R–CI - the future results in this part will be interesting.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer applauded a very good set of experimental data. This person also said that it seems like it would be useful to do combustion modeling in parallel with experimental work to help understand data and guide future experiments, and that this could be done by partnering.

Reviewer 2:

The reviewer acknowledged that there was some excellent data. It seems to need a bit more integration to draw overall conclusions, and still seems to be somewhat a collection of individual experiments in this reviewer's mind.

Reviewer 3:

The reviewer pointed out the wide range of results and accomplishments. The choice of fuels (different compositions and different octane numbers) seems to make it difficult to identify specific reasons for different performance of fuels. The reviewer wanted to know if, for example, the better results for E30 are due to the significantly higher octane number or charge cooling effects. In other words, it would be interesting to know the contribution of each.

Reviewer 4:

The reviewer expressed that the project results for 75% coverage with RCCI are promising. However, the reviewer thought it is uncertain how many fuels will be used, and wanted to know if the researchers envision using more than two fuels to get this coverage, as Slide 17 shows four fuels including diesel, gasoline, biodiesel and E30. Results for the capability of using renewable super premium (RSP) for downsizing and downspeeding options are very encouraging; further investigations might be rewarding. The reviewer criticized that results on Slide 19 for fuel economy comparison are misleading, as transient fuel penalty is not included in those results. However, it is very good that the project links both engine data and vehicle data for the FTP drive cycle.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer reported a good set of collaborators between universities, national laboratories, and industry.

Reviewer 2:

The reviewer reinforced the good mix of collaborators from industry (OEMs and an energy company), other national laboratories including SNL, and universities.

Reviewer 3:

The reviewer recounted that the project includes in-depth involvement with industry and academia and other national laboratories. Having joint publications is good evidence of this strong collaboration. The reviewer commented that providing the data from this project in common database platform (for example CLEERS) can leverage further collaboration opportunity and expand the application of this work.

Reviewer 4:

The reviewer observed that there is generally good collaboration. The reviewer said that there are a somewhat limited number of industrial interactions, but observed a very strong collaboration with University of Wisconsin.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer expressed that the plans seem reasonable.

Reviewer 2:

The reviewer asserted that there is an excellent plan to continue sorting this unique concept against other options and varying fuel types. The reviewer would like to see more on what happens in a total, customer-operated system. The researchers have to cold start, idle, and run transients under all conditions. The Bosch ACCESS project seems to be showing major loss of HCCI opportunity related to transitions in and out of HCCI, and catalyst effects (the data will be in publication soon); similar analyses are required for RCCI. The reviewer wondered what the real benefit is, considering cold start and transients.

Reviewer 3:

The reviewer said that before the six-stroke work is done, energy balances and parasitic losses should be modeled. This person stated that there are good plans for RCCI. The reviewer also affirmed that generally, work should include more engine and combustion type modeling to help with optimization and better understanding of turbo requirements and flame speed effects.

Reviewer 4:

The reviewer indicated that in addition to turbocharger (TBE) and fuel efficiency metrics, emission results are equally important. The presentation did not include substantial emission results (except for Slide 19). Future work may present both fuel economy and emission metrics side by side. The reviewer suggested that more apples-to-apples comparisons will be insightful for the scholars in the field.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted the significant impact on efficiency and emissions.

Reviewer 2:

The reviewer pointed out that the project achieves petroleum savings by both engine efficiency and renewable fuels. The data provides a direct comparison of a variety of combustion strategies and fuel effects and requirements.

Reviewer 3:

The reviewer observed that the investigation of fuel property effects and identification of optimal fuel formulations for LD advanced combustion engines should enable development of fuel-engine systems that have higher efficiencies and lower emissions.

Reviewer 4:

The reviewer commented that this project directly supports DOE objectives of petroleum displacement by further utilizing renewable fuels in advanced combustion regimes.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the funding is probably sufficient, and expressed interest in seeing some expansion on transient and cold testing and that may need added funding.

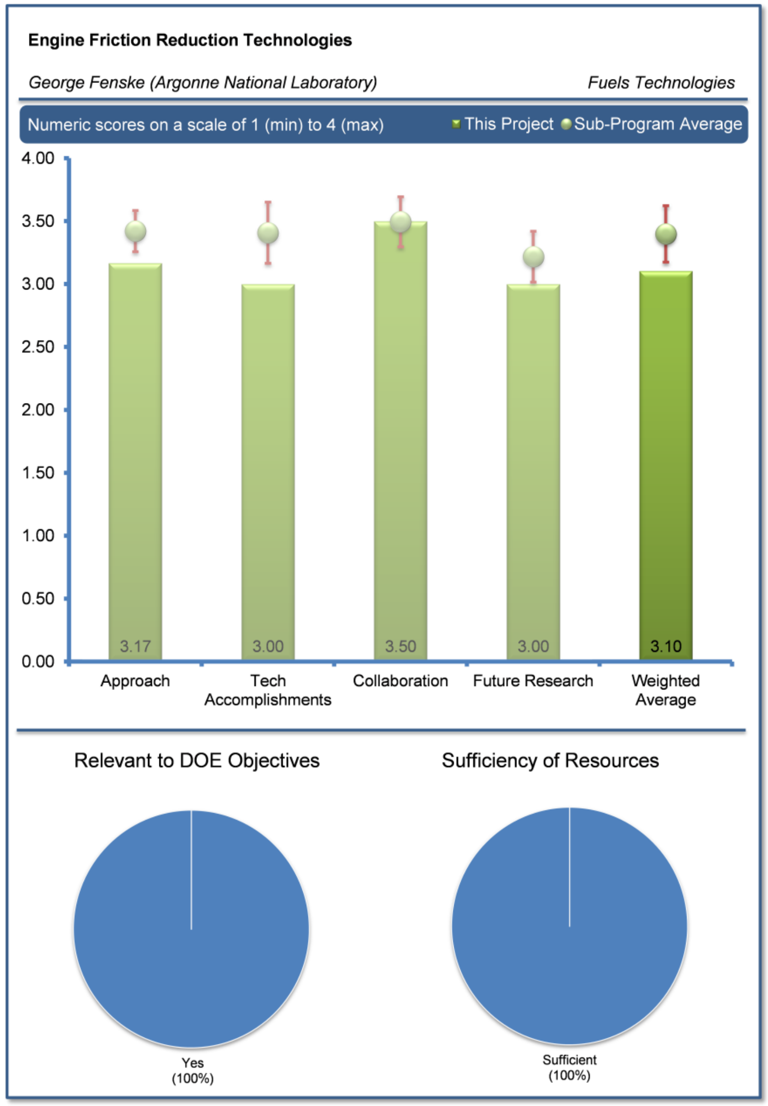
Reviewer 2:

The reviewer remarked that resources appear adequate for experimental work, but more may be needed to include increased modeling work.

Reviewer 3:

The reviewer pointed out that it will be very helpful for this project to have access to a Cooperative Fuel Research (CFR) engine for testing different combustion modes which require different compression ratios and then comparing fuel effects on different combustion modes. This can add a strong value to this work, so fuel effects comparisons will be more conclusive.

Engine Friction Reduction Technologies: George Fenske (Argonne National Laboratory) - ft012



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the project is divided into multiple sub-topics (i.e., protocols, base oils, and additives).

Reviewer 2:

The reviewer expressed that the authors created a very extensive list of barriers faced by crankcase oil industry. It would be advantageous to select one specific area to pursue their interests, for example, HD diesel hardware, LD gasoline hardware, LD diesel hardware, marine, small engines, etc. The reviewer commented that more focus in the approach can provide better opportunities for a successful outcome.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer asserted that there appeared to be some very good demonstrations of friction and wear reduction. The reviewer is not sure why base oils tested are unique or special, but posited that maybe the researchers are adding knowledge. The reviewer suggested that protocols should be firmed up and published, and that it would be really great if others started using them.

Reviewer 2:

The reviewer offered that the most impressive progress was made on Task 1, aligning lab bench tests to engine tests. However, a better definition of the desired engine hardware needs to be put forward. The reviewer explained that development of novel nano-additives needs to include storage stability studies and exhaust catalyst degradation studies. Failure in any of these two areas will prevent any technical advances. The reviewer went on to say that a narrow focus in frictional or wear results is not sufficient to make additives acceptable for commercialization. The reviewer also pointed out that novel base oils studies did not include additive solubility assessments.

Reviewer 3:

The reviewer stated that it was unclear how much of this work will be published and how it will contribute to future improvements in the field.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that ANL has partnered with lots of excellent companies.

Reviewer 2:
The reviewer commented that ANL has been proven to be very effective in collaborative studies in the past and continues to be a leader in this area.

Reviewer 3:
The reviewer voiced that the project appears to have a wide range of collaborations through Cooperative Research and Development Agreements (CRADA) and other relationships, but some are vague on the poster. The reviewer wanted to know who is committed to real collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer expressed that continuing the work is a logical approach.

Reviewer 2:
The reviewer characterized the need to continue to focus on providing relevant data to the DOE program and the lubricants community.

Reviewer 3:
The reviewer suggested that a more detailed plan and a better focus on selective hardware will help to deliver deep fundamental understandings.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer confirmed a good definition of needs, barriers, and plans to make progress to improve system efficiency via lubrication regimes.

Reviewer 2:
The reviewer pointed out that drop-in lubricants can save fuel.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer mentioned that the financial plan is well defined.

Reviewer 2:
The reviewer acknowledged that resources are sufficient to support potential collaboration.

Ionic Liquids as Anti-Wear Additives for Next-Generation Low-Viscosity Fuel-Efficient Engine Lubricants: Jun Qu (Oak Ridge National Laboratory) - ft014

Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

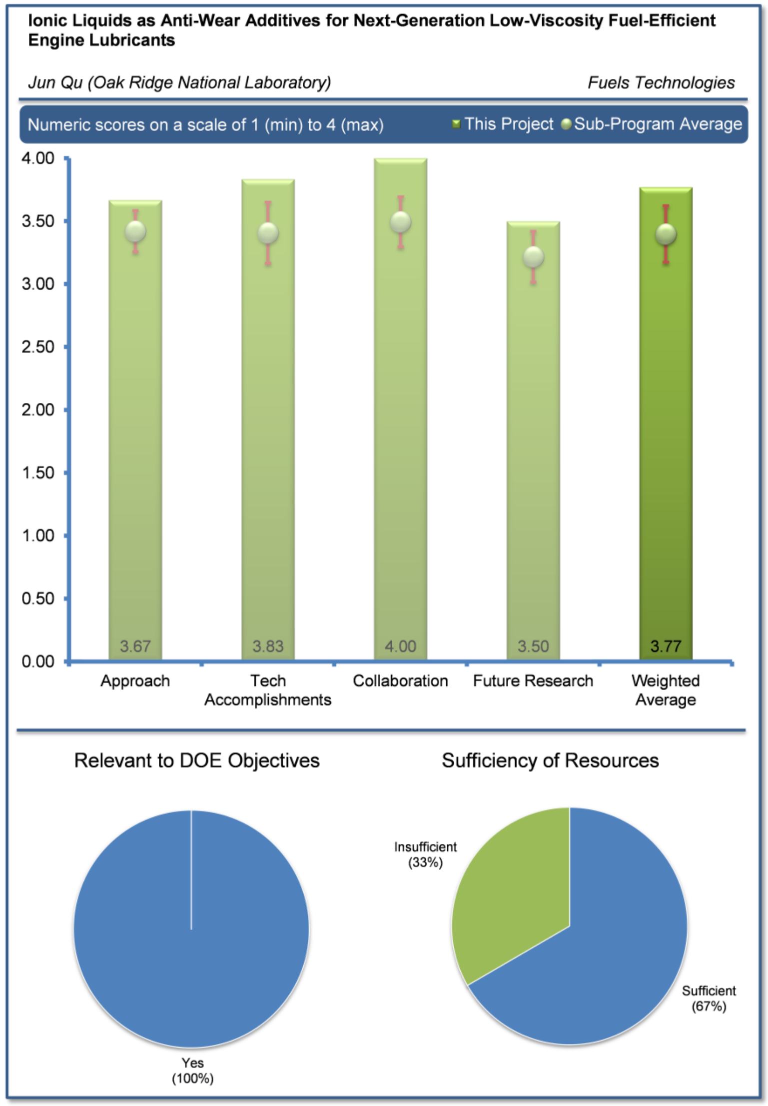
The reviewer remarked on a very logical approach to answer the most typical questions about introducing a new additive. The researchers are covering all of the necessary questions as they continue.

Reviewer 2:

The reviewer mentioned that the research combines screening, bench tests, and multi-cylinder tests along with ionic liquids (IL) formulation, lube formulation, and fit-for-use tests.

Reviewer 3:

The reviewer indicated that bench testing and engine dynamometer tests demonstrate friction performance well with quantifiable metrics. The wear data and analysis of the tribofilm is documented as well. The lubrication mechanisms are not fully understood and must be addressed in future work.



Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer emphasized that demonstrating a 2% fuel efficiency (FE) improvement on Sequence VID tests is a monumental achievement. The reviewer commented that demonstrating a fully formulated oil on full engine tests is about as good as it gets to demonstrate the technology, and that ORNL has gone beyond using just benchtop rigs, which really improves the confidence in the technology.

Reviewer 2:

The reviewer applauded very strong performance indicators, including accomplishing a FE improvement without sacrificing durability. The reviewer criticized that the project lacked the conclusive fundamental understanding of the underlying mechanisms that explain the performance enhancement, although there were some tribofilm analyses and hypotheses that seemed feasible to explain superior performance.

Reviewer 3:

The reviewer offered that the research has demonstrated real benefits along with ability to meet practical requirements for a lubricant such as catalyst effects, water, corrosion, etc. The development of oil soluble ionic liquids (ILs) is a very good step forward. However the reviewer cautioned that it is not clear what the development path was to get to IL-18 and where the project was going next.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer acknowledged an excellent team including an OEM, national laboratory, oil formulator, and additive supplier. There are no weaknesses.

Reviewer 2:

The reviewer stated that the project had very excellent partners: GM for practical requirements and final engine tests; Lubrizol for realistic formulation; and the project team's IL feedstock partner for ability to formulate new ILs.

Reviewer 3:

The reviewer noted that the strong collaboration between automobile OEM and lubricant formulators resulted in a very promising project outcome.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that future work should include some work testing the sensitivity and stability of the formulated oil to the extremes of engine operation (water, acid, soot, oxidation, etc). It would be interesting to see how the IL formulation holds up compared to conventional oils as the contaminants increase. The typical condition results look good; knowing how it compares on worst-case scenarios would be useful.

Reviewer 2:

The reviewer claimed that this project is successfully completed and a follow-up project has begun. It was not clear to the reviewer how, or if, new IL chemistries will be developed.

Reviewer 3:

The reviewer specified that this project is completed but did address some research barriers for future work if funded through a different project line.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer offered that this could save more petroleum in one year than electric vehicles (EV) or fuel-cell vehicles will in decades, or ever. A 2% increase across the entire fleet is a huge number.

Reviewer 2:

The reviewer emphasized that this technology could revolutionize anti-wear additives for oils. If superior, it would enable the use of lower viscosity lubricant base stocks without sacrificing durability. A FE enhancement was demonstrated without compromising wear performance.

Reviewer 3:

The reviewer affirmed that drop-in fuel savings of greater than 2% have been demonstrated for a novel lubricant.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer reported that this project represents the cutting edge of lubricants research. ILs are the first true competitor to ZDDP in decades. The market introduction is being held back by limited funding. The reviewer explained that the quicker ILs can get into the market, the sooner the existing car parc can experience better fuel efficiency. Funding should be doubled at a minimum; a five-fold would be appropriate.

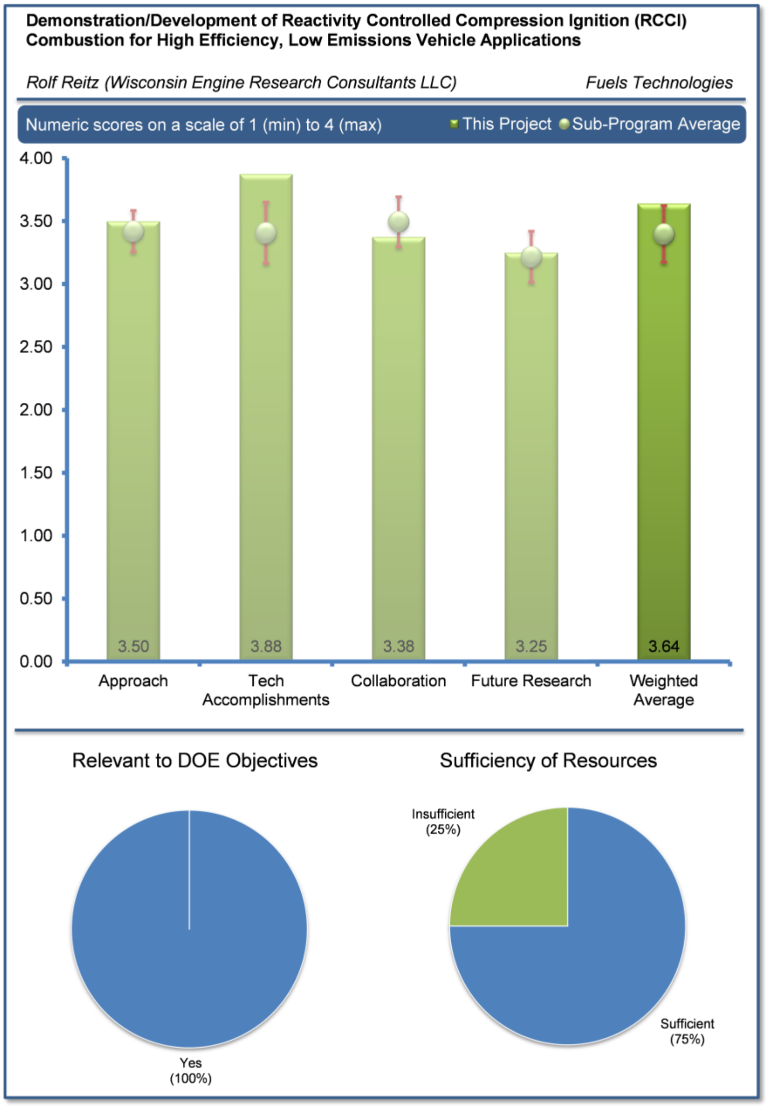
Reviewer 2:

The reviewer noted that the project meets objectives, and that DOE needs to ensure that follow-up work is funded.

Reviewer 3:

The reviewer commented that the PI's resources combined with the invested collaborators were sufficient to perform the project objectives. All stated milestones were met on time despite some large technical barriers.

Demonstration/Development of Reactivity Controlled Compression Ignition (RCCI) Combustion for High Efficiency, Low Emissions Vehicle Applications: Rolf Reitz (Wisconsin Engine Research Consultants LLC) - ft015



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer affirmed that the team has developed an excellent ability to model and optimize combustion chamber design.

Reviewer 2:

The reviewer mentioned that the approach of coupling engine tests with CFD spray and combustion models to further investigate RCCI is reasonable.

Reviewer 3:

The reviewer noted that the project incorporates a good mix of simulation of experimental work. In particular, use of simulation for developing a new concept piston was very interesting. The reviewer observed that the capability of the model for hydrocarbon (HC) and carbon monoxide (CO) emissions was not presented, while RCCI is typically known to have high HC and CO emissions. This can be added to the final report of the project.

Reviewer 4:

The reviewer expressed that the project had an excellent approach to address a major limitation in RCCI for both LD and HD engines. On the other hand, cold start, idle, and transient issues remain to be addressed.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that there appears to be rapid development of the experimental work, driven by modeling. This should be a style for all DOE work.

Reviewer 2:

The reviewer acknowledged very solid results in the testing and models. A main RCCI limit has been moved significantly, broadening the operation range.

Reviewer 3:

The reviewer described how the results of low rate of pressure rise (RoPR) with low unburned hydrocarbons by using new piston design are very promising. In particular, the results on Slides 10-11 show excellent accomplishments. The reviewer went on to say that including both LD and HD applications in one project is excellent. Including synergy between these two applications in the final RCCI report from this project would be valuable.

Reviewer 4:

The reviewer applauded good progress on further understanding and advancing LD and HD RCCI. It is good to see advancement to multi-cylinder studies in collaboration with ORNL. The reviewer remarked that it looks like good agreement between the models and experimental data. It would be good to see additional work with models to determine optimal amount of 2-ethylhexyl nitrate (EHN) to use with gasoline.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer pointed out the good partnerships with industry and national laboratories, and that the team is very willing to share the work and the credit.

Reviewer 2:

The reviewer offered that the project includes a strong collaboration involving academia, an industry partner, a national laboratory and a consulting company. Tasks are clearly defined for each involved party.

Reviewer 3:

The reviewer affirmed the project’s good collaboration with ORNL. The collaboration with Caterpillar seems to be mainly providing hardware to the project. No other industrial collaborations are listed.

Reviewer 4:

The reviewer expressed that there are some collaborations, mainly ORNL and Caterpillar.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer mentioned that there is a logical plan to complete this project by September 2014, and that this project will open up many new future research opportunities.

Reviewer 2:

The reviewer remarked that research continues in a practical direction of optimization and commercialization. The reviewer suggested continuing to focus on commercial, practical fuels in order to concentrate on optimization of engine concept.

Reviewer 3:

The reviewer stated that plans seem reasonable.

Reviewer 4:

The reviewer was disappointed to see no plans to look at cold start, idle, higher-than-RCCI load, and especially transient work. The Bosch ACCESS project and others have indicated that mode switching limitations can significantly reduce the amount of time actually spent in advanced combustion modes. Mode switches are not instantaneous, and catalysts have a memory effect that limits mode switches. The reviewer cautioned that without addressing these issues, there is a risk the concept can only apply to steady state operations such as stationary engines.

The reviewer thought these issues are not necessarily job stoppers but they are critical to gaining wider acceptance leading to real- world applications, and that the plans shown here do not address these issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer expressed that the project is very relevant to DOE goals of efficiency and emissions.

Reviewer 2:

The reviewer affirmed that this project directly supports DOE objectives of petroleum displacement by increasing brake thermal efficiency of IC engines, and creating new opportunity for utilizing renewable fuels in advanced combustion regimes.

Reviewer 3:

The reviewer commented that practical development of RCCI concept will improve engine efficiency to reduce petroleum consumption. Modeling tools and approaches make work more efficient and easier to apply to new variations.

Reviewer 4:

The reviewer pointed out that RCCI represents a promising advanced combustion option. If successfully advanced to commercialization, it would reduce fuel consumption and lower emissions.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that there do not appear to be any gaps in research due to funding limitations.

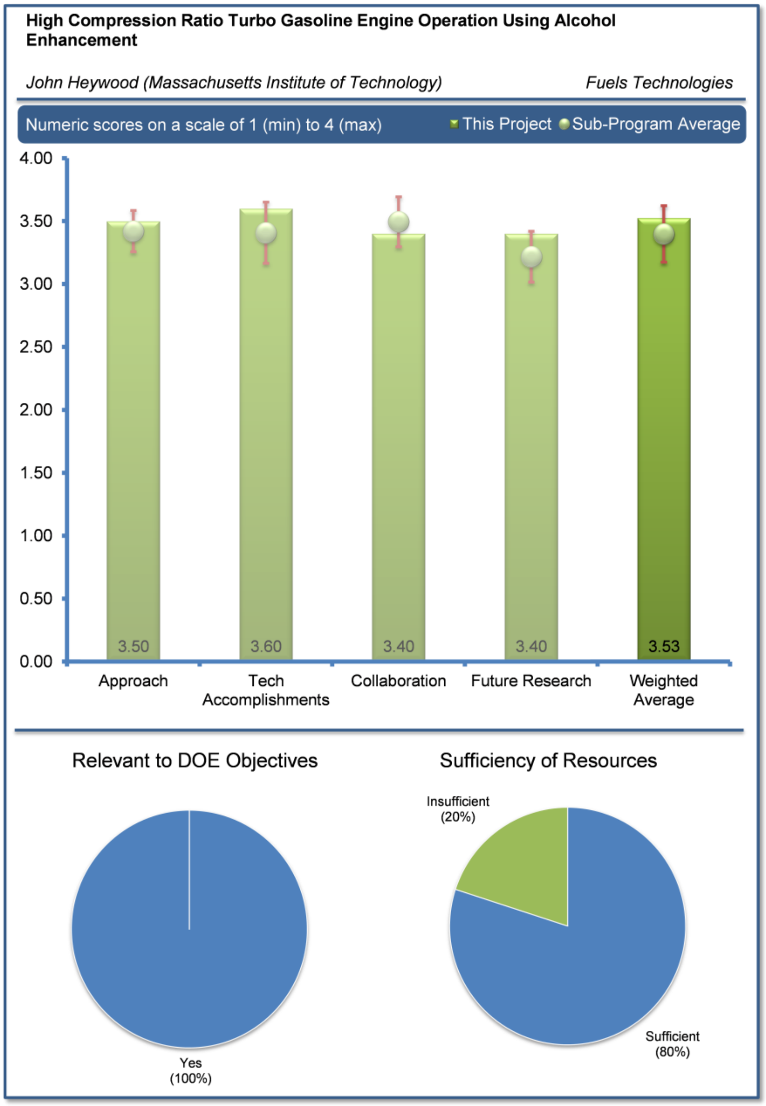
Reviewer 2:

The reviewer asserted that simulation works are mostly completed. The project has access to sufficient experimental facility for both LD and HD engine testing.

Reviewer 3:

The reviewer assumed the reasons for not addressing wider load range, cold start and transients are budget-related – taking those on is a major effort. The funding seems appropriate for the work actually planned. The reviewer believed that expanded funding would be justified if the open issues can be addressed effectively.

High Compression Ratio Turbo Gasoline Engine Operation Using Alcohol Enhancement: John Heywood (Massachusetts Institute of Technology) - ft016



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that this is a very well-constructed set of analyses and test data to illuminate an interesting idea.

Reviewer 2:

The reviewer stated that there is a good approach to the project by combining some modeling work with experimental data.

Reviewer 3:

The reviewer asserted that this project uses a classic approach of combining engine experimental testing and modeling (using Chemkin and GT-Power). While the modeling work is very valuable, the extension of the results for the area that model is not necessarily valid can limit the conclusions from this work. Further experimental data is required to provide conclusive results from this work. The reviewer went on to point out that no emission data was presented in the work, and expressed interest in knowing if the assumption is that efficiency is studied while a same emission level is maintained.

Reviewer 4:

The reviewer mentioned that the value of ethanol to higher compression ratio (CR) and the associated efficiency is understood. This technique is appropriate to use for octane only when it is required.

Reviewer 5:

The reviewer notes how the project targets the development of knock-free SI engines through blending of alcohol and blending with gasoline. The reviewer asserted that it was unclear how this project complements or expands upon other combustion strategy approaches being explored under DOE funding. For example, there are other projects under the Advanced Technology Powertrains for Light-Duty Vehicles program, such as the 85% ethanol blend with gasoline (E85) injection studies by Ford to extend knock limits, and ORNL efforts on fuel effects in DISI.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer applauded excellent results. It is very useful in clarifying where the benefit and limitations of downsized and boosted engines arise. This reviewer added that the project pushed the boundaries.

Reviewer 2:
The reviewer observed excellent work. The project demonstrated a practical and feasible technology to improve FE without excessive cost or changes to the infrastructure. The research reached a very interesting conclusion that one does not need to use EGR since the fuel can prevent LSPI.

Reviewer 3:
The reviewer offered that the results from this project provide an excellent understanding for comparing the benefit of using knock-resistant gasoline blends with alcohol (which means use of higher compression ratio), boosting intake air pressure, and downsizing, all of which can contribute to increase engine thermal efficiency. The reviewer also said that engine-in-vehicle simulation results are important, although it is more important to ensure those simulations are valid for transient operating conditions in a common drive cycle.

Reviewer 4:
The reviewer explained that since the project's initiation, engine had been configured, GT-Power model had been configured and calibrated, and other models have been applied to the study. The project explored knock onset limitations and defined fuels to allow extension of knock limits. The research shows that E85 allows wide-open throttle (WOT) operation for this 2-bar boosted engine. The project mapped knock limits for various compression ratios and boost levels to identify limits of high alcohol fuels and interaction with spark retard requirements. Through vehicle drive cycle simulation, the results from the engine combustion mapping have been translated to practical vehicle impacts of the high alcohol optimized strategy. The reviewer indicated that the project demonstrated that downsizing has the greatest impact on miles per gallon (MPG) as compared to increasing CR. Therefore, boost (and downsizing) is more effective at allowing engines to operate at higher CR (which requires high ethanol dosing).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the project includes a strong industry collaboration.

Reviewer 2:
The reviewer said that the project has a solid collaboration with Cummins. It would be nice to see a broader collaboration with the LD OEMs and suppliers.

Reviewer 3:
The reviewer pointed out the good link with an industrial partner, but no link to national laboratories or other universities.

Reviewer 4:
The reviewer's only caution is to consider and address through other outside organizations the viability of multiple in-vehicle tanks, or other issues associated with a dual fuel retail or consumer experience.

Reviewer 5:
The reviewer suggested that some integration with a LD OEM and component suppliers might have helped determine if the power cylinder can actually hold up to the very high pressures necessary.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer recounted the good approach for completing the work in the next year - including more experimental results to evaluate findings from this work will be invaluable.

Reviewer 2:
The reviewer stated that the project is ending but future work is good to complete it.

Reviewer 3:
The reviewer indicated that project is wrapping up in January 2015, so the project is in a phase of consolidating the lessons learned from the project for potential future vehicle design and fueling requirements.

Reviewer 4:
The reviewer voiced that the remaining plan is very good, and that it would be nice to have a future vehicle demonstration to examine some of the issues of transient response and drive cycle effects but that obviously would not fit the budget. The reviewer concluded that the idea of an onboard separation seems worthy of some serious effort, but also may be beyond the scope of the project.

Reviewer 5:
The reviewer commented that lean burn combustion with ethanol needs to be better understood.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer expressed that the project is very relevant to DOE goals of efficiency and alternate fuels use.

Reviewer 2:
The reviewer reported that the project targets the dramatic improvement of light-duty vehicle fuel economy, which can displace petroleum use by improving efficiency.

Reviewer 3:
The reviewer emphasized that this project directly supports DOE objectives of petroleum displacement by proving understanding which will lead to optimum use of renewable fuels in future engine technologies.

Reviewer 4:
The reviewer noted that the project offers an alternative to the simple raise-the-octane argument, which is getting tired. Simply raising the octane for everyone is a waste of money for the vast majority of people. The reviewer believed that refiners have to balance out the streams, and high octane will unquestionably cost more.

Reviewer 5:
The reviewer stated that ethanol is directly replacing HCs as a fuel source.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that this is a pretty well funded project and it appears that funding has been stable, which is essential for university-led projects.

Reviewer 2:

The reviewer mentioned that resources are sufficient for the work scope. The reviewer would like to see future funding for vehicle demonstration, and especially for an onboard separation system that would make the idea highly attractive because customers would not have to fill two tanks.

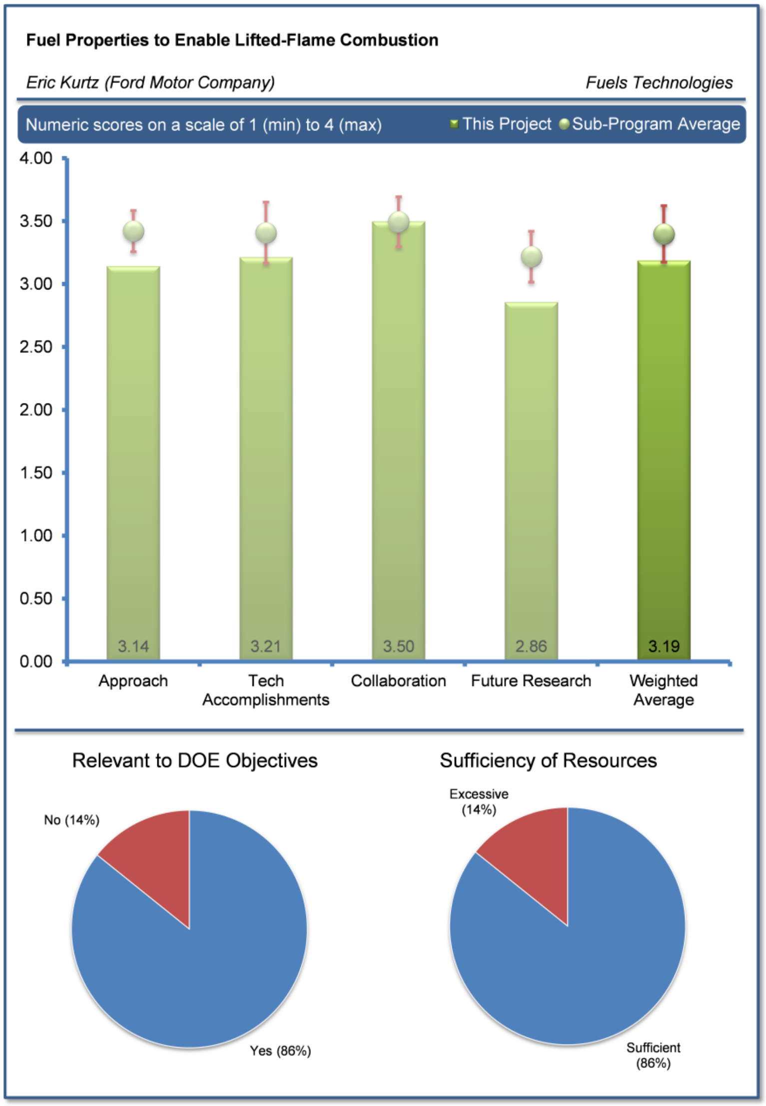
Reviewer 3:

The experimental facility and modeling capability seem to be in place to achieve the targets for the next year.

Reviewer 4:

The reviewer remarked that similar work should continue at Massachusetts Institute of Technology (MIT) or elsewhere in the future, and believed that octane-on-demand ideas are not represented enough.

Fuel Properties to Enable Lifted-Flame Combustion: Eric Kurtz (Ford Motor Company) - ft017



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated the researchers have an excellent approach to the project.

Reviewer 2:

The reviewer affirmed that the approach is well thought out and has necessary combination of existing data, new data, and simulation. The reviewer added that the combination of resources is also very nice.

Reviewer 3:

The reviewer affirmed that the project has a good mix of research covering modeling, special measurements, fuel selection, and engine results. However, there is no discussion of nitrogen oxides (NO_x) emissions or engine efficiency in this talk; it needs to be included in future work.

Reviewer 4:

The reviewer mentioned that the project is using LLFC to achieve high efficiency and low emissions. The project is looking to identify fuel properties to enable LLFC, wherein a longer lift-off-length enables greater air entrainment and reduction of local equivalence ratio at base of the flame. The research involves optical spray and combustion engine work, tied with modeling to achieve combustion system optimization.

Reviewer 5:

The reviewer remarked that the project uses a systematic approach, including modeling and experimental testing to provide fundamental understanding for LLFC combustion regimes including fuel effects. Although this project centers on fundamental study, the reviewer felt that it is important to close the loop by the end of this project for how practical is the LLFC with a best candidate oxygenated fuel from this study.

Reviewer 6:

The reviewer mentioned that the project uses a combination of engine testing, advanced optical diagnostics, and computational modelling to study LLFC (and resulting ignition delay) as a function of cetane number and oxygen content of fuel. It was not clear to the reviewer, however, to what extent other fuel parameters will be factored into the analysis (if at all), despite the results to date producing an apparently anomalous result with regard to cetane number (Slide 9). The reviewer concluded that the use of tri-propylene glycol methyl ether (TPGME) as the source of oxygen in the test program was not adequately explained or justified because TPGME is essentially non-existent as a fuel component today.

Reviewer 7:

While the reviewer can support evaluating how fuel effects impact LLFC and the apparent beneficial effects of oxygen-containing compounds, the reviewer does not understand the focus on TPGME blends, especially at high TPGME concentrations studied. TPGME is a specialty chemical produced in relatively small quantities (relative to the amount that would be required at the apparently required level of 25-50% in transportation fuels). It is produced by reacting propylene oxide with methanol. It is stated by Dow to be "completely" water-soluble. The reviewer wondered if there is any reason to believe that 25-50% blends of TPGME (or something similar) can, or will, ever be commercialized. The reviewer inquired whether the U.S. Environmental Protection Agency (EPA) and/or the state regulatory agencies would ever allow the use of another ether in fuels even in the unlikely event that it could be produced at a reasonable cost at the required quantities, and given the issues with methyl tertiary butyl ether (MTBE). The reviewer explained that if TPGME is just being used as a model compound, the researchers should make this very clear and provide their ideas for compounds that are feasible for use in fuels. If there are more feasible alternatives, the reviewer suggested switching the focus to those. The reviewer presumed that bio-derived methyl esters which also contain oxygen may be an alternative. However, perhaps the issue is that since they contain less oxygen than TPGME, the amount required to be blended in fuel may be greater than 50%, which would raise serious issues such as lube oil dilution, cold temperature handling, etc.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that progress on testing of the fuels is good.

Reviewer 2:

The reviewer described that the project has a good understanding of experimental fuel effects but not much about how fuel effects can be mitigated by mixing parameters. It is a useful result that robust, commercial LLFC cannot be achieved without a special fuel.

Reviewer 3:

The reviewer recounted that spray studies are completed and transitioned to ongoing optical engine studies. The outcome from the spray studies was development of a novel optical diagnostic for luminosity, soot, and lift off length. The reviewer reported that the test fuels analysis is completed. The simulation study on fuel effects, via a combination of physical and chemical surrogate mixtures, led to good agreement between the simulation and spray and single cylinder engine (SCE) experiments, after improvement of kinetic models for TPGME fuel. Overall, there is an impressive amount of valuable outcomes from this research effort.

Reviewer 4:

The reviewer remarked that the work is interesting in that is shows how some fuel properties can reduce soot by a specific mechanism.

Reviewer 5:

The reviewer pointed out that the results on Slide 10 are very interesting for relating flame lift-off and soot for different oxygenated fuels. This should be helpful to understand the required level of oxygenation for proper LLFC operation.

Reviewer 6:

The reviewer applauded the nice accomplishments on understanding the relationship between ignition delay and lift-off length. The role of oxygenated fuels on LLFC is very interesting and provides new information. While outside of the scope, the reviewer will be interested to see how relationships with soot and lift-off length hold for other oxygenated fuels.

Reviewer 7:

The reviewer mentioned that the presentation shows a clear relationship between ignition delay and lift-off length but that is hardly a major discovery as it was presumably expected. It also shows clear relationship to oxygen content and to soot formation but those relationships were apparently already established by prior research under a separate grant. More importantly, the reviewer added, the reported results – that LLFC is dependent on highly specific fuel parameters including oxygen content and others, and that these required parameters may be different for different vehicles (on Slide 26) – point to very limited practical application of the subject technology.

The reviewer remarked that this is an important discovery but one that does not support great promise for the subject technology and suggests that further research should possibly be limited.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the researchers have chosen excellent partners for tasks being done outside of Ford. The University of Wisconsin approach of splitting surrogates between physical and chemical is very important for complex modeling of LLFC.

Reviewer 2:
The reviewer stated that the project has ties to national laboratories and the University of Wisconsin.

Reviewer 3:
The reviewer affirmed that SNL is an excellent choice for partnership.

Reviewer 4:
The reviewer offered that nice collaborations pull in world class expertise from SNL, LLNL, and University of Wisconsin. The addition of LLNL on simulation and mechanisms was very good move and important to success.

Reviewer 5:
The reviewer noted that there is strong collaboration involving industry, two national laboratories and one university.

Reviewer 6:
The reviewer said that it looks like good coordination and collaboration between the small number of partners.

Reviewer 7:
The reviewer pointed out that the team includes two DOE laboratories and a university in addition to the major automaker project leader.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that the project will continue optical engine work and single-cylinder metal engine work to explore different fuel effects on LLFC. The project will also apply the simulation results to better explain the results from the spray studies. There appears a lot remaining to be done by the end of the project in December 2014.

Reviewer 2:
The reviewer suggested that the proposed future research must include NO_x, fuel efficiency, HC, and CO trends.

Reviewer 3:
The reviewer said that continuing to evaluate LLFC makes sense, but strongly suggested moving away from blends (particularly high-level) of TPGME unless the team can develop a convincing case that it has a reasonable chance of being approved for use in high quantities in fuels by regulatory agencies, and could potentially be produced in very large quantities at a reasonable price.

Reviewer 4:
The reviewer noted the logical simulation and experimental testing plan exists before concluding this project in December 2014. The reviewer looks forward to seeing optical engine and metal engine results from this project. It would be important to assess if final results are promising for further research in this area, particularly because the project will need huge research efforts before practical benefits are realized. For instance, developing chemical mechanisms for fuels with different level of oxygenation is a challenging area.

Reviewer 5:

The reviewer summarized that the future work until project completion in December 2014 seems reasonable. Including the single-cylinder metal engine experiments is important. The reviewer mentioned that it would be nice to also see another fuel included for completeness and to better understand if the observations from TPGME blends hold.

Reviewer 6:

The reviewer reported that the project is ending so there is not much more additional work. Additional work could be performed with legacy engines to show the potential for LFC in a future project.

Reviewer 7:

The reviewer indicated that the proposed work tasks are logical, well-conceived steps toward the objectives stated of furthering understanding of LLFC. However, the reviewer added, the results to date seem to indicate that LLFC is likely to be of very limited practical application. The presentation indicates that it would require a very tightly specified fuel to be universally available – cetane, aromatic content, oxygen content, likely specific oxygenate, and etc. would all have to be completely standardized. The reviewer cautioned that even that might not be sufficient, as the Reviewer Only slide (Slide 26) indicates that each vehicle (engine design) may require a different oxygen level. Even assuming that the different oxygen levels could be attained through a kind of diesel “blender pump,” the reviewer commented that it was extremely unclear how this could be accomplished in a world of existing vehicle populations, incremental introduction of new engine designs, differing refinery configurations and fuel production streams, etc. The reviewer said that it could require a whole new set of infrastructure, such as separate refueling stations, due to space limitations at existing stations.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer recounted that LLFC can promote high efficiency clean combustion and displace petroleum through improved efficiency and use of biofuels if possible and still provide good combustion performance.

Reviewer 2:

The reviewer responded that, yes, a better understanding of oxygenated bio-based fuels on enabling advanced and high efficiency combustion modes is very important.

Reviewer 3:

The reviewer reported that this project supports DOE objectives of petroleum displacement by providing fundamental understanding which can potentially lead to further application of renewable fuels in advanced combustion regimes.

Reviewer 4:

The reviewer affirmed that it is relevant to understanding low-temperature, clean, and efficient combustion but the requirement of a special fuel may limit future usefulness.

Reviewer 5:

The reviewer asserted that the relevancy is marginal. While the LLFC approach could potentially lead to lower emissions and support DOE goals, the requirement for high levels of TPGME makes it highly unlikely to ever be commercialized.

Reviewer 6:

The reviewer explained that for the reasons stated in their previous response, the practical limitations of this work appear to make it extremely unlikely that it would ever have any real impact in transportation fuel markets so that petroleum displacement appears unlikely.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the funding level has fluctuated recently, but appears to be sufficient.

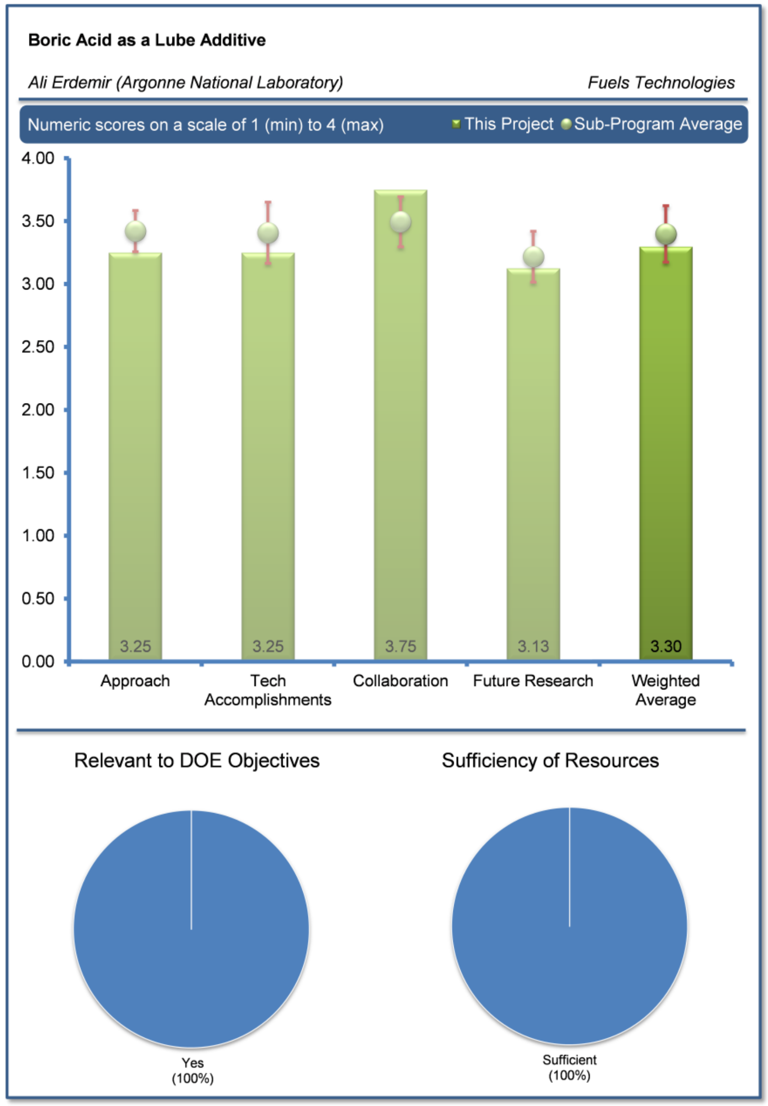
Reviewer 2:
The reviewer agreed that it appears that project goals can be met with current resources.

Reviewer 3:
The reviewer noted that the project seems to have adequate resources to complete the final milestones.

Reviewer 4:
The reviewer observed that resources seem sufficient but it is hard to tell for sure based on the presentation. The project funding is substantial.

Reviewer 5:
The reviewer remarked that for the reasons stated in the previous response regarding the practical limitations of the subject technology, LLFC, the level of funding for the research seems excessive.

Boric Acid as a Lube Additive: Ali Erdemir (Argonne National Laboratory) - ft018



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer recounted that the project combines boron additive formulation with bench tests and final engine performance test.

Reviewer 2:

The reviewer recounted that this is a well-defined project plan regarding bench testing of boron species in PC diesel and HD lubricants and that no storage stability results planned. The reviewer highlighted that there is a less clear definition of advanced, fully formulated lube performance testing such as oxidation, deposit formation, and exhaust catalysts assessments.

Reviewer 3:

The reviewer suggested that the researchers should also consider testing in used oils with high fuel dilution and water content. The current work is all based on a best-case scenario which weakens the confidence in the technology.

Reviewer 4:

The reviewer emphasized that there is still a lot of uncertainty as to why the boron-based nano-additive performs well in boundary lubrication. Thorough investigation through analytical techniques has to be performed post-tribology bench test to truly understand the underlying mechanisms of the nanofluid's performance. The reviewer acknowledged that this issue is addressed in the presentation's future work, but there is some question as to whether the researchers have enough time in the remaining period of performance. It would have been good to see this work being done concurrently with bench-scale testing.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that there has been excellent progress and results to date.

Reviewer 2:

The reviewer applauded the very impressive bench tests results, and noted that no Sequence VID data was shown on baseline versus boron-containing oil. The reviewer said that a side-by-side comparison with oil formulated using commercially available organic borated species is needed.

Reviewer 3:

The reviewer said that bench-top tribology performance seems very promising, but should only be used as an initial screener for lubricant performance. There is no investigation to explain the mechanisms behind superior lubricant performance, but will be addressed in future work. The engine test demonstrated potential fuel economy (FE) improvement, but far more testing needs to be done before any conclusions can be made.

Reviewer 4:

The reviewer noted that not enough detail was given about additives to assess concentration, chemistry, or dispersants, or how rigorous the development work was. The results appear to be significant in terms of friction and wear reduction, but work needs to be completed and fully presented.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the project has excellent partners, no weaknesses.

Reviewer 2:

The reviewer remarked that there is a good collaborative plan including crankcase lube formulators.

Reviewer 3:

The reviewer observed that there are good collaborations with lube companies and researchers have handed out samples for independent assessment. Good cost share partners show real interest and belief in the results.

Reviewer 4:

The reviewer affirmed that coordination between in-house testing, formulators, and industry engine collaborator seems well thought out and feasible. All of the respective pieces come together to demonstrate a novel lubricant's potential.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer pointed out that more real engine tests are needed, especially in HD engine area to answer questions related to soot and boron interactions.

Reviewer 2:

The reviewer claimed that proposed work should wrap up this project and determine potential for further development. Further work must assess the water compatibility of the additive and its contribution to ash.

Reviewer 3:

The reviewer suggested that future programs should include stability tests (look for settling) of both used and new oil at both very high and very low temperatures. Water content should also be part of the study.

Reviewer 4:

The reviewer asserted that upcoming collaboration work to close out the period of performance seems sufficient to fully demonstrate lubricant performance through nanofluid reformulation, engine testing, and bench-top tests. The reviewer explained that truly understanding the tribology mechanisms behind superior lubricant performance may not be possible within the remaining time. Supplementary analytical techniques would help the approach to understand the tribofilms (i.e., tribofilm depth chemistry profiles via X-ray photoelectron spectroscopy (XPS).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that this is a well-focused plan, and more engine performance is needed.

Reviewer 2:
The reviewer remarked that fuel savings from a drop-in lubricant is of great interest to DOE.

Reviewer 3:
The reviewer affirmed that the proposed technology sufficiently demonstrated the potential of a superior lubricant through initial screen testing. Initial fuel economy tests showed the feasibility to meet the DOE objectives.

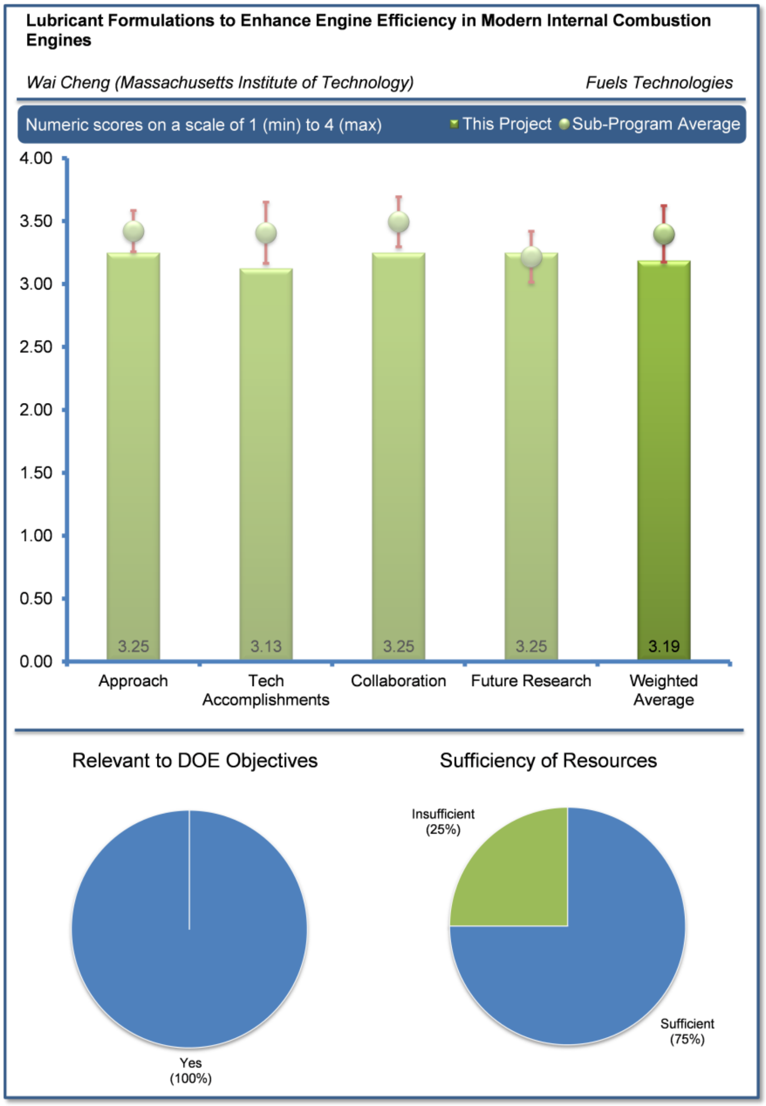
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that there is a very strong research team with a lot of resources at their disposal. Several milestones already met and the project is on schedule.

Reviewer 2:
The reviewer applauded a good approach and plan as well as a good utilization of collaborative laboratories.

Reviewer 3:
The reviewer stated that resources are sufficient to complete work.

Lubricant Formulations to Enhance Engine Efficiency in Modern Internal Combustion Engines: Wai Cheng (Massachusetts Institute of Technology) - ft019



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project has a good approach to split lubricant requirements of an engine and optimize for each. The main factors studied appear to be viscosity, temperature relationships, and oil changes due to evaporation in the ring zone.

Reviewer 2:

The reviewer noted that the program presents an interesting, but not novel, approach as it contains previously patented ideas. The strength of the approach includes abilities to utilize frictional and lubricant vaporization models.

Reviewer 3:

The reviewer mentioned that the project is an interesting approach to solve a problem. Based on the vastly different operating conditions from the valve train to the power cylinder, it makes logical sense that a large improvement in FE could be gained by separating the systems and optimizing the lubricant individually for each system.

Reviewer 4:

The reviewer affirmed that the modeling and experimental approach is sound and well thought out. The only weakness is the choice to use an older technology engine. The reviewer offers that the chosen engine does not represent modern diesel engines very well. A more modern engine would have cost more but been worth it in hindsight.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that the results to date show there is true potential to have different oils in a split system and get gains. The idea is not new, but more worthwhile to pursue now that the FE landscape has changed. The reviewer added that too many people scoff at the idea of a split engine but there is no technical reason it cannot be done. This demonstrates the idea truly has merit and tries to quantify them.

Reviewer 2:

The reviewer affirmed that the project was a good balance of modeling and experimentation. The test rig seems to yield feasible data. The reviewer questioned how translatable this would be to different engine platforms. The whole process would have to be repeated every time, but it provides interesting groundwork to demonstrate the feasibility of a split system engine design. Data from oil optimization for each system illustrates the potential benefits to be had.

Reviewer 3:

The reviewer cautioned that the test engine used in this assessment does not include novel hardware (it is small-engine, IDI technology), therefore experimental data collected may not be directly applicable to current or novel SI or CI engines.

Reviewer 4:

The reviewer commented that not much detail was given about the model, making it hard to assess. The reviewer wondered if the Kohler engine is relevant to modern automotive engines. The reviewer pointed out that there was no detail presented about how oils were modified to change viscosity index (VI) behavior, friction, and volatility. Researchers need to show real data curves for the oils such as viscosity, volatility, and VI behavior.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that involvement of the lubricant additive representative in formulating novel candidate oils is a positive step.

Reviewer 2:

The reviewer commented that Infineum is a good partner for lube formulation.

Reviewer 3:

The reviewer commended the project for coordinating well between all partners to build a split system engine test rig and also to optimize oil formulations. Partners from automobile and oil additive formulators with full participation are completely necessary for the success of this project.

Reviewer 4:

The reviewer asserted that a major on-highway engine manufacturer would have been useful but the other partners are excellent.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the project is ending but the proposed future work is good. A follow-on project should be conducted through either MIT or a national laboratory, or both. The reviewer suggested that the next project should definitely try to get a major on-highway partner to see if the project can get the idea into a production model.

Reviewer 2:

The reviewer remarked that the PI has placed himself in such a spot that all scheduled milestones were met to date. The only logical future milestones are to fully demonstrate the split system engine test rig using optimized oils.

Reviewer 3:

The reviewer did not think it was clear if floating liner work will be done. Until FE improvement is demonstrated and explained, there is no reason to study aftertreatment.

Reviewer 4:

The reviewer said that there are no clear plans to include a more modern engine design, no test cycles definition provided.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer acknowledged that the research provides further understanding of engine lubricant requirements and effects on friction.

Reviewer 2:
The reviewer mentioned that the split system engine design has the potential to increase fuel efficiency because it allows for independent selection of lubricants for the power cylinder and valve train.

Reviewer 3:
The reviewer commented that it may be difficult to implement a split oil approach to legacy vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

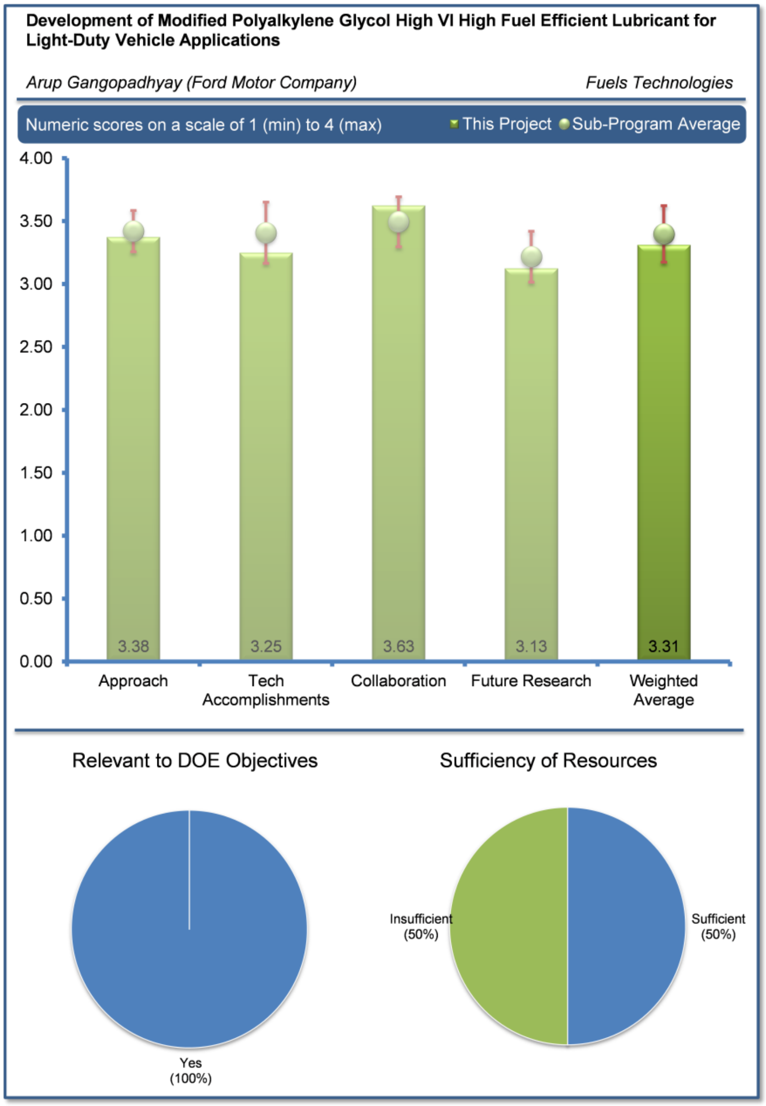
Reviewer 1:
The reviewer offered that the project needs money for a follow-on project.

Reviewer 2:
The reviewer stated that there is a good collaborative testing plan in place.

Reviewer 3:
The reviewer noted that the resources are sufficient to complete work.

Reviewer 4:
The reviewer pointed out that the project has all of the necessary resources at their disposal. Seems the project has full cooperation between all partners.

Development of Modified Polyalkylene Glycol High VI High Fuel Efficient Lubricant for Light-Duty Vehicle Applications: Arup Gangopadhyay (Ford Motor Company) - ft020



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project has a good mix of experimental bench tests, engine sub-system tests, measurement of wear films, and final evaluation in engines and vehicles.

Reviewer 2:

The reviewer commented that the project had a very logical approach to answering the most pressing questions with the technology.

Reviewer 3:

The reviewer observed a well-documented research program plan and technical/commercial barriers to achieve improved efficiency goals.

Reviewer 4:

The reviewer offered that friction performance was sufficiently demonstrated through bench-top tribology testing but was not accompanied by wear data or post-test characterization. The reviewer pointed out that it may potentially be a better lubricant technology, without fully understanding the mechanisms that explain the claimed benefit. This leaves a large technical barrier that must be addressed very late in the project. However, the reviewer acknowledged that this investigation will be continued in future work.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the researchers have made and evaluated a large number of formulations, some of which show real improvement in friction and wear. The reviewer had a hard time distinguishing effects from type of polyalkylene glycol (PAG), additives, and viscosity.

Reviewer 2:

The reviewer affirmed that the results to date are interesting. The only weakness is that there is no clear understanding of how PAG chemistry is affecting friction versus viscosity. Perhaps a national laboratory can partner with Ford to look at some more fundamental aspects on the surface.

Reviewer 3:

The reviewer recounted that the authors reported an impressive set of frictional improvement data. New testing techniques were introduced. No data reporting acceptable hydrolytic stability of PAG based oils were shown or discussed.

Reviewer 4:

The reviewer mentioned how the friction performance is well documented through bench-top testing and motored test rigs. The reviewer found the wear data and post-test characterization investigating the mechanisms behind the superior friction performance lacking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer asserted that the project appears to have a very close partnership with collaborators. The PI relies on these collaborators for oil formulation, bench testing and post-test characterization.

Reviewer 2:

The reviewer mentioned that it was very good to have Dow for oils and ANL for bench tests and surface analysis. Ford has lots of capabilities for remainder of the research and appears to be committed to completing the project.

Reviewer 3:

The reviewer indicated that there is a well-rounded group of scientific laboratories participating in this study. However, a participation of the lubricant additive representative is missing.

Reviewer 4:

The reviewer pointed out that Dow and Ford are a strong team but a national laboratory with some of the more advanced tools would be helpful. Looking at the tribofilm using a focused ion beam (FIB) is one example where ANL or ORNL could help out the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer recounts that the authors mention other durability sequence testing (i.e., ASTM Sequence IIIG) in the next steps. It will be interesting to see how the authors are proposing to manage to balance FE and durability factors such as oxidation, sludge, wear, etc. Used oil performance will be critical part of this study.

Reviewer 2:

The reviewer asserts that it will be very useful to end up with real vehicle tests with aged oils, as well as a study of wear surfaces and tribofilms. The reviewer wondered if oil 17-1 meets all relevant specifications. Results need to be explained in terms of chemistry, additives, viscosity, and VI behavior of oils. The reviewer said that questions about water and contamination with other oils will need to be answered.

Reviewer 3:

The reviewer cautioned that there are still a lot of technical barriers to overcome before the end of project. Limited time left in period of performance will make it difficult to overcome all of the barriers.

Reviewer 4:

The reviewer suggested that the researchers should include some work on exposing the finished product to a more typical engine environment and testing its stability. Acid, water, soot, etc. are in real oils but it does not appear that the project is testing the extremes (not just a durability engine or drive cycle) of these parameters to see the sensitivity of PAG compared to conventional oils. The reviewer explained that PAG may very well perform better than conventional oils with contaminants but it is not known. There should also be some work to see what happens if conventional oils are mixed with it.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer pointed out that drop-in fuel savings is very relevant to DOE goals.

Reviewer 2:
The reviewer commented that this new lubricant classification seems to hold some promise to reduce frictional losses in an engine.

Reviewer 3:
The reviewer noted that PAG cost and available volume analysis would be critical to commercialization.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

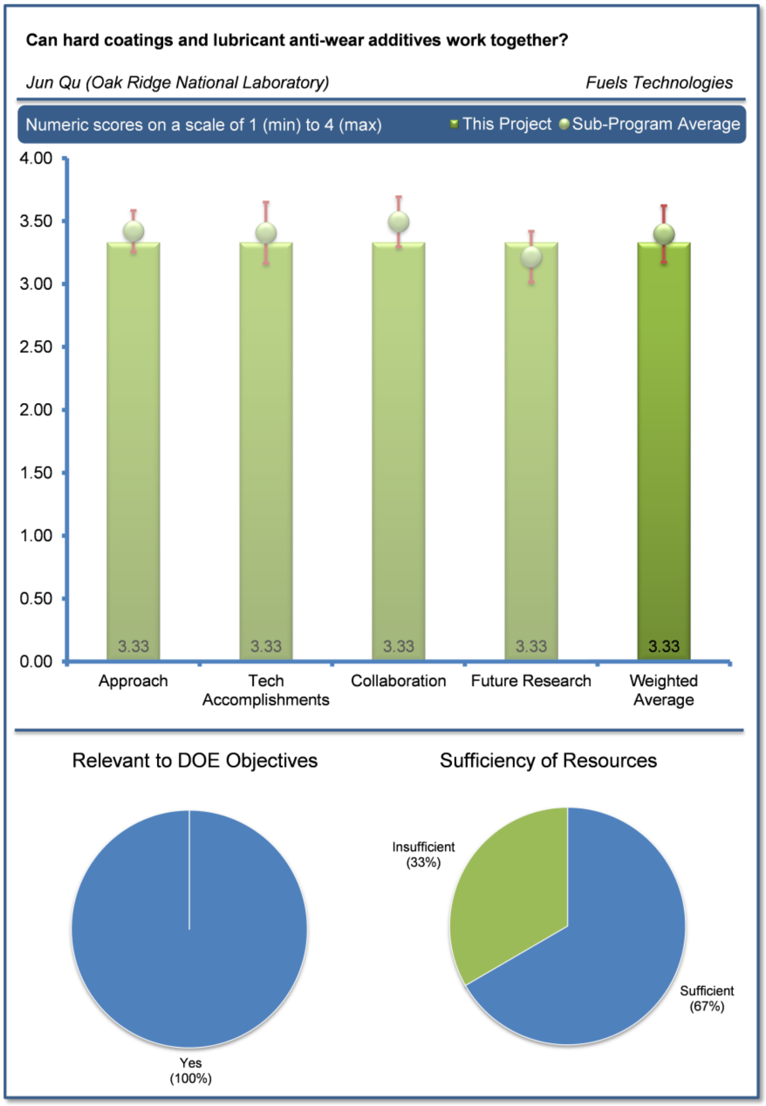
Reviewer 1:
The reviewer mentioned that resources seem sufficient and Ford seems very motivated to finalize the results.

Reviewer 2:
The reviewer suggested that more work on PAGs for axles and transmissions would be useful. The engine oil is nowhere near as likely to come to fruition as the axle and gear lubricants.

Reviewer 3:
The reviewer said that it seems all interested parties are invested in the technology. All necessary resources are at their disposal to see out the project objectives.

Reviewer 4:
The reviewer warned that engine sequence tests are expensive and depending on number of formulations examined the proposed budget may not be sufficient.

Can hard coatings and lubricant anti-wear additives work together?: Jun Qu (Oak Ridge National Laboratory) - ft021



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer asserted that the project answers an excellent question of what will happen when engines start using less ferrous materials.

Reviewer 2:

The reviewer pointed out the project’s well-defined technical goals and project plan. No clear description on why boride coatings were selected for this study. The reviewer wondered what the advantage of using boride coatings over chromium nitride- or tungsten-based coatings in SI or CI engine is.

Reviewer 3:

The reviewer commented that the project focuses on studying interactions of ILs and ZDDP on several hard coatings.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer noted that the project had great results to date.

Reviewer 2:

The reviewer applauded the project’s impressive selection of initial friction and wear control data. Since frictional phenomena are driven by formation of tribofilm, the chemistry of examined coatings plays a huge role. The reviewer raised the question of why boride coatings were selected for this study, and which OEM is planning to use them in future engines. The reviewer also wanted to know what happens when IL ages, and if it is still effective in wear control.

Reviewer 3:

The reviewer wondered how coatings were selected, and if it would be better to extend work to other engine materials such as aluminum or copper first.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer suggested that the collaborative team should include an OEM representative, so that the commercially available choice of coatings type is examined.

Reviewer 2:
The reviewer noted that the researchers appear to be able to get parts and coatings from commercial suppliers.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer asserted that more work with ILs on non-ferrous coatings should be funded.

Reviewer 2:
The reviewer claims that a wider range of commercial coatings need to be studied. Furthermore, wear and friction control in a few engine tests with coated parts needs to be assessed.

Reviewer 3:
The reviewer believed that there needs to be more focus on achieving an in-depth understanding of synergy between ILs and ZDDP and how they interact with surfaces, as opposed to Edisonian testing.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that low friction and hard coatings are already incorporated in engine design and will be used even more frequently in a future.

Reviewer 2:
The reviewer affirmed that research extends additive findings to new materials and includes some study of fundamental mechanisms.

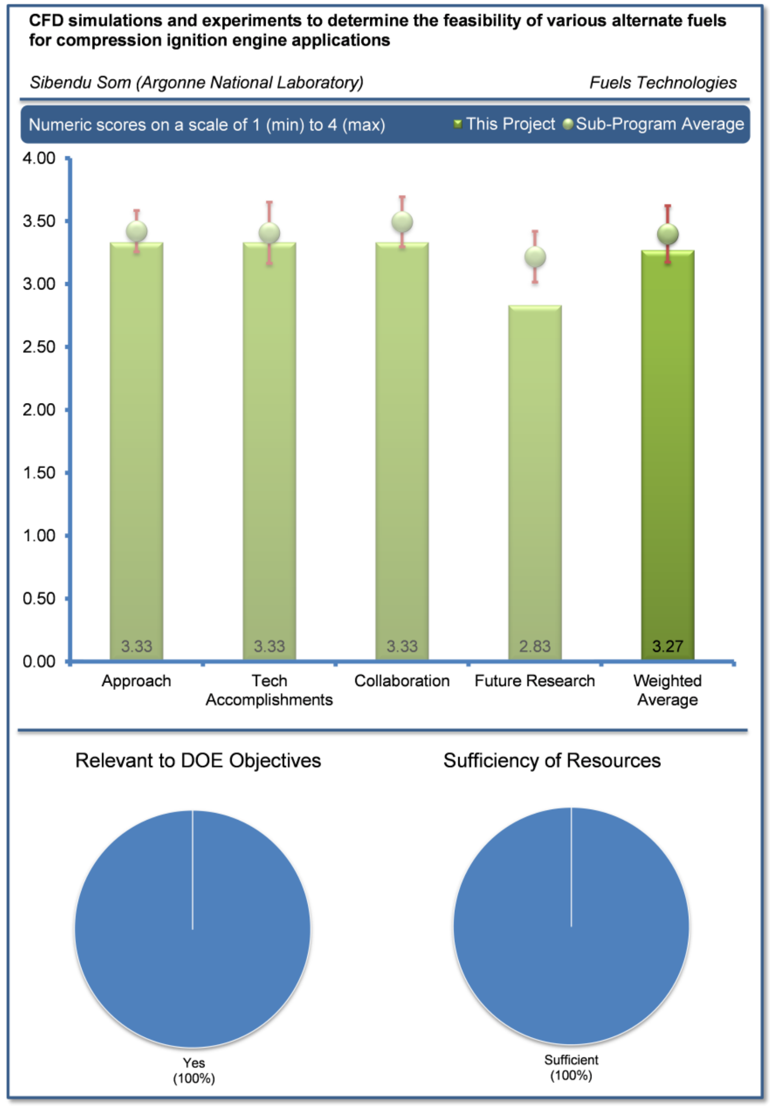
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer brought to light the fact that this is an extremely important topic to handle and there are not enough resources being devoted in the industry. DOE could fill a big hole with more funding.

Reviewer 2:
The reviewer stated that the resources are sufficient to meet deliverables.

Reviewer 3:
The reviewer mentioned that collaboration with OEM laboratory is encouraged.

CFD simulations and experiments to determine the feasibility of various alternate fuels for compression ignition engine applications: Sibendu Som (Argonne National Laboratory) - ft022



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded project's excellent approach to the CFD work utilizing multiple resources at ANL.

Reviewer 2:

The reviewer recounted that the project is developing a biodiesel surrogate model and studying viscosity effects on fuel injection.

Reviewer 3:

The reviewer reported that the project combines simulations of nozzle spray patterns from biodiesel fuels (and biodiesel surrogate fuels) with kinetic and combustion modeling to better understand injection spray properties of biodiesel. The project observes and models a variety of key nozzle- and spray-related characteristics for different types of biodiesels at different temperatures, pressures, and other conditions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer pointed out that the project team has done calculations no one else has to date.

Reviewer 2:

The reviewer observed that the results reported appear to be very informative and long-neglected in helping understand how biodiesel injection and combustion differ from that of conventional diesel, possibly suggesting future hardware changes as biodiesel continues to substantially penetrate diesel fuel markets.

Reviewer 3:

The reviewer said that a lot of people are working in these areas and was unsure if this project is leading or following.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commended the project for good collaborations with other laboratories.

Reviewer 2:
The reviewer noted that collaboration appears strong between the lead researcher and other government laboratories and academic institutions. Research might benefit from participation from engine makers or fuel producers, blenders, and refiners.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer recounted that research will continue to move modeling forward and having SCE work will close the loop.

Reviewer 2:
The reviewer report that the validation of the ignition quality tester results through simulations appears to be a useful exercise. Further testing with Cuphea biodiesel, as proposed, may also be of some value, although such value may be limited considering that Cuphea biodiesel is not in production in any substantial volume and may never be. The reviewer concluded that research of the type undertaken with differing blends of soy methyl ester and petroleum diesel would probably be of greater value.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer mentioned that the project provides an understanding of how new fuels interact in engines relative to physical and chemical properties.

Reviewer 2:
The reviewer explained that biodiesel production and blending has continued to proliferate over the last two decades and RFS2 is likely to dictate that it will continue to do so in the future. The optimal strategies for blend levels and how to take advantage of widespread availability of biodiesel blends have not been adequately investigated. The reviewer went on to say that while biodiesel producers emphasize that the fuel is compatible with engines at up to 100%, engine makers continue to resist that assertion and the fuel’s ultimate effects at high blend levels have not been determined, particularly in cold weather conditions. This research could help establish what blend levels would be appropriate at what conditions and how future engines (such as injectors) could be designed to take advantage of those blend levels for enhanced efficiency and reduced emissions.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer asserted that the impressive results shown to date with only one year of research at a fairly low funding level suggest that the funding has been sufficient. It also suggests, however, that additional funding might be justified to better realize the benefits of the research, particularly if multiple blends of biodiesel with petroleum diesel are to be investigated.

Reviewer 2:
The reviewer stated that resources are adequate and collaborative laboratories are helping with the larger effort.

Acronyms and Abbreviations

Acronym	Definition
AEC	Advanced Engine Combustion
AMR	Annual Merit Review
ANL	Argonne National Laboratory
ASTM	American Society for Testing and Materials
AVFL-18	Project 18 under Advanced Vehicle/Fuel/Lubricants of the Coordinating Research Council
CAFE	Corporate Average Fuel Economy
CFD	Computational Fluid Dynamics
CFR	Cooperative Fuel Research
CI	Compression Ignition
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CO	Carbon monoxide
CR	Compression ratio
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CSM	Colorado School of Mines
CV	Combustion vessel
DISI	Direct Injection Spark Ignited
DOE	Department of Energy
E0	0 percent ethanol blend with gasoline
E10	10 percent ethanol blend with gasoline
E30	30 percent Eethanol blend with gasoline
E85	85 percent ethanol blend with gasoline
EHN	Ethyl hexyl nitrate
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
EV	Electric vehicle
FE	Fuel Economy
FIB	Focused ion beam
FTP	Federal Test Procedure
FY	Fiscal Year
GDI	Gasoline Direct Injection
GHG	Greenhouse gas
GM	General Motors Corporation
GTDI	Gasoline Turbocharged Direct Injection
HC	Hydrocarbon
HCCI	Homogeneous Charge Compression Ignition
HD	Heavy-duty
HMN	Heptamethylnonane (a.k.a. cetane, a.k.a hexadecane)
HRR	Heat release rate
HTHS	High-temperature, high shear
ICE	Internal combustion engine

Acronym	Definition
IL	Ionic Liquids
IQT	Ignition Quality Tester
LD	Light-duty
LII	Laser-Induced Incandescence
LLFC	Lean Lifted-Flame Combustion
LLNL	Lawrence Livermore National Laboratory
LSPI	Low-speed preignition
LTC	Low-temperature combustion
MD	Medium-duty
MECA	Manufacturers of Emission Controls Association
MIT	Massachusetts Institute of Technology
mL	milliliters
MOU	Memorandum of Understanding
MPG	Miles per gallon
MTBE	methyl tertiary butyl ether
NO_x	nitrogen oxides
NREL	National Renewable Energy Laboratory
NTC	Negative temperature coefficient
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PAG	polyalkylene glycol
PI	Principal Investigator
PM	Particulate Matter
PPC	Partially premixed combustion
R&D	Research and Development
RCCI	Reactivity Controlled Compression Ignition
RFS	Renewable Fuel Standards
RON	Research octane number
RoPR	Rate of pressure rise
RSP	Renewable super premium
SCE	Single cylinder engine
SCRE	Single-cylinder Research Engine
SI	Spark Ignition
SIDI	Spark Ignition Direct Injection
SNL	Sandia National Laboratories
TBE	Turbo-back exhaust
TDC	Top Dead Center
TPGME	tri-propylene glycol methyl ether
VI	Viscosity index
VTO	Vehicle Technologies Office
WOT	Wide-open throttle
XPS	X-ray photoelectron spectroscopy
ZDDP	zinc dialkyl-dithio-phosphate

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6. Lightweight Materials

Advanced materials are essential for boosting the fuel economy (FE) of modern automobiles while maintaining safety and performance.

Because it takes less energy to accelerate a lighter object than a heavier one, lightweight materials offer great potential for increasing vehicle efficiency. Replacing cast iron and traditional steel components with lightweight materials such as high-strength steel, magnesium (Mg) alloys, aluminum (Al) alloys, carbon fiber (CF), and polymer composites can directly reduce the weight of a vehicle's body and chassis by up to 50% and therefore reduce a vehicle's fuel consumption. A 10% reduction in vehicle weight can result in a 6%-8% FE improvement.

By using lightweight structural materials, cars can carry additional advanced emission control systems, safety devices, and integrated electronic systems without increasing the overall weight of the vehicle. While any vehicle can use lightweight materials, they are especially important for hybrid electric, plug-in hybrid electric, and electric vehicles (EVs). Using lightweight materials in these vehicles can offset the weight of power systems such as batteries and electric motors, improving the efficiency and increasing their all-electric range. Alternatively, the use of lightweight materials could result in needing a smaller and lower cost battery while keeping the all-electric range of plug-in vehicles constant.

Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the U.S. fleet could save more than 5 billion gallons of fuel annually by 2030.

The Vehicle Technologies Office (VTO) collaborates with industry to improve materials that will increase vehicle efficiency while meeting consumer and industry expectations. It does this through multiple approaches, including working to lower the cost and improve the properties of lightweight materials while maintaining safety, comfort, reliability, performance, recyclability, and cost.

The major research and development (R&D) goal for Lightweight Materials is:

- By 2015, validate the ability to reduce the weight of a passenger vehicle body and chassis system by 50% compared to a 2002 vehicle. This reduction needs to be cost-effective and the materials need to be recyclable as well.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: William Joost (U.S. Department of Energy) – lm000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:

The reviewer said yes. The reviewer commented that the overall program was easily understood and well presented. The business case and gaps were clearly articulated and logical in sequence.

Reviewer 2:

The reviewer said yes, and that the presentation showed a good strategy based on feedback from the industry.

Reviewer 3:

The reviewer said that the program covers the lightweighting and propulsion materials. The reviewer said that in the area of lightweighting, all the constituent materials, including aluminum (Al), magnesium (Mg), carbon fiber composites (CFCs), and steels, are well represented. The projects are addressing the identified barriers very well. The reviewer thought that similarly, the Propulsion Materials projects are developing solutions for light-duty and heavy-duty engines; the efforts on electric vehicles (EVs) is just beginning. It is expected that more material issues for EVs will be dealt with in the future as their use increases.

Reviewer 4:

The reviewer said that the Vehicle Technologies Office (VTO) program was clearly explained, the strategy was clear and consistent with the goals.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:

The reviewer said yes, there is a good balance.

Reviewer 2:

The reviewer emphasized yes, there is a balance. The reviewer commented there is an appropriate balance between the mid-term and long-term development and research projects.

Reviewer 3:

This reviewer is impressed with that balance. Appropriately, the majority of projects and funding focus on near-term projects that are industry driven. The reviewer pointed out that there are also several basic technology development projects that may have longer term potential. For example, development of third-generation advanced high-strength steel (AHSS) appears to have a mid-/long-term potential, whereas much of the design and simulation tools have nearer term potential. The reviewer also pointed out the Graduate Automotive Technology Education (GATE) project, which focuses on education. This is clearly a longer term investment.

Reviewer 4:

The reviewer said that as more and more industry partners are involved, the projects may be moving from long-range to near- and mid-term, so a balance needs to be kept with some fundamental aspects of the materials in the portfolio.

Question 3: Were important issues and challenges identified?

Reviewer 1:

The reviewer said yes, the challenges were very well identified.

Reviewer 2:

The reviewer said that the issues/gap analysis as presented is very detailed by covering the various aspects as property requirement and performance enhancement are needed in medium- to long-term.

Reviewer 3:

The reviewer said generally speaking, yes. The propulsion materials presented gaps quantitatively with long term goals for each area. The reviewer noted that the lightweight materials (body) program identified focus areas, but did not set quantitative targets. The reviewer really liked the “When it Works" slide for the various materials. This slide summarized and brought into focus the prior slides, which explained the various considerations of lightweighting on commercial automotive.

Reviewer 4:

The reviewer commented that issues and challenges were mostly identified. The reviewer elaborated by stating that there are more broad societal issues that should be mentioned that set the framework for the technical goals and strategies. The reviewer believed that the issues of energy security and the challenges of light-duty vehicle customer expectations should have more of an airing. These help set policy and strategy.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:

The reviewer commented that the plans for addressing the technical issues were clearly identified.

Reviewer 2:

The reviewer said yes.

Reviewer 3:

The reviewer said yes, extensively. The reviewer commented that the currently funded programs were clearly and logically set up to tackle the stated priorities. For this reviewer, the only improvement might be building a longer term trajectory. For example, there is a shift in the composite area from low-cost carbon fiber (LCCF) funding to integrated computational materials engineering (ICME) and non-destructive evaluation (NDE) projects. According to the reviewer, this was great, but it might be a good idea to show what has been accomplished, what the current plans are intended to accomplish, and what is still to be done at some future time.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:

The reviewer found that the presentations from various researchers have shown the year over year progress very clearly.

Reviewer 2:

The reviewer said yes, progress was clearly benchmarked against the previous year.

Reviewer 3:

The reviewer said that the progress highlights were presented clearly. The efforts were proceeding as expected.

Reviewer 4:

The reviewer said no, and elaborated that the accomplishments of the previous year were clearly presented. However, the reviewer observed that it was not shown how that translates into a trend or curve or measures relative to a benchmark. The reviewer noted that the accomplishments were impressive, and that the program is producing significant results.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer said yes. The reviewer commented that the major barriers industry is facing in the area of lightweighting are being addressed in an interesting mix of targeted technology development, such as LCCF and third-generation AHSS, and broader integrated efforts, such as the multi-material vehicle and magnesium intensive front end.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer commented that the projects address the multi-faceted issues and barriers surrounding lightweight materials and technologies.

Reviewer 4:
The reviewer observed that the energy efficiency of a vehicle is impacted by the weight and the efficiency of the powertrain. These aspects are being investigated by the subprograms on lightweighting and propulsion (internal combustion and electrification); while lightweighting is being supported very well, the support for the propulsion materials is marginally lower. The reviewer commented that lightweighting contributes to the short- and mid-term goals and the powertrain may contribute more towards long-term. The funding should reflect this aspect.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer said yes the program area appeared to be focused, well-managed, and effective in addressing VTO's needs.

Reviewer 2:
The reviewer found that the projects are selected to address the priority areas and are well managed.

Reviewer 3:
The reviewer concluded that the program is properly focused with efforts in many material and process systems, joining, corrosion and the computational tools that enable product and component design.

Reviewer 4:
The reviewer responded yes. The reviewer commented that the efforts are not a multitude of diluted efforts across a wide variety of potential performers, but rather focused, integrated efforts targeted at addressing a particular problem. This ensures sufficient resources are invested to address the problem and make significant progress towards a solution. The reviewer commented that it also allows course corrections in future years to address the new problems that are exposed based on the ongoing efforts.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
The reviewer said that the projects are all good.

Reviewer 2:
The reviewer found key strengths to include integrated efforts across multiple performers to address significant issues (ICME of composites, multi-material vehicles [MMV], ICME of third-generation AHSS).

A key weakness is the project that is modeling weight impacts on crashes is not moving towards success. This reviewer's comments of that project have been submitted.

Reviewer 3:
The reviewer commented that there are few projects that are just evaluating existing materials; the data which are being generated needs to be correlated to metallurgical/manufacturing variables so that the data can be used in future. The reviewer cited lm073 and pm038.

The reviewer noted, on the other hand, projects such as lm054 and lm075 are very relevant to industry and have delivered good results. The new projects on ICME based research are having a good start and need to be watched.

Reviewer 4:
The reviewer detailed as strengths the diversity of the portfolio. This reviewer is particularly interested in the high strength aluminum efforts. The reviewer identified as weaknesses end-of-life recycling, especially for CFCs.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer responded yes.

Reviewer 2:
The reviewer commented that there is a healthy mix of evolutionary and revolutionary efforts to enhance the use of lightweight materials in automotive structures.

Reviewer 3:
The reviewer commented some yes, others no. The reviewer thinks in almost all cases the approach taken is appropriate and justified. The reviewer found that the approaches generally speaking do not have major holes, validate everything, and tackle a problem of significant importance.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer commented that the program has successfully engaged OEMs, suppliers, universities, consultants and national laboratories, and concluded good collaboration.

Reviewer 3:
The reviewer commented that the primary partners appear to be the following: Oak Ridge National Laboratory (ORNL), with focuses on carbon fiber and propulsion simulation; Pacific Northwest National Laboratory (PNNL), with a focus on metals; USCAR/ original equipment manufacturers (OEMs), with focuses on integrated and validation projects; and some material suppliers. The advanced topics, such as breakthrough techniques in multi-material joining, are conducted by universities. The reviewer concluded that for transition purposes, these are all the right organizations. That said, the reviewer suggested it may be appropriate to look at what other technologies are being developed by other government laboratories beyond the U.S. Department of Defense (DOD) laboratories, including the National Aeronautics and Space Administration (NASA) (likely simulation), Forest Services labs (have developed a lightweight nano-fiber from wood), and DOD laboratories. The reviewer suggested that particularly in the area of composites, more coordination might be possible.

Reviewer 4:
The reviewer noted that the partnerships in the program, for both lightweight and propulsion materials, is made of many North America producers and Tier 1 suppliers; the presence of other international OEMs is not evident. The reviewer suggested that even though international OEMs may not be investing in R&D in North America, some efforts may be needed to bring them to the program.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes. The reviewer remarked that these laboratories have the specialized facilities, expertise, and industry relationships that make them natural partners for VTO.

Reviewer 3:
The reviewer said yes, and commented that there appeared to be good support, direction, monitoring, and interactions.

Reviewer 4:
The reviewer noted that while some of the industrial partners are contributing heavily through in-kind participation, the quantum of this is not consistent across all the partners/projects.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer said that the program needed more funding.

Reviewer 2:
The reviewer remarked that some of the barriers to adoption are not technical per se, but rather business and design process driven. The reviewer provided as an example qualifying composites has been cited as a barrier, and there have been numerous efforts across the government to address this issue. Yet, this issue still comes up, and it is not clear to this reviewer how it will be addressed in the automotive space. The reviewer asked is this not an issue for automotive, and if not, why not. If so, the reviewer would like to know what its impact is. The reviewer asked about the supply chain, and if there was adequate supply. The reviewer would like to know if the supply chain model is broken, or is industry able to handle this naturally. Technical gaps that came to mind for this reviewer are adhesives and corrosion. The MMV project should help identify the major issues that would prevent the adoption of some of the technologies that lead to a 30% weight reduction. The reviewer would like to know what areas could benefit the most from focused government investment to develop the technologies that would lead to a 50% lighter vehicle.

Reviewer 3:
The reviewer pointed out that sustainability, lifecycle assessment, and recycling needed to be integrated in the projects as new materials are being introduced. The reviewer noted that few existing projects have some of the issues covered but making it another task item will be useful.

Reviewer 4:
The reviewer commented that gaps include recycling of carbon fiber and many composite materials. The reviewer suggested that DOE can be the referee for more standardized composite material and process systems. Designers are still required to pick a raw material supplier, a sizing system, a resin system and then fabric form and part manufacturing all that influence the structural behavior of the finished part. The reviewer noted that designers need to have robust material properties, like DP600 steel or AA-6062-T4 extrusion whose material performance is rather independent of the supplier(s).

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer responded yes. The projects the reviewer evaluated appeared to address the topics adequately to achieve significant progress. The reviewer acknowledged that these projects will not likely solve all the problems. This is in part because it is often impossible to control for geometry and design architecture. The reviewer commented that further evaluations and projects will be necessary within the commercial community to understand the strengths and limits of the technologies. But, within the priorities and gaps outlined in the program, the topics are being adequately addressed.

Reviewer 2:
The reviewer commented low-cost composite manufacturing.

Reviewer 3:
The reviewer commented that there needs to be more attention to end of life and recycling especially for the composite areas.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer commented that the program is focused on supporting the needs of the existing high volume automotive industry. These companies have significant infrastructure to support and are, for the most part, tied to their particular vehicle architectures. The reviewer commented that smaller companies do not have these restrictions and could utilize alternative vehicle architectures. These new architectures might be superior in electric and fuel cell vehicles. The reviewer remarked that there appears to be no significant investment in exploring non-established vehicle architectures.

Reviewer 2:

The reviewer commented that CFCs need more funding.

Reviewer 3:

This reviewer referenced the response given in Question #2. Some fundamental aspects of materials research need to be supported; this should provide a long-term goal for the program.

Reviewer 4:

The reviewer recommended that there needs to be further efforts on end-of-life and recycling, reuse, reclamation of composites, especially CFCs.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer commented that the current approach is good.

Reviewer 2:

This reviewer will have to think about this more before the reviewer can offer significant suggestions.

Reviewer 3:

The reviewer commented that the program must attack composite and CFC recycling and end-of-life. Additionally, DOE should increase efforts on manufacturing aspects, especially joining and corrosion.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer said that even though the scientific community is aware of past development in the area of their research, the industry/government team may not be aware of them. The reviewer commented that it will be helpful to have some experts provide state of the art/reviews. This can provide context to some of the new research themes. The reviewer provided as an example a presentation on the capability of internal combustion engines as evolved through the years will show the light for work on new high-temperature materials.

Reviewer 2:

The reviewer commented mostly good job here. This reviewer suggested focusing on fewer, larger value projects. Work on including all the aspects of a full vehicle performance, especially noise, vibration, and hardness (NVH) and heating, ventilation, and air conditioning (HVAC) requirements into the vehicle systems that are the subject of lightweight actions.

Reviewer 3:

The reviewer did not offer any suggestions to improve the materials technical area. However, this reviewer did offer a suggestion under the EV Everywhere umbrella. Similar to the way the use of EVs are tied to high-occupancy vehicle (HOV) lanes in California to encourage public purchase of EVs, linking EVs to parking benefits in Washington, DC, or other high density urban areas might have significant impact. The reviewer cited as an example that landlords who install charging stations would get some sort of tax or other financial benefit that would have to be partially shared with the tenant through reduced parking fees for some period of time [DOE Program Note: The reviewer's suggestion has been passed to the EV Everywhere team.].

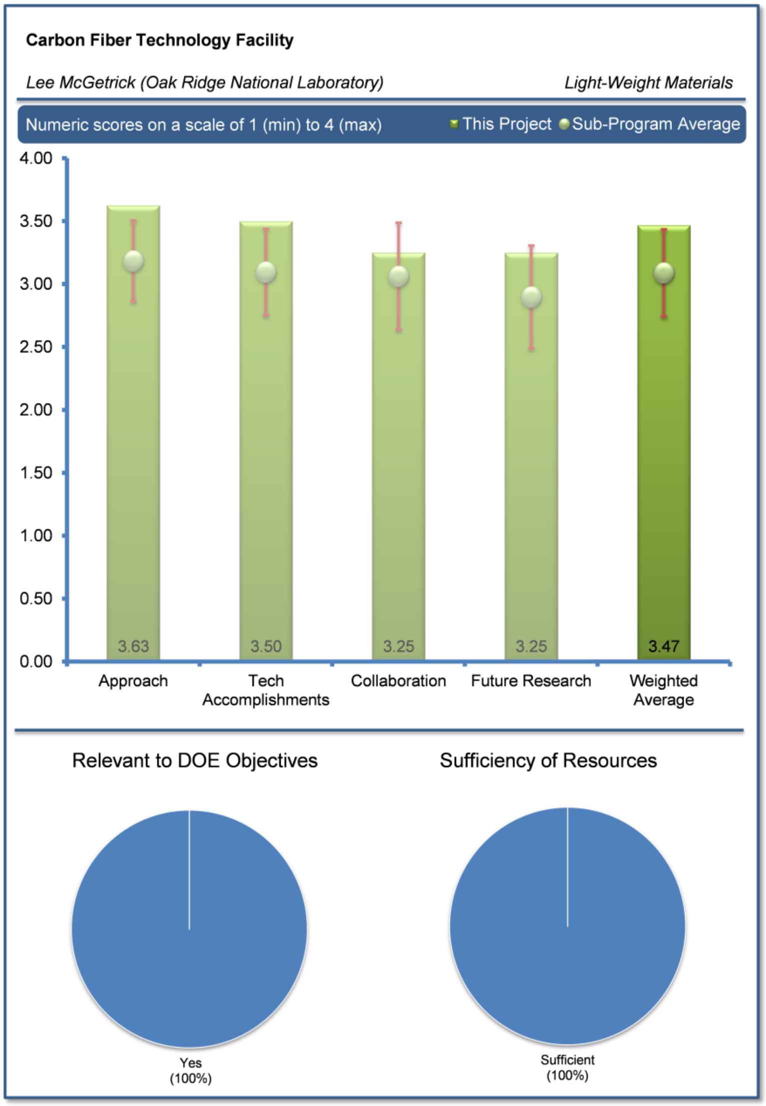
Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Carbon Fiber Technology Facility	Lee McGetrick (Oak Ridge National Laboratory)	6-12	3.63	3.50	3.25	3.25	3.47
Advanced Oxidation & Stabilization of PAN-Based Carbon Precursor Fibers	Dave Warren (Oak Ridge National Laboratory)	6-14	3.63	3.13	3.00	3.25	3.25
Scale-Up of Magnesium Production by Fully Stabilized Zirconia Electrolysis	Steve Derezinski (MOxST)	6-16	3.25	3.50	3.63	2.88	3.38
Development and Commercialization of a Novel Low-Cost Carbon Fiber	George Husman (Zoltek)	6-19	2.75	2.50	2.88	2.88	2.66
On-Line Weld NDE with IR Thermography	Dave Warren (Oak Ridge National Laboratory)	6-21	3.50	3.20	3.00	3.00	3.23
Non-Rare Earth High-Performance Wrought Magnesium Alloys	Curt Lavender (Pacific Northwest National Laboratory)	6-24	3.13	3.63	3.00	3.00	3.34
Mechanistic-Based Ductility Prediction for Complex Mg Castings	Xin Sun (Pacific Northwest National Laboratory)	6-28	3.50	3.00	3.13	3.00	3.14
Aerodynamic Lightweight Cab Structure Components	Mark Smith (Pacific Northwest National Laboratory)	6-31	2.83	3.00	3.00	2.83	2.94
Improving Fatigue Performance of AHSS Welds	Dave Warren (Oak Ridge National Laboratory)	6-34	3.25	3.25	2.88	3.00	3.17
Relationships between Vehicle Mass, Footprint, and Societal Risk	Tom Wenzel (Lawrence Berkeley National Laboratory)	6-37	2.75	2.75	2.88	2.00	2.67
Multi-Material Lightweight Prototype Vehicle	Tim Skszek (VEHMA International of America)	6-41	3.67	3.17	3.33	3.33	3.33
Residual Stress of Bimetallic Joints and Characterization	Thomas Watkins (Oak Ridge National Laboratory)	6-44	3.00	3.33	3.00	3.00	3.17
SPR Process Simulation, Analyses, & Development for Mg Joints	Elizabeth Stephens (Pacific Northwest National Laboratory)	6-46	2.75	2.50	3.13	2.63	2.66
High Speed Joining of Dissimilar Alloy Aluminum Tailor Welded Blanks	Yuri Hovanski (Pacific Northwest National Laboratory)	6-49	3.75	3.50	3.50	3.13	3.52
Understanding Protective Film Formation by Magnesium Alloys in Automotive Applications	Kinga Unocic (Oak Ridge National Laboratory)	6-52	3.13	3.25	2.75	2.88	3.11
Magnesium-Intensive Front End Sub-Structure Development	Steve Logan (United States Automotive Materials Partnership)	6-56	3.33	3.33	3.50	3.33	3.35
Aluminum Formability Extension through Superior Blank Processing	Xin Sun (Pacific Northwest National Laboratory)	6-59	3.25	3.25	3.38	3.13	3.25

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Enhanced Room-Temperature Formability in High-Strength Aluminum Alloys through Pulse-Pressure Forming	Rich Davies (Pacific Northwest National Laboratory)	6-62	3.17	2.83	3.17	2.50	2.92
Integrated Computational Materials Engineering Approach to Development of Lightweight 3GAHSS Vehicle Assembly	Lou Hector (United States Automotive Materials Partnership)	6-65	3.38	3.25	3.63	3.38	3.34
GATE Center of Excellence at UAB for Lightweight Materials and Manufacturing for Automotive, Truck and Mass Transit	Uday Vaidya (University of Alabama at Birmingham)	6-69	3.13	3.13	3.25	2.13	3.02
Development of 3rd Generation Advanced High Strength Steels (AHSS) with an Integrated Experimental and Simulation Approach	Xin Sun (Pacific Northwest National Laboratory)	6-73	2.50	2.17	1.83	1.83	2.17
Predictive Engineering Tools for Injection-Molded Long-Carbon-Fiber Composites	Ba Nghiep Nguyen (Pacific Northwest National Laboratory)	6-76	2.88	2.88	3.25	3.00	2.94
Validation of Material Models for Automotive Carbon Fiber Composite Structures	Libby Berger (General Motors LLC)	6-78	3.25	3.25	3.25	3.13	3.23
Collision Welding of Dissimilar Materials by Vaporizing Foil Actuator	Glenn Daehn (Ohio State University)	6-81	3.25	3.25	3.13	3.38	3.25
Active, Tailorable Adhesives for Dissimilar Material Bonding, Repair and Assembly	Mahmood Haq (Michigan State University)	6-84	3.00	2.88	1.88	2.63	2.75
Overall Average			**3.19**	**3.10**	**3.07**	**2.90**	**3.09**

Carbon Fiber Technology Facility: Lee McGetrick (Oak Ridge National Laboratory) - lm003



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this is an ambitious effort, but significant progress is being made. The reviewer said that the project team is learning that some of the industry assumptions may no longer be valid and they are breaking new ground.

Reviewer 2:

The reviewer commented that the approach laid out by the leadership of the Carbon Fiber Technology Facility (CFTF) has established the facility as a national resource and the CFTF continues to reach out to organizations to solicit additional collaborators, as well as workforce development.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the accomplishments of getting this facility up and running are impressive. The reviewer added that the education component is also working well.

Reviewer 2:

The reviewer observed that the output of the CFTF has exceeded the performance targets (250 kips per square inch (ksi)/25 mega pounds per square inch [Mpsi]) initially set by the program and have reached levels of 500ksi tensile strength and 35ksi modulus. The reviewer added that the project team’s focus on the textile pan will help improve the cost position of the carbon fiber, but more work needs to be done.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the Oak Ridge National Laboratory (ORNL) has a significant list of industrial and academic collaborators utilizing the carbon fiber (CF) product produced on the CFTF line. The reviewer added that while running at only 60% capacity, more opportunities for additional collaboration may help accelerate adoption into the marketplace.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer commented that improving efficiency, expanding industrial partnerships and scaling up other technologies (e.g., plasma surface treatment) are outlined in the proposed future activity section and are all solid ideas. The reviewer noted that the displays at the end of the CFTF line are of great value to visiting engineers. The reviewer added that actual parts from actual production applications allow engineers and scientists the opportunity to think about the possibilities that carbon fiber composites (CFCs) can bring to industry.

Reviewer 2:
The reviewer stated that the project team is proposing to tackle key problems in the industry that will advance the entire composites field.

Reviewer 3:
The reviewer remarked that it seems the bulk of the of proposed future research focuses on efficiency improvements, productivity improvements, and expansion of industry partnership. The reviewer added that it would be valuable to demonstrate a better clarity on the degree at which such initiatives would influence long-term impact of the center for meeting original project goal objectives.

Reviewer 4:
This reviewer did not hear a list of research ideas.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

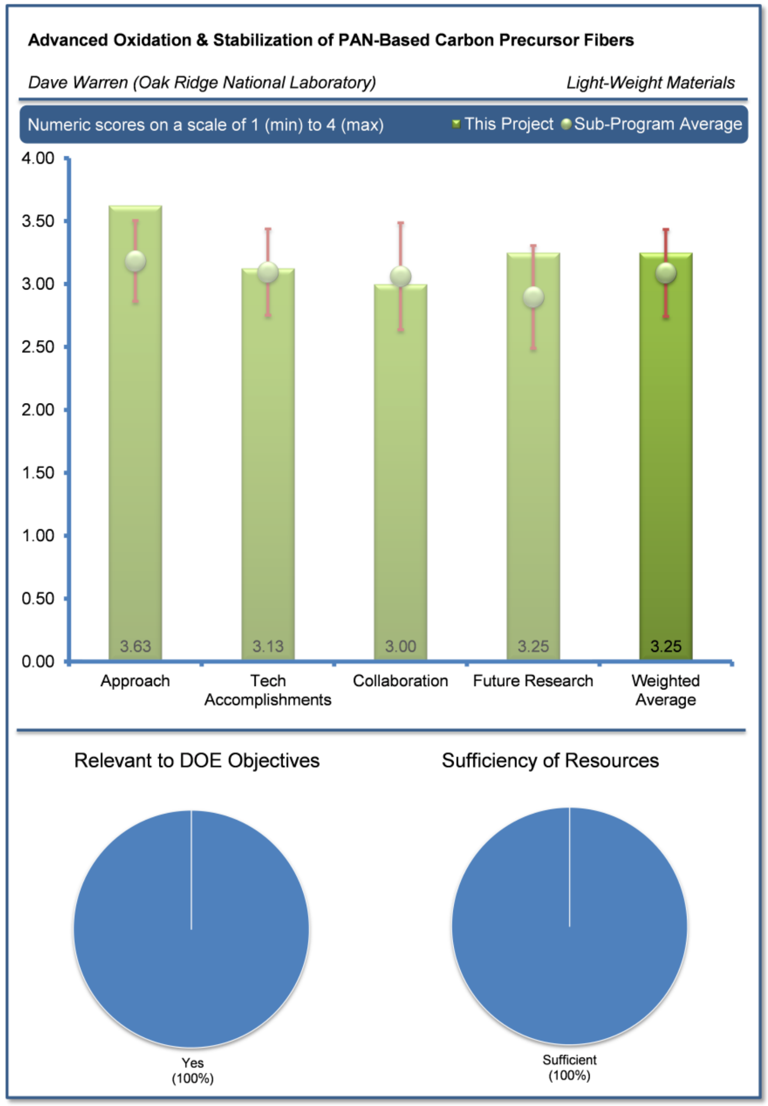
Reviewer 1:
This reviewer commented that having such facility is absolutely critical in achieving long-term DOE objectives.

Reviewer 2:
The reviewer said that low cost CF has many implications in transportation, wind energy, natural gas, etc.

Reviewer 3:
The reviewer stated that CFCs are key material technologies that will bring lightweight solutions to the automotive industry to help original equipment manufacturers (OEMs) meet current and future fuel economy and greenhouse gas emission standards.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
No comments were received in response to this question.

Advanced Oxidation & Stabilization of PAN-Based Carbon Precursor Fibers: Dave Warren (Oak Ridge National Laboratory) - lm006



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this project addresses some key issues in manufacturing CF that have wide ranging implications. This manufacturing improves the efficiency and speed of the process. The reviewer added that the lower temperatures used in oxidation can allow for changes in the precursor that have yet to be explored. This could be extended to the other low cost precursor programs and combine for even larger savings.

Reviewer 2:

This reviewer commented that the approach of using plasma instead of diffusion for oxidation of the precursor fibers is a solid approach towards decreasing the cost of CF by addressing 18% of the cost equation. The reviewer added that a four-zone reactor will help address the variability and lower properties exhibited as compared to the diffusion oxidation fibers.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the project team has exceeded the performance targets thus far and it seems that further improvements will be possible.

Reviewer 2:

The reviewer commented that the small reactor resulted in fibers with lower properties than conventional fibers; however, a significant reduction in cycle time was exhibited (2-3X). The scale up of the four-zone reactor should help with physical properties.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer pointed out that this technology could be further extended to other programs.

Reviewer 2:

The reviewer stated that ORNL is collaborating exclusively with RMX Technologies, who will execute an option to exclusively license. Several companies have expressed interest.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the current work on the large reactor should continue. The reviewer added that scaling up a plasma oxidation oven for an advanced technology/demonstration line in the CFTF would be valuable.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This reviewer remarked that lowering the manufacturing cost of CF and maintaining properties has implications in lightweighting vehicles and also wind energy.

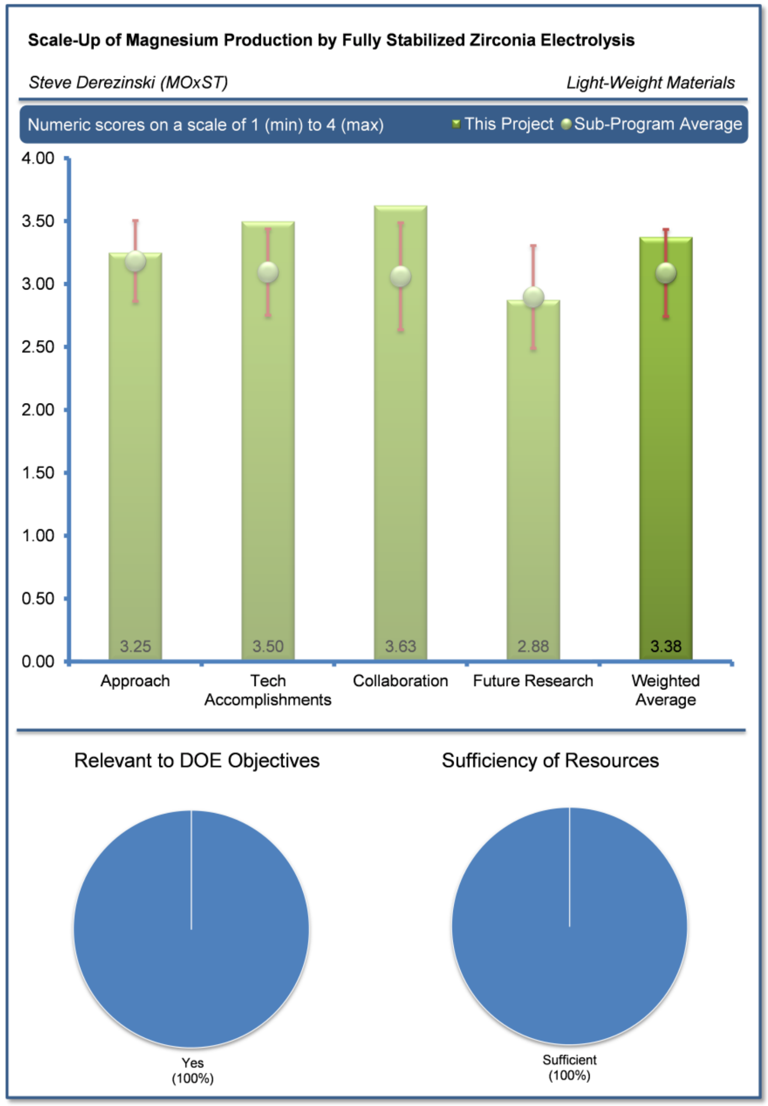
Reviewer 2:

This reviewer commented that research to reduce the cost of CF should continue. The reviewer added that low cost CFCs are needed in the transportation industries to address current and future fuel economy and greenhouse gas emission regulations.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were received in response to this question.

Scale-Up of Magnesium Production by Fully Stabilized Zirconia Electrolysis: Steve Derezinski (MOxST) - lm035



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the overall approach appears to be well designed and likely to produce good results for the project. The reviewer placed a strong emphasis on applying the study data to the production of real world vehicle components and so more of that type of data is always welcome.

Reviewer 2:

The reviewer asked if the anode lifetime is the rate-limiting step for this process. The reviewer also asked if there is any theoretical modeling going on to support design enhancements to the current version of the instrumentation.

Reviewer 3:

The reviewer stated that the approach as originally planned is being kept but the timeline is being extended. The reviewer added that even though there is no additional cost to the U.S. Department of Energy (DOE) the time for the return on investment (ROI) is being prolonged.

Reviewer 4:

The reviewer commented that the project team should hurry up and deliver a scaled production process, there are many opportunities for magnesium (Mg) in automotive and we need a domestic source of basic ultra high purity (UHP) Mg.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that this is a tough technical project and it appears that barriers are being steadily addressed and overcome. Well done.

Reviewer 2:

The science put into the anode development and the process development is sound, structured and on target based on the original Funding Opportunity Announcement (FOA). All targets are being met and the project must continue.

Reviewer 3:
This reviewer pointed out that Alpha 3.0 shows promise. The reviewer asked how much material can be made from this technique upon scale-up. The reviewer also asked if the proposed approach to Mg manufacturing could match existing manufacturing approaches in size and cost.

Reviewer 4:
The reviewer stated that the progress is incremental from the previous year; it is difficult to estimate the level of progress because the timeline is being extended. The reviewer added that technical accomplishment in the electrolysis is dependent on the life of the anodes. The life of the anodes is being evaluated now. The reviewer stated that it would be useful to know what specifications were used on the life of material for the other electrolysis process. The reviewer also added that enough Mg would have been produced through the alpha and beta cells; the quality of pure Mg from the impurity stand point is not presented.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that all collaborators are excellent choices, and the reviewer is looking forward to the developments with Spartan and Magna/Vehma to make actual automotive parts.

Reviewer 2:
The reviewer remarked that there were many collaborators developing enabling technologies. The reviewer added that it is nice to know as the new technology is evolving the project team is looking after the various needs such as gas recycling and anode material suppliers.

Reviewer 3:
The reviewer commented that seven industrial partners were noted from this presentation. The Principle Investigator (PI) is communicating with these partners and appeared to be listening to their recommendations.

Reviewer 4:
The reviewer said that collaboration appears to be strong, well organized and effective.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer said to continue the great work.

Reviewer 2:
The reviewer stated that the only tangible work to be carried out will be the long term durability of the electrodes. The reviewer added that the testing of Mg on parts is mostly carried out by partners but the project produces only pure Mg, which does not need lots of testing.

Reviewer 3:
The reviewer asked if there is any chance that Mg alloys can be produced with this technique that do not corrode (or at least corrode far less than existing alloys). The reviewer also asked what range of alloys can be produced with this technique. The reviewer asked if this technique would produce wrought Mg alloys (following subsequent processing) that are more formable that existing Mg alloys available commercially. The reviewer asked what advantages this technique offers to end users such as the automotive industry. The reviewer also asked if it will only be cost reduction compared with existing alloys, or will more formable alloys become available. The reviewer also asked what about greenhouse gas emissions. The reviewer asked if measures to reduce greenhouse gases will add much cost to this process upon scale-up. The reviewer asked, assuming that this process is successful, if this process will be able to keep up with demands based upon current outputs from the traditional Mg manufacturing base.

Reviewer 4:

The reviewer aid that the project overall, was quite good but the reviewer would have appreciated somewhat more detail on where this project is headed next.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that this project seems to be fully aligned with DOE goals for lightweighting of future vehicles because it deals directly with the production of large scale amounts of Mg for commercial use.

Reviewer 2:

The reviewer noted the need for lower cost and domestic sources for Mg to enable all Mg alloy development.

Reviewer 3:

The reviewer asked if this process could be integrated into a hot rolling step. The reviewer then inquired that perhaps this is a dumb question, but in the end, how is the material produced with this technique to be processed into sheet, plate, extrusions, etc.

Reviewer 4:

The reviewer remarked that even though the project is not directly feeding to the objective, it is aimed to increase the availability of Mg from a U.S. supplier.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer remarked that the project seems to be a bit thin on resources. The reviewer then asked if there is a shortage of personnel.

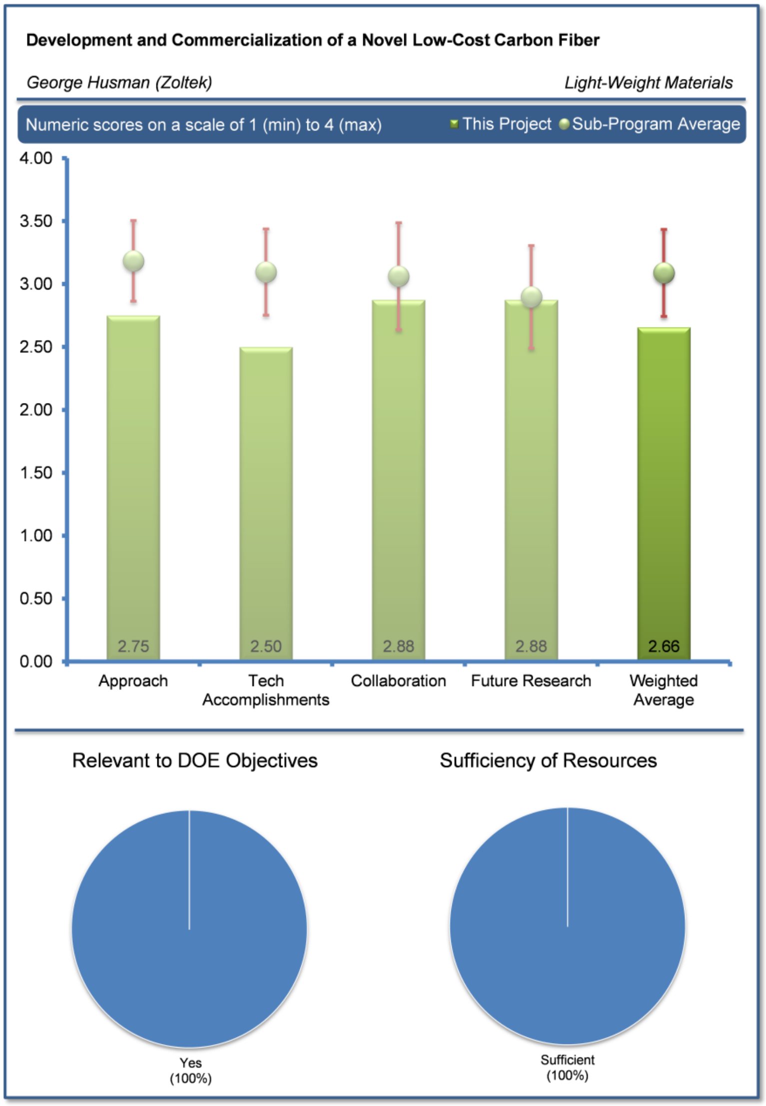
Reviewer 2:

This reviewer stated that the resources appear to be adequate.

Reviewer 3:

This reviewer said that the project was appropriately resourced.

Development and Commercialization of a Novel Low-Cost Carbon Fiber: George Husman (Zoltek) - lm048



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this effort can lower the cost of CF and essentially be a drop into existing manufacturing processes. This makes it more likely to be achievable in the short term. The reviewer added that other projects may have larger overall cost savings, but these are significant and implementable. Also, the reviewer said that other programs can also be combined with this effort to achieve even larger savings.

Reviewer 2:

The reviewer remarked that the approach of combining lignin with polyacrylonitrile (PAN) is acceptable. The reviewer added that the plan to evaluate high molecular weight PAN and evaluating it while blended with lignin to determine a go/no go decision is warranted.

Reviewer 3:

The reviewer commented that mixing lignin with PAN is not innovative. The reviewer added that the project team should look at how to disperse lignin at the molecular level and avoid phase separation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that it seems there are still some hurdles to overcome, but significant progress was made.

Reviewer 2:

The reviewer said that as outlined in the presentation, this project has undergone some challenges in compatibility during the process. Only precursor containing 25% lignin made it through carbonization. Physical properties were lower than traditional PAN based composite (61.2 versus 47.9 ksi flexural strength; 4.06 versus 3.74 msi flexural modulus). The reviewer then asked what additional work the project team is doing to understand the chemistry of oxidation.

Reviewer 3:

This reviewer said that the data showed poor properties.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer suggested that it may be a bit more difficult since Zoltek is now owned by Toray; however, it seems this could be better connected with other programs on low cost CF manufacturing for additional benefits. The reviewer added that at the same time this effort is well focused and practical so some of that collaboration should occur after this has been commercialized. The reviewer then asked how the lignin containing fibers would work in the plasma process being developed at ORNL.

Reviewer 2:

The reviewer said that it is unclear as to whether sufficient brain power is working on this project to fully understand the science/chemistry. The reviewer suggested that outside consultants or laboratories may be of value.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked that the plan for future work is sufficient to quantify the findings of the pilot scale optimization and equipment modifications. The reviewer is looking forward to more positive technical results in the coming year.

Reviewer 2:

The reviewer commented that the path forward to accomplish reasonable properties was not clear.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that this project aims to reduce the cost of CFCs by addressing the cost of the precursor. The reviewer added that lightweight CFCs will help car companies build lightweight applications in order to meet current and future fuel economy and greenhouse gas emission regulations.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

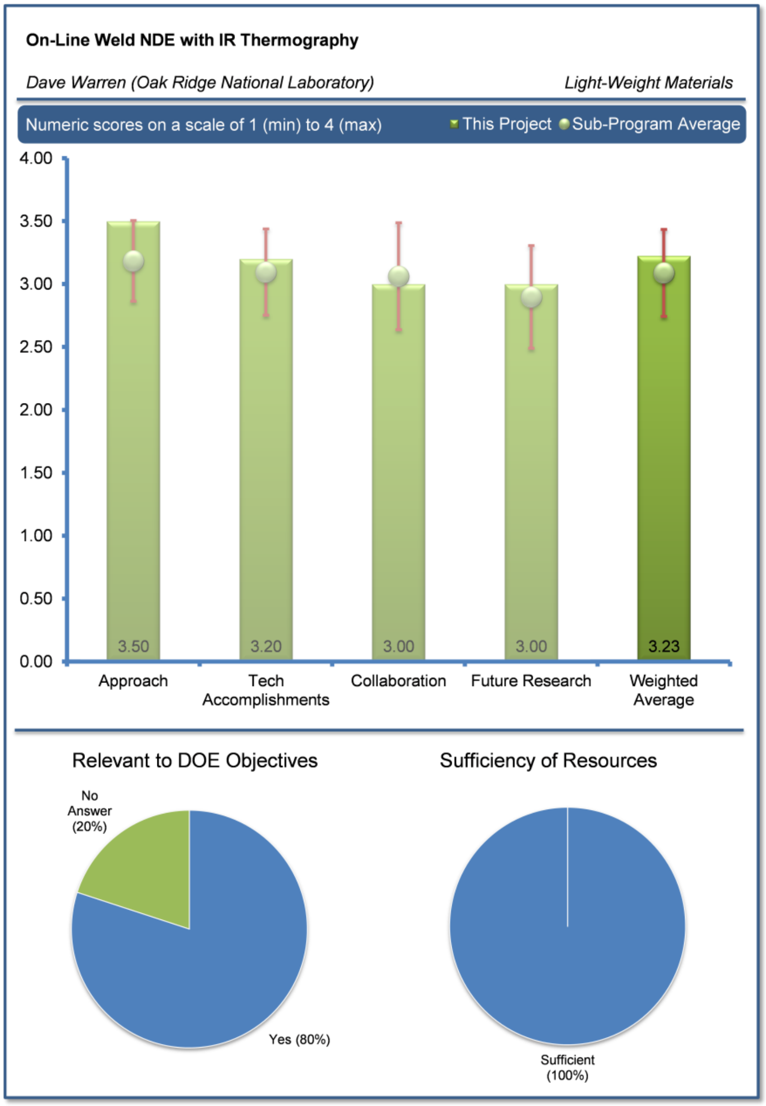
Reviewer 1:

This reviewer pointed out that the significant cost sharing by the industrial partners seems appropriate.

Reviewer 2:

This reviewer stated that as outlined previously, the team may have sufficient resources to execute on the work plan, but the project team may want to consider additional scientists to understand the chemistry of the lignin/PAN oxidation reactions.

On-Line Weld NDE with IR Thermography: Dave Warren (Oak Ridge National Laboratory) - lm054



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that the project has addressed the shortfall as identified in the proposal very well. The approach is good and has produced reliable results overcoming the barrier cited as the reason for the project.

Reviewer 2:

The reviewer remarked that it would help to have some quantitative definition of what is meant by "weld quality." The reviewer then asked if this is based upon measurements or observations from weld surfaces. Alternatively, the reviewer asked what information can be provided about the state of the weld interior. The reviewer then asked what is meant by measuring the thermal response of the weld. The reviewer asked can the proposed technique measure size and location and morphology of porosity. The reviewer also asked can the measured fields be input to finite element programs (i.e., is there a connection with weld modeling in component simulations. The reviewer stated nice graphical user interface. The reviewer then asked is it easy enough for a weld technician (who does not have a Ph.D.) to learn within 15-30 minutes or so. It is not clear as to the amount of effort required to train or calibrate the measurement system for different types of welds.

Reviewer 3:

This reviewer stated that the project addresses the major technical barriers of non-destructive weld evaluations. The approach is well founded and the project team is well constructed with OEMs, weld experts and suppliers. The reviewer added that future efforts on the weld tip degradation and part fit up are key efforts for the next fiscal year. Additionally, the reviewer said that the next barriers that must be addressed are system reliability for hundreds of welds per shift, maybe thousands of welds per day and cost of the systems.

Reviewer 4:

Although a mature inspection technique, this is still a big want for high volume NDE of spot welds in automotive

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the efforts on stick welds and undersized welds are encouraging. The reviewer added that the overall agreement between predicted and measured weld diameter is great, congratulations. This project is well along the path to achieving an important goal for improved weld quality and nondestructive testing. An OEM testing site in Fiscal Year (FY) 2014 is the next critical step. The reviewer wanted to see more details on the training of the system.

Reviewer 2:
The reviewer stated that under controlled situations the new technique has shown to be very reliable and accurate. The reviewer added that the industrial trials are underway, which can prove whether the variations in the shop floor can be accommodated by the new software.

Reviewer 3:
The reviewer said that the project team developed an on line weld inspection system. The reviewer remarked that it would help to know the limit of resolution for the thermal imaging system. The reviewer asked what the smallest pore diameter that can be detected is (assuming a weld has porosity - this would be particularly important for laser welds in Al). The reviewer also asked if the authors have thought about combining their method with x-ray tomography. The reviewer inquired about limiting the thermal imaging. Additionally, the reviewer asked how fast the spot welds can be moving beneath the measurement system and still have the system give meaningful results. The reviewer asked is this process one where the weld movement stops, then the weld is measured, then the part is moved so that the next weld appears beneath the camera. The reviewer also asked how fast the part can be moving beneath the camera. The reviewer asked what the limit of weld thickness is. For example, it seems that the infrared technique will work for 1 millimeter (mm) x 1mm stack-ups. The reviewer also asked what that is increased to 2mm x 2mm stack-up.

Reviewer 4:
The reviewer stated that the system robustness still remains an issue but progress is being made with each review and development at ORNL. The reviewer added the project team should consider developing a supply base for the infrared (IR) system to build production systems and robust software

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer pointed out that this project is well connected via excellent collaboration

Reviewer 2:
The reviewer commented that there was good collaboration and coordination with the team members. The reviewer added that it is not clear what progress has been made on commercialization of this technology through licensing or other commercial arrangement.

Reviewer 3:
The reviewer commented that the infrared cameras are export controlled. The reviewer warned that industry cannot simply stick one of these on a production line without export clearance and strict control over who is using the camera, where the camera is stored when not in use, etc. The reviewer added that it appears that this will add some cost to any future implementation in a weld line. The reviewer asked if the PIs have discussed this with any of the U.S. automotive OEMs. The reviewer added that the project team is working with industry stakeholders.

Reviewer 4:
The reviewer remarked that the project has many industrial participants as advisors; no work was carried out by the industrial team but now one OEM is testing the product.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the future efforts are clearly identified in the field trial and then commercialization. The reviewer added that the areas for future research, perhaps future projects, are less obvious from the presentation. The reviewer commented that the areas within the project are all surrounding the field test in a plant location, this will be critical to the project.

Reviewer 2:
The reviewer asked if there has been any thought as to how this infrared measurement system could be integrated in robotic welding where robots are moving at high speeds to make welds, or has the infrared measurement system limited to joining processes, which do not involve robots.

Reviewer 3:
The reviewer pointed out that this is the last year of the project; the plan for the technology transfer is good but has only one facility is testing it now. The reviewer remarked that the project team needs to increase the number of facilities involved. The reviewer added that it is understandable as the new patented technology the dissemination will be slow in the beginning.

Reviewer 4:
The reviewer requested that the project team develop a system for inspecting un-coated, highly reflective, Al spot welds, noting this is not easy but a big want in the automotive industry.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that it is all about lightweighting and the quality tools to deliver lightweighting; this IR inspection is perfectly aligned as an enabler.

Reviewer 2:
The reviewer said yes, real-time and/or post weld quality and evaluation schemes are critical for increasing the use of advanced high strength steels. These AHSS materials reduce vehicle weight and therefore displace petroleum.

Reviewer 3:
The reviewer stated that the online testing tool will improve the efficiency of the process. Spot welding is one of the most widely used joining techniques and improving the speed of this process will improve the implementation of multi materials in the vehicle structures.

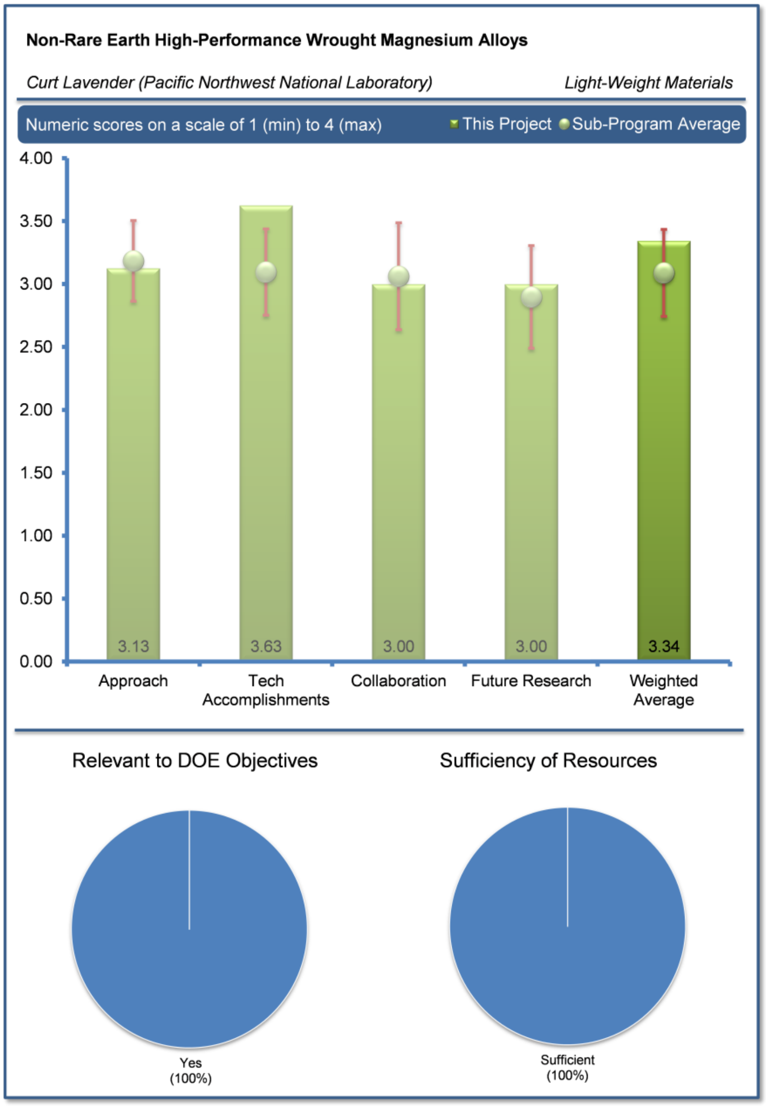
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that resources are adequate.

Reviewer 2:
The reviewer said no changes, appropriately resourced.

Reviewer 3:
This reviewer stated that resources appear sufficient. The reviewer had a question about how to engage a supplier to bring this system to commercialization.

Non-Rare Earth High-Performance Wrought Magnesium Alloys: Curt Lavender (Pacific Northwest National Laboratory) - lm056



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the development of non-rare earth Mg alloys continues to be of great interest to the automotive industry and the reviewer encourages this work. The reviewer added that this is a well thought out approach and the jump to larger extrusions would be a great next step. The reviewer recommended that this work continue.

Reviewer 2:

The reviewer stated that this appears to be a well thought out project with a sensible focus on the challenging balance among properties, ease of manufacture and cost. The reviewer added that the description of the extrusion process was very good and helpful in understanding the approach but the presentation would have been strengthened a bit by having data on the conventional approach available as a comparator (for example, extrusion speed). Having such data in the presentation would have made the work easier to evaluate in terms of performance and manufacturability improvements. The reviewer also commented that the comparator with data for energy absorption of 6061 aluminum in the slide deck was very useful, given that (as the reviewer understands it) a key goal of the project was to develop an Mg alloy with properties that are comparable to widely used alloys of aluminum.

Reviewer 3:

The reviewer asked if the modeling work was multi-scale. In other words, the reviewer asked are the magnesium-silicone (Mg-Si) particle properties being predicted with discrete Fourier transform or some other computational technique. The reviewer then asked how much the modeling work relied upon existing experimental data. The reviewer asked what checks have there been on the quality of the existing experimental data upon which the modeling effort in this project draws (it seems that modeling relies upon crystal plasticity which has many unknown parameters). The reviewer stated that it seems that the modeling relies upon many unverified assumptions/inputs; however, the PIs can check to see what the origin of all parameters in the modeling is (e.g., good guess, literature data, and data produced in the project). The reviewer then asked why the load versus displacement curve for the AA6061 alloy is so smooth, but undulatory for the Mg/Mg-Si materials. The reviewer also asked if the oscillations are truly due to fracture nucleation, or are they some type of ringing artifact in the measurement system. The reviewer asked is the fracture modeling in this work based upon microstructure and microstructural defects (inclusions, etc.). The reviewer also asked if not, why not.

Reviewer 4:

The reviewer remarked that the justification to the selection of the alloy systems needed to be explained more. The reviewer asked what other alloy systems were considered and what the rationale for selection of ZK60 alloy was. The reviewer added that the reason to conduct experiments using Mg-Si systems was explained but similar reasoning for ZK60 would be helpful.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the process could be developed and scaled to larger extrusion; this is truly an advancement for Mg alloys. The reviewer particularly liked the linkage between the ICME studies and the process conditions that allow you to micro-tailor the properties. The reviewer said well done.

Reviewer 2:

The reviewer remarked that the development of the new extrusion process can produce fine micro structures in Mg alloys is good. Also, the reviewer said that the modeling efforts to explain the strengthening in the alloys during extrusion are good development; however, it is necessary to compare the process for the existing alloys.

Reviewer 3:

The reviewer stated that the extrusion patent application has been filed; good to see that emphasis is not solely on writing publications and reports. The reviewer added that intellectual property is critically important.

Reviewer 4:

The reviewer commented that it appears that many or most of the goals as stated in the project have been achieved and this is great, but again, a more direct comparison of project data with that for conventional alloys (of either aluminum or other Mg materials) would have been helpful. The reviewer is always interested in cost data and estimates (which the reviewer recognizes are very challenging to develop in a research project), but little was said about cost and this is something that will eventually determine the applicability of this technology to commercial production. The reviewer stated that it is just a stylistic point, but charts or tables of data are more informative than wordy slides when trying to compare data from different materials.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that collaboration appears to be very strong and efficiently organized.

Reviewer 2:

The reviewer remarked that there was good collaboration with Georgia Technology. The reviewer was still looking for the part that Magna might make and the reviewer will follow up with them with a few automotive ideas. The reviewer thought extruded valves for use in a transmission valve body; the project team has the right size die to make us parts.

Reviewer 3:

The reviewer commented that the only technical partner is Georgia Technology and others are not contributing technically to the project. The reviewer added that the project is developing new processes it will be beneficial to Pacific Northwest National Laboratory (PNNL) which is carrying out the bulk of the work; however, it is necessary to involve some commercial extruders to scale up the process.

Reviewer 4:

The reviewer asked who the end users are to be of the Mg extrusions being developed in this project. The reviewer also asked have the PIs communicated with any companies in the mobility industry. The reviewer asked can enough material be made from the process being developed in this project for suitable scale up for mass production. The reviewer then asked if the project team had put any thought to costs of Mg extrusion versus 6XXX alloy of interest in this project. The reviewer asked how often the PIs from Pacific Northwest

National Laboratory (PNNL) meet/speak with Georgia Technology group. The reviewer said good leveraging of DOE/Basic Energy Sciences in this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that PNNL is encouraged to continue this work as the reviewer has not seen this level of depth in academia and coming from a national laboratory it puts it closer to industrial application. The reviewer said the project team should consider a linkage with Ames in the future regarding critical materials and replacing rare earth's, which would be a potential collaboration with another DOE funded program.

Reviewer 2:
The reviewer stated that the scaling up process is the next step proposed; this is important as the new technology needs to be proven in large volume production. The reviewer also noted the scaling up of the sizes from the current 5mm wall thicknesses.

Reviewer 3:
The reviewer asked if a technical cost model for the proposed extrusion process planned for the future. It is not quite clear what the future work will be other than scale up; however, for scale up to work there needs to be a customer base and this has not been defined. The reviewer then asked how one knows that the extrusion process and material produced per pound (with the improved properties) do not outweigh cost-advantages for the Al alloy.

Reviewer 4:
The reviewer may have missed it, but this portion of the presentation appeared to not be as well developed as other components and the reviewer would have appreciated a list of upcoming tasks.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that Mg along with CFC is identified as the best potential for lightweighting; however, the reduced ductility and increased cost of rare earths make the Mg not suitable for crash sensitive applications. The reviewer added that improving the dynamic fracture behavior without increasing the cost is important for the Mg to be used effectively in vehicles. This project is developing a new manufacturing process to overcome these two shortcomings.

Reviewer 2:
The reviewer noted that reducing weight is foundational to DOE goals and this will require new materials and new manufacturing processes and thus, enhancing the properties and manufacturability of Mg is essential in the reviewer’s view.

Reviewer 3:
The reviewer stated that although this was not discussed, reduction in mass of ground transportation vehicles seems to be an overriding goal of this project.

Reviewer 4:
The reviewer stated that Mg and CF are both of great interest and on our roadmap for vehicle lightweighting.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer described resources as okay.

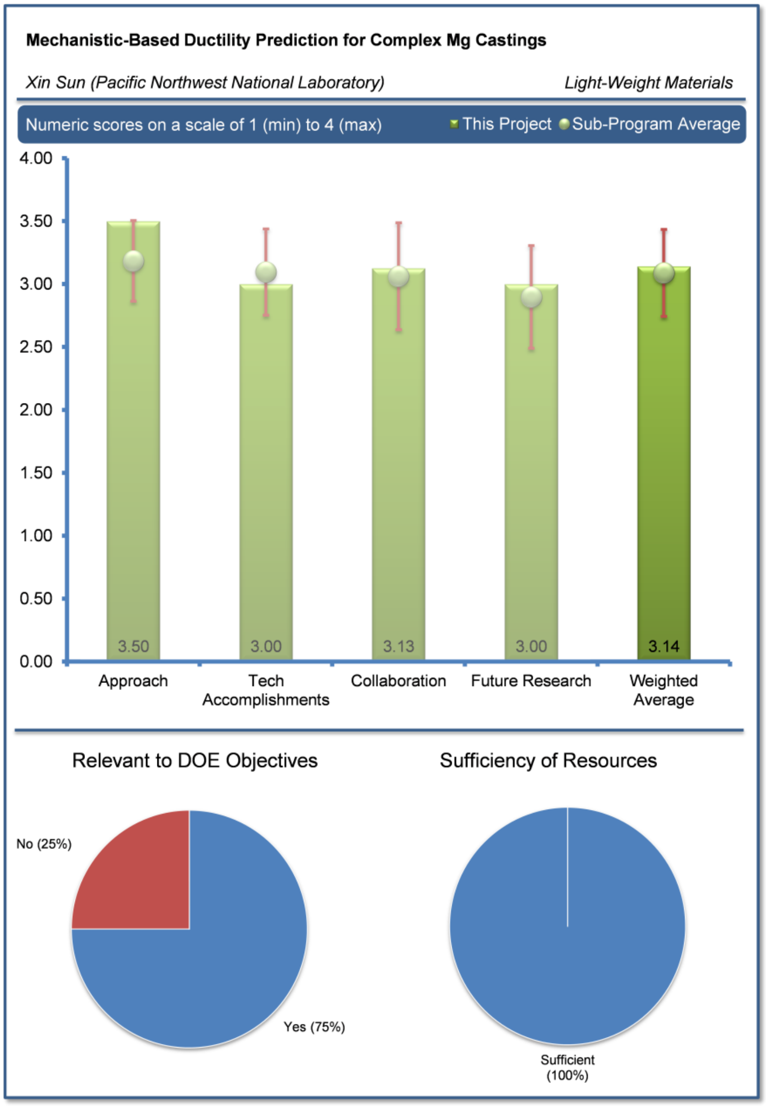
Reviewer 2:

The reviewer said just right, no changes.

Reviewer 3:

The reviewer asked where all of the data being generated in this project is being saved/archived/curated. The reviewer also asked if there was a SharePoint site at PNNL that has been developed for this purpose.

Mechanistic-Based Ductility Prediction for Complex Mg Castings: Xin Sun (Pacific Northwest National Laboratory) - lm057



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project team had an interesting scientific approach. The reviewer added that the project was strongly dependent on ensuring that the casts created under controlled conditions vary according to the major variables that affect the cast quality. The reviewer stated that the project team had a very interesting approach to address a very complex problem. Essentially the team is investigating the main effects of a variety of variables across the thickness of the casting. Some of these main effects are difficult to extract and the team has developed some interesting ways of getting at these effects. The reviewer suggested that future work (beyond the scope of the current project) depending on the degree of correlation from the main effects, investigate interaction effects.

Reviewer 2:

The reviewer remarked that the team seems to have a good understanding of what is needed and clear direction to get the needed information.

Reviewer 3:

The reviewer said excellent approach, one likely to be used by the industry. The reviewer noted the importance of Mg alloys in lightweighting applications. The reviewer noted the variation in casting (e.g., defects, surface quality, etc.). The reviewer also noted the predictions based on empirical methodology and mechanistic approach.

Reviewer 4:

The reviewer commented that the measured ductility appears to be dominated by extrinsic factors (porosity) which provide considerable scatter in the data, limiting its commercial use. In the reviewer's opinion, the work plan was flawed.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that very good progress has been made from the 2013 review, better focused and more thorough.

Reviewer 2:

The reviewer remarked that there was good progress in modelling and in correlating with test results.

Reviewer 3:

This reviewer commented that the team has made good progress on the variety of investigations as presented. It would be good to get an overview slide that shows the relationships between the various tasks (perhaps a fishbone diagram or other conceptual based diagram that relates the variables and their investigation to the goal of ductility prediction). The reviewer added that the project is still very difficult to understand.

Reviewer 4:

The reviewer indicated that predictive results and measurement do not correlate, thus they are not applicable to commercial use. Local material property prediction and correlation with actual test samples is an objective of ICME and in fairness to the researchers will require significant research effort over the next 10 years to achieve.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer thought that the degree of collaboration was evident from the number of different participants in the room from the project answering questions, as well as their respective roles in investigating specific variables to feed into the various prediction soft wares. The demonstrated collaboration is among the best of the 10 projects the reviewer reviewed.

Reviewer 2:

The reviewer stated that there appears to be good cooperation and coordination between PNNL, Ford, University of Michigan (UM), Mag-Tec and Canmet.

Reviewer 3:

The reviewer commented that the collaboration is good. The reviewer expressed interest in seeing the partners be more involved than presented.

Reviewer 4:

The reviewer stated that the role of Canmet and UM appear to be window dressing for the application. The reviewer recommended that future projects include magnitude of inking from each collaborator.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the future research is straightforward following the plan and pursuing the goal. The reviewer added that there are some details that are fuzzy, such as the leap from the detailed models to the software and the correlation with the quality map, if that is planned. This begs the question what the risks are and the risk abatement plan, assuming there is still time to even do anything about them.

Reviewer 2:

The reviewer said that the proposed work looks good. The speaker indicated that the results of this work should be applicable to an array of Mg alloys and to Al alloys. It would be good to verify that.

Reviewer 3:

The reviewer remarked that the project team did excellent work but the project is on its last trimester and it is more a question of finishing what has been commenced than starting new ideas. The reviewer added that even though the dimensions of cast samples match thicknesses of larger cast parts, the thermodynamic effect on large casting can have drastic effects on the microstructure and yield different results than from small samples.

Reviewer 4:
The reviewer recommended to "put a bow on it."

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that casting is a major process by which Mg will be added to automotive body structures. Adding Mg to body structures is a key factor for light weighting. Understanding Mg casting to the point where the process and product can be simulated for both manufacturing quality and product performance is essential. The reviewer added that this is one project of several that will help accelerate the adoption of Mg castings. Additional projects are necessary in this area (measuring porosity formation, developing porosity models, etc.)

Reviewer 2:
The reviewer noted that if successful, this project can enable more extensive use of cast Mg (and possibly Al), which in turn will enable reducing the mass of vehicles, and increasing their efficiency.

Reviewer 3:
The reviewer mentioned that any additional material knowledge can lead to weight reduction and, therefore, saving fuel.

Reviewer 4:
The reviewer pointed out that ICME and automotive fuel savings are not rated. ICME efforts related to local material property prediction does not provide tangible mass reduction, but rather an improved understanding of the problem.

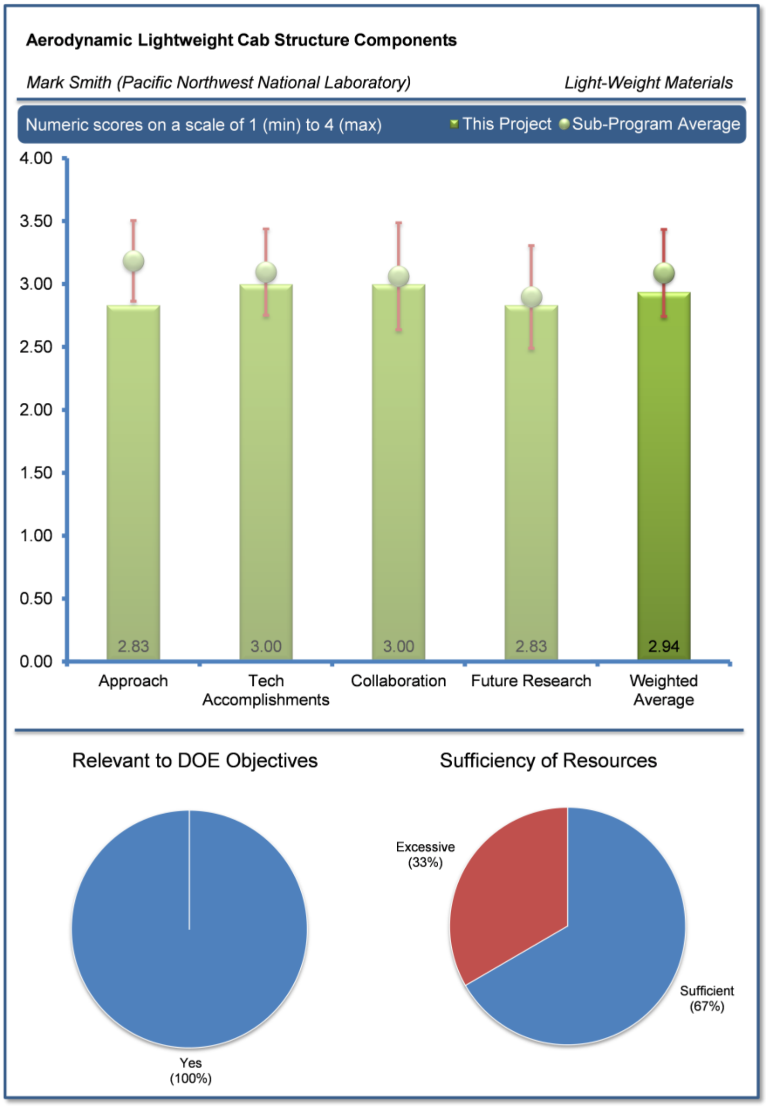
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that for this project the funding appears sufficient; however, without understanding the gaps and risks of the remaining work, it is a bit difficult to assess.

Reviewer 2:
The reviewer remarked that it is sufficient because the PI is working more than reasonable.

Reviewer 3:
The reviewer commented that the findings or lack thereof indicate that the problem is much larger than assumed.

Aerodynamic Lightweight Cab Structure Components: Mark Smith (Pacific Northwest National Laboratory) - lm060



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer did not see quantitative goals and success to goals. The reviewer added that the approach is very straightforward. The reviewer said that the degree of ICE or other simulation tool integration was unclear. The approach appears to target a specific component and is based on trial and error. The degree of generalize of the knowledge gained from the project to other components with different geometry is unclear.

Reviewer 2:

The reviewer said that the approach appears to deviate from direction of earlier phases. Last year's work had significant emphasis on simulation of the heating steps, and results. The reviewer added that this year the emphasis appears to have been on using empirical techniques to determine a production process for producing a specific family of parts for test rather than on more generally applicable techniques.

Reviewer 3:

The reviewer noted that this was a cooperative project with PACCAR. The reviewer said that the project team had a straightforward approach and that the project can represent a substantial benefit for the trucking industry. The reviewer added that the project was necessary work but, as presented, appears boring.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that if one interprets the stated project goals to apply only to the selected part, then progress appears excellent. The team has determined the process parameters needed to form the A-pillar. If one however, interprets the project's goals to develop a warm forming process that is applicable to a broader set of geometries, the project still appears to have some major barriers, specifically with regards to process parameter determination. The reviewer questioned whether the same process parameters would work on a larger, deeper draw panel or a more complex shape part. Further, if the process parameters did need to be altered for a different part, could they be determined from simulation, analysis, or other non-empirical method. This reviewer is under the impression that a significant part geometry deviation would require an empirical determination of new process parameters (such as temperature profiles). The reviewer considers this a barrier, and the project's progress does not appear to address this barrier. At a minimum the performers have to state the limits of the process with regards to material and forming geometry as it is understood whit the current process parameters.

Reviewer 2:

The reviewer stated that the project addresses hurdles for this particular product in this particular alloy. It is difficult to determine how to apply those findings to other alloys or product forms.

Reviewer 3:

This reviewer commented that the project was well conceived but limited and will lead to meaningful results. The reviewer added that it probably reflects the culture of the industry.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that there were strong linkages between PNNL, PACCAR and Magna SCFI is evident.

Reviewer 2:

The reviewer commented that the collaboration between PACCAR and Magna appears excellent. They work together appropriately on their respective work tasks. Novelis's involvement beyond simply supplying the material is a bit less clear for FY 2013.

Reviewer 3:

The reviewer commented that even though PACCAR is important for the trucking industry, the project should significantly increase its membership.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer is not going to keep commenting on the generalizability of the results. The project is in its last year. The future work is very straight forward (i.e., make parts and test for paint, bake, and performance on vehicle). This is a validation task that is important, but not particularly risky.

Reviewer 2:

This reviewer remarked that no future plans were explicitly stated. It appears that all that remains is for PACCAR to paint mount and test the 25 pairs of parts. Since this is not a very demanding application, the reviewer is not confident that much of value to anyone but PACCAR will be obtained.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that weight reduction in the cabin will translate into a larger cargo, therefore the price per unit freight will diminish. The reviewer further noted that this is also petroleum displacement.

Reviewer 2:

The reviewer stated that developing advanced forming processes that are demonstrated to work on lower density alloys, such as Al, will help industry adoption of these alloys to lighten vehicles, improve fuel economy, and reduce petroleum use.

Reviewer 3:

The reviewer stated that in principle, the goals of this project are relevant to DOE’s objectives. The reviewer added that it would enable improved aerodynamics (thereby reducing drag and improving efficiency) while also reducing vehicle weight. In actuality, however, it is not clear that the results of the work will be generally applicable, and thus may not actually be highly relevant.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

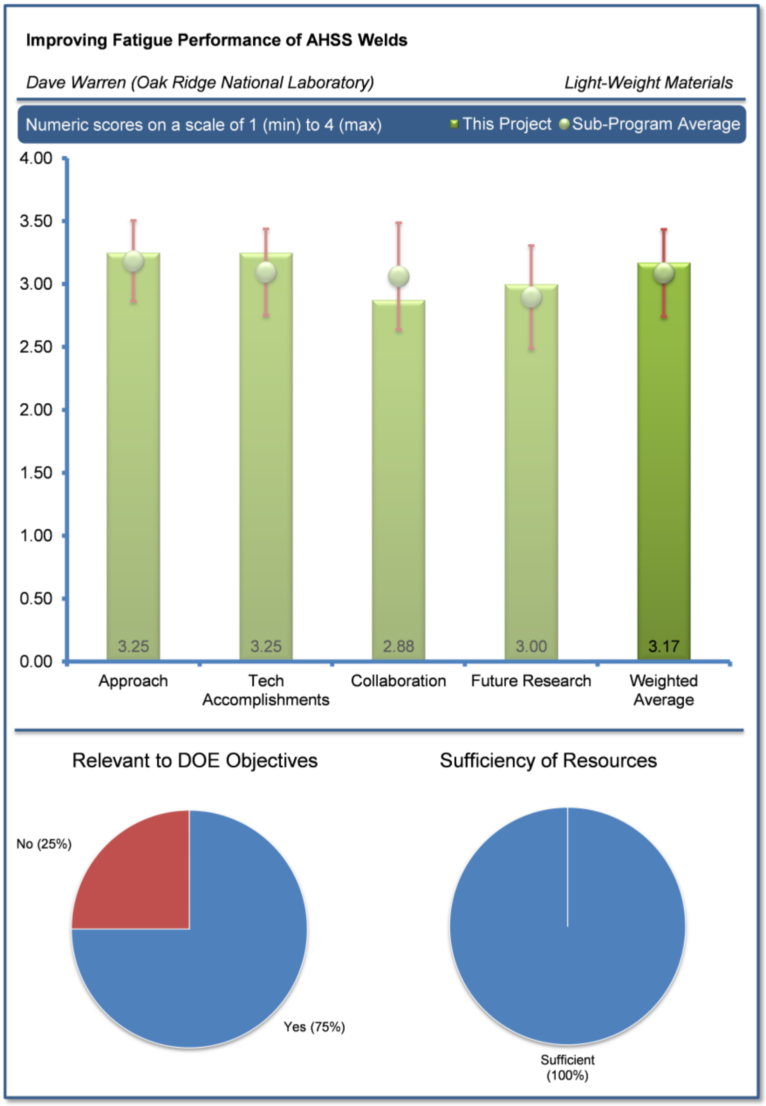
Reviewer 1:

The reviewer said that the team should be able to complete the project within the project's budget.

Reviewer 2:

This reviewer concluded that $1.2 million of DOE funding to develop a manufacturing process of limited applicability seems excessive.

Improving Fatigue Performance of AHSS Welds: Dave Warren (Oak Ridge National Laboratory) - lm062



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this still remains to be a significant development as a look up table for the fatigue performance of AHSS weldments. Having a design guideline will further present options to the design and release engineer to develop a robust joint design.

Reviewer 2:

This reviewer said good effort; a significant improvement in the area of understanding weld quality and IR imaging has been realized. The reviewer added that the research effort extended to pre-commercialization state for application real time and post weld validation.

Reviewer 3:

This reviewer stated that the project is focused on developing a solution for the problem of low fatigue strength of welds in AHSS. The proposed plan was good which had been successfully executed. The reviewer added that the work can be termed success as a good solution was found along with capability to simulate the welds.

Reviewer 4:

The reviewer asked how the weld fracture (e.g., in transformation induced plasticity steel spot welds) is incorporated into this project, or is it. The reviewer also asked what the interplay is between fatigue and fracture in the welds of interest in this project. For the digital image correlation (DIC) measurements under high temperatures, are the PIs correcting for heating of the surrounding air, this can greatly skew the DIC results (if not appropriately corrected for).

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that this project had an excellent overall deliverable, very focused on AHSS with plenty of opportunity to expand to other lightweight systems like Al weldments.

Reviewer 2:

This reviewer indicated a very good result, illustrating practical application of IR imaging and real time processing. The benefit of providing real-time inspection is associated with reducing the number of welds (increased weld spacing) and lower manufacturing cost.

Reviewer 3:

The reviewer stated that the project team developed new material as well simulation capability to predict the weld performance; the weld performance was significantly enhanced by the new material. The reviewer added that this will help auto makers to confidently use the new grade AHSS for the structures.

Reviewer 4:

The reviewer asked if the finite element model (e.g., the as-meshed model) has been compared with a real weld joint. The reviewer also asked what constitutive models were being used for the weld materials in the finite element (FE) models and how have these been validated. The reviewer also asked if the new special filler wire will add more cost to existing welding processes. The reviewer added that it would be helpful to show more of the modeling results and then validation of modeling results against experiments. The reviewer then asked if this will be possible for next year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

This reviewer stated that there was good collaboration with Arcelor Mittal, modeling software suppliers and industry partners.

Reviewer 2:

This reviewer said that there was good collaboration; the project needs to be applied to production environment and then a non-destructive testing (NDT) firm needs to commercialize the technology. Commercialization need not take place at the lab. The model should demonstrate and validate for commercial use and move on. The reviewer added that the next step of collaboration is to disseminate the methodology to the public domain.

Reviewer 3:

This reviewer indicated that the PIs have sampled OEMs on weld patterns. The reviewer asked how the PIs are coordinating the sharing and transfer of data between the different institutions involved in this project (e.g., ArcelorMittal, Colorado School of Mines). The reviewer also asked who is integrating the results from these different groups to address the fatigue issue in the welds.

Reviewer 4:

The reviewer stated that the project has one stakeholder (ArcelorMittal) who is providing material support; the work is carried out the research and development (R&D) organizations. As this is a cooperative research and development agreement (CRADA) the total contribution from the industrial partner need to be quantified.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that this work will be excellent if continued expansion into press-hardened steel (PHS), hot stamped steels and high strength (HS) Al alloys like 7075.

Reviewer 2:

The reviewer said that this is the last year of the project; from the presentation it is obvious that the objectives of the proposal were met; unique solutions were provided to the problem of low fatigue strength of welds.

Reviewer 3:

This reviewer indicated that commercial trials are the next step.

Reviewer 4:

The reviewer was not quite sure how the planned future work will be integrated to address the fatigue issues in this project. The PIs need to think about other AHSS, such as fully martensitic and press hardened steel with ultimate tensile strength (UTS) values in excess of those currently being investigated. The reviewer then asked if the results from this study will be such that computer-aided engineering (CAE) engineers might be able to use it in simulations of welded AHSS components. The reviewer also asked if this work will result in weld constitutive models that are materials based rather than component based for the weld zones.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that welding is one of the major joining processes used for the vehicle assembly; improving the fatigue performance of these joints is useful in enhancing the durability of the structure. The good understanding of the problem and novel solution for that will pave the way for increased use and reliability.

Reviewer 2:

This reviewer said that the project was especially relevant for B pillars, lower A pillar and truck frames, all of which are going toward more dual-phase steel (DP), PHS and hot stamped steels.

Reviewer 3:

The reviewer asked if the proposed concept, in-process residual stress modification during welding, is viable from a cost and process intensity standpoint for use in the auto industry. The reviewer stated that any modifications or enhancements to existing weld schedules for vehicle components are likely to add costs. The reviewer asked if some thought been given to weld modifications or enhancements.

Reviewer 4:

The reviewer pointed out that weld quality of steel does not correlate with fuel reduction. The reviewer added that the project team needed to point out cycle time and the cost reduction benefits of reducing the number of welds.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

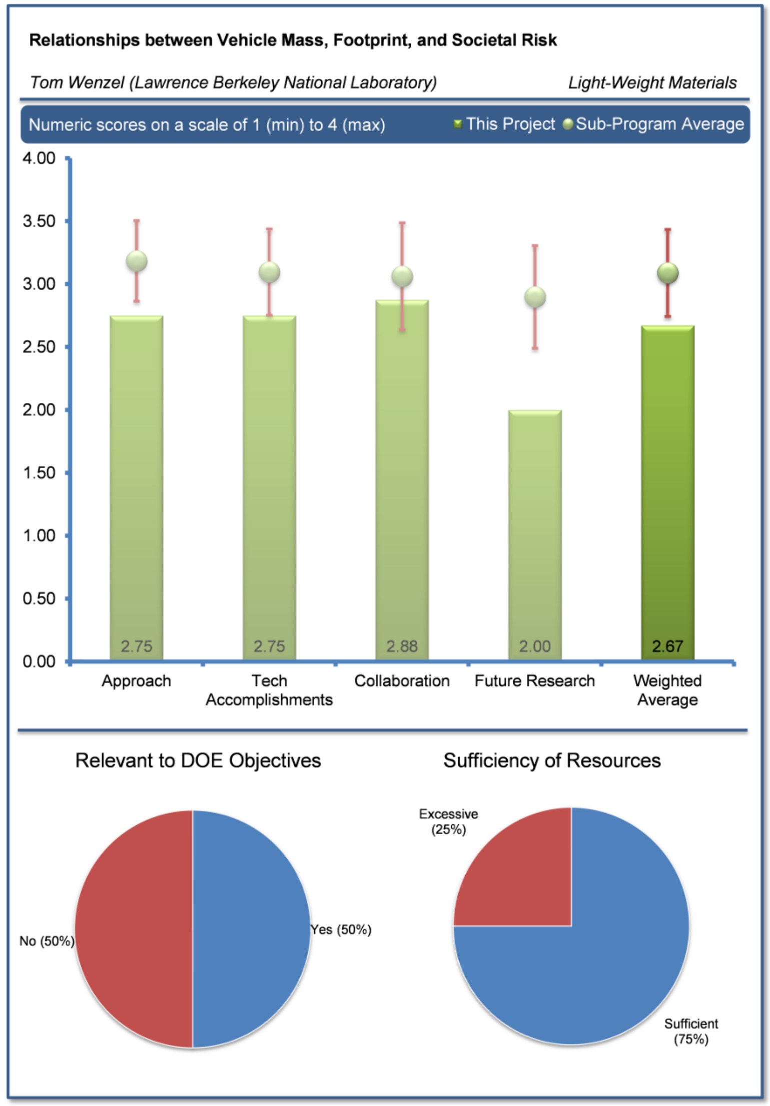
Reviewer 1:

The reviewer indicated that the project was very well staffed and managed. The reviewer also said good job.

Reviewer 2:

This reviewer pointed out that no additional funding is required but current levels should be kept.

Relationships between Vehicle Mass, Footprint, and Societal Risk: Tom Wenzel (Lawrence Berkeley National Laboratory) - lm071



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that this project is doing a good job at the approach to overcoming the concern that mass reduction may reduce societal safety. The two analytic approaches are good choices for the study. The reviewer pointed out that the similarities, differences and shortcomings in each approach and the data sets employed give the level of transparency and honesty that this study requires.

Reviewer 2:

The reviewer said that it appears that the project leaders are going to great lengths to be objective in their analysis; however, adding driver demographic variables did not seem to help in identifying strong trends. While the reviewer is not generally in favor of adding more variables (as they may tend to cloud the results), the reviewer thinks including things such as vehicle age would be worthwhile, since safety standards (such as roof crush, side airbags, etc.) have changed markedly over the years.

Reviewer 3:

This reviewer stated that the regression analysis is time consuming and an "art." Without more details it is impossible to evaluate the approach. For example, in one of the presentations the team mentions they use a sequential regression analysis to add and remove variables. The reviewer then asked what validation methods were used. The reviewer also asked what alpha values were used and how were they justified. The reviewer then asked how the hypotheses were generated. These details are lacking, but very much go to the core of the "approach." Further, the reviewer questioned whether following the National Highway Traffic Safety Administration (NHTSA) approach is of sufficient value. Simply duplicating or following similar lines of reasoning may not yield benefits for the DOE. The reviewer stated that if the purpose is to address the public's concern that lighter smaller vehicles are not safe relative to larger, heavier vehicles, then the study should focus on that particular aspect. The reviewer then asked how a lighter vehicle (controlled for the usual factors) will perform relative to a heavier vehicle.

Reviewer 4:

The reviewer stated that even though the reviewer appreciates the effort being made to establish the effect of vehicle weight in relation to societal risks, the reviewer is still not convinced that the presented correlations give a meaningful relationship between weight and accidents. The reviewer then asked if there is any other analysis technique that would validate the present results. It would be desirable to have car makers participating in such a study. The reviewer then commented that small cars is a relatively new phenomenon in the

United States, would it be more meaningful to look at data from some European countries where the small car population is much more significant and for a much longer time frame.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the progress on the technical accomplishments is satisfactory. There has not been much substantial progress from the 2013 Annual Merit Review (AMR) report. The efforts on risk by model are illustrative but few strong conclusions can be drawn. The reviewer indicated that the work on the breakpoint in weight where mass reduction changes from a detriment to a benefit is intriguing. This area warrants further investigation. Also, the reviewer indicated interest in the differences between self-safety which is prime in single vehicle crashes for fatalities and serious injuries, and the effects of mass plus size on multiple vehicle incidents. Perhaps the societal risk is reduced because self-safety will remain unchanged but reducing mass in heavier vehicles is good in reducing societal risk.

Reviewer 2:

The reviewer stated that there was good progress in analysis, but unfortunately not in establishing a conclusive link between size, weight, and safety.

Reviewer 3:

The reviewer said the progress appears to be satisfactory, but asked if the project should be continued.

Reviewer 4:

The reviewer said that the technical accomplishments were to continue to add additional variables (not related to weight) to the overall model to determine whether the error in the model was sufficiently reduced to determine the effect of curb weight on crash frequency and crash worthiness. The reviewer added that the models could not be improved to such a degree to determine that cause and effect; however, the performers did not present any statistics, (power or beta error) that would indicate whether they even need to reduce the noise further (given the relative low R2 of the models the reviewer is guessing that the power is low). Further, there is no statement as to the magnitude of effect the project team is trying to detect with regards to curb weight. The reviewer then asked if the project team is trying to detect a 1% increase in frequency due to 50 lbs. in curb weight increase at a 95% confidence. Without such a statement, this project could go on ad infinitum. The reviewer then stated that the project team must also check the variance inflation factor of the entire X-matrix before model building every time the project team introduces a new variable. Lastly, the project should investigate possible model validation methods or statistics, such as the PRESS statistic (popular in the late 80s, early 90s - may be better ones by now). The reviewer would also like to know how the architecture of the model is determined with so many variables (non-linear and interaction effects).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the speaker indicated closely working with NHTSA, Volpe and the U.S. Environmental Protection Agency (EPA) on data, variables and methodology. It appears that the information gained in this project will be used by the U.S. Department of Transportation and the EPA.

Reviewer 2:

The reviewer commented that the slides relating to collaboration appear to have a satisfactory listing of collaborators. The reviewer added that there was little evidence of collaboration in the presentation. Though perhaps, regression analysis is not a great example of a team sport.

Reviewer 3:

The reviewer stated that in order to get access to the data as well as gain acceptance of their results, the collaboration with the other federal and state agencies must be excellent. That said, the reviewer wondered whether their closeness biases the performers view to follow similar approaches taken by those agencies.

Reviewer 4:

The reviewer pointed out that carmakers are absent from the study, while they should be represented.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that analysis apparently is required for midterm review of federal standards, so some additional work will be required. The reviewer would like to see analysis aimed more at why differences occur rather than if differences occur. Thus far the most significant finding is that (unexpectedly) there is a higher crash frequency in lighter vehicles, it would be beneficial to understand why that is. Also, the reviewer pointed out it would be beneficial to understand why a poor driving record reduces crash frequency in light trucks and crossover utility vehicles/minivans.

Reviewer 2:

This reviewer does not believe adding more variables to the current modeling method will yield any significant results. These performers must change their approach. The reviewer would suggest that alternative model formulations, such as taking an engineering approach to model formulation and using regression modeling to validate the hypotheses, should be investigated. For example, if the public is concerned about heavy on light vehicle crashes, particularly that lighter vehicles are less likely to survive in such crashes, then test that hypothesis (controlling for driver age, vehicle safety devices, etc.). The reviewer added that if a vehicle is involved in a stationary accident, such as a tree, and then gives the tree a very large weight (infinite). If it is involved in stationary with a parked vehicle, then it is the same as a two vehicle accident. If this reduces the data set for some reason, then so be it. The reviewer went on to say that the independent variable should not be curb weight of the vehicle, but rather difference in curb weight between the vehicles. This might also change the approach of creating separate models by vehicle type. The reviewer mentioned this as an example off the top of my head as a non-safety expert.

Reviewer 3:

The reviewer said fair because the reviewer did not know what to say.

Reviewer 4:

The reviewer stated that the proposed future research of, "... illuminate relationship between vehicle mass, size and safety" should be discussed with more details. The reviewer added that the two proposals sound okay, but the reviewer wanted more details on the next steps. The reviewer suggested that perhaps a hypothesis to test with the regression analysis would be helpful here, in particular, looking more closely at single versus multiple vehicle incidents.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that as a nation, we need facts and an enlightened discussion of petroleum demand, societal safety and societal benefits of mobility. The "third rail" issue of safety needs these sorts of facts and deep statistical studies.

Reviewer 2:

The reviewer pointed out that the present results seem to indicate that heavy vehicles are safer than lighter ones.

Reviewer 3:

The reviewer commented that the project team should demonstrate that "small" is not automatically worse than "large" in vehicle safety, so as not to dissuade consumers from buying smaller or lighter vehicles.

Reviewer 4:

The reviewer indicated that this team needs to change its approach and provide a greater value and that being a team the ostensibly duplicates or runs parallel to NHTSA modeling so that regulations are transparent. That type of work should be supported by public non-profit, not DOE’s VTO. The reviewer added that DOE VTO should support projects that can statistically determine whether the public's concern regarding vehicle size and weight are valid, but the reviewer fears that the current approach taken will not get that answer and a more aggressive modeling approach that targets that question is required.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that it is hard to judge the resources here. The reviewer had hoped for more progress so maybe there needs to be more resources applied to this project.

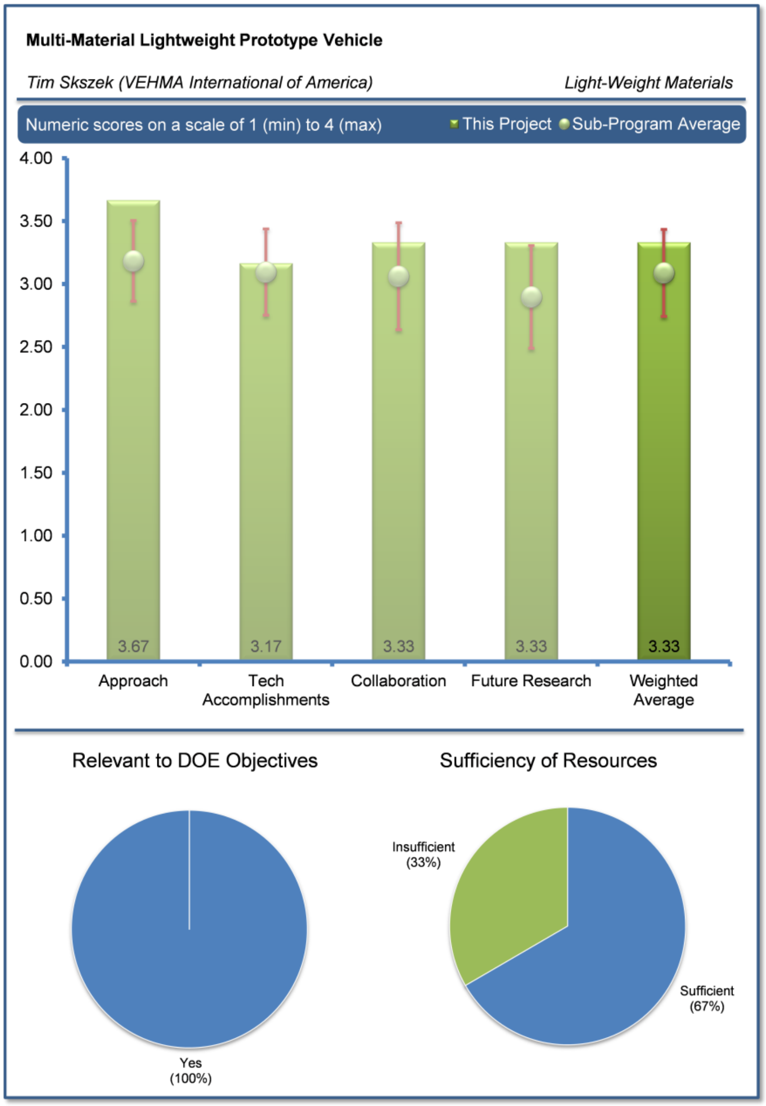
Reviewer 2:

The reviewer guessed that resources were sufficient.

Reviewer 3:

The reviewer said that the current approach is not likely to achieve the desired goals of the DOE and therefore, the project in its current form should be cancelled. The reviewer added that if the project is redefined and scoped, then additional funding may be required.

Multi-Material Lightweight Prototype Vehicle: Tim Skszek (VEHMA International of America) - lm072



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach is very good given the complexity and comprehensiveness of the project. The reviewer stated that the reviewer’s positive feedback on the other review areas would not be possible without the overall approach being able to accommodate both the project goals and the constraints placed on the project from cost, availability of technologies, and commercial interests. The reviewer did not see how the project could have taken a better approach.

Reviewer 2:

The reviewer indicated that the project team had a reasonable approach given the relatively short timeframe and limited resources; however, the analysis suffers from a number of compromises and estimates to guesstimate mass save, since they are building on a 2013 Fusion rather than the original 2002 Taurus baseline (referred to in last year's report).

Reviewer 3:

This reviewer asked how the project team knows that a critical component has not been overlooked in a project this complex. The reviewer reported coating and/or painting/corrosion testing, and structural testing.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that the project team made very good progress. The reviewer added that it is hard to believe that there should so much difference between 2013 and 2014.

Reviewer 2:

The reviewer stated that the technologies developed and implemented are both effective as well as of commercial interest. While some of the deadlines are slipping, it is not a major concern as of yet; however, this should continue to be monitored. It is interesting to note the wide variety of areas that were included for lightweighting (powertrain, body, chassis, interior, etc.). The reviewer believed that as the project progresses, the major gaps to further advancements will become clear.

Reviewer 3:

The reviewer stated that the project team has made great progress in producing prototype parts and mule vehicles; however, most of those appear to have been made using technologies that are available and in use somewhere in the industry, rather than focusing on new technologies that would ultimately yield closer to the 50% mass save target.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer remarked that the roles and responsibilities are clearly defined. Despite the overall complexity and large number of partners, coordination and cooperation appears to be working well. The reviewer also expressed congratulations to NCMS.

Reviewer 2:

The reviewer pointed out outstanding collaboration between Vehma and Ford is evident; however, there is no indication of the amount of "collaboration" versus simply purchased parts from other suppliers listed in the reviewer slides (Sabic, Corning, Autoneum, Michelin, etc.)

Reviewer 3:

The reviewer stated that the project is geared towards one particular vehicle, but lightweighting is not Ford's privilege focus. The reviewer would have liked to see whether similar projects were contemplated for other car makers.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that future plans are in line with the overall program and straightforward. The reviewer believes there is a high probability of success. The reviewer also recommended the team should begin identifying major gaps that if addressed in the future would enable major weight reduction improvement. The reviewer stated that this project should be able to help identify VTO lightweighting goals for the next five years.

Reviewer 2:

The reviewer observed that the future plans appear focused on identifying additional barriers but not on finding a way to address them.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that this project is at the core of what VTO is doing. It is a culmination of a wide variety of technologies and demonstrates how much of the advanced technology has made it to the commercial level, the current state of the art with respect to light weighting, and gaps that still need to be addressed.

Reviewer 2:

The reviewer stated that the goal of achieving 50% mass save is absolutely relevant to DOE's goals.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

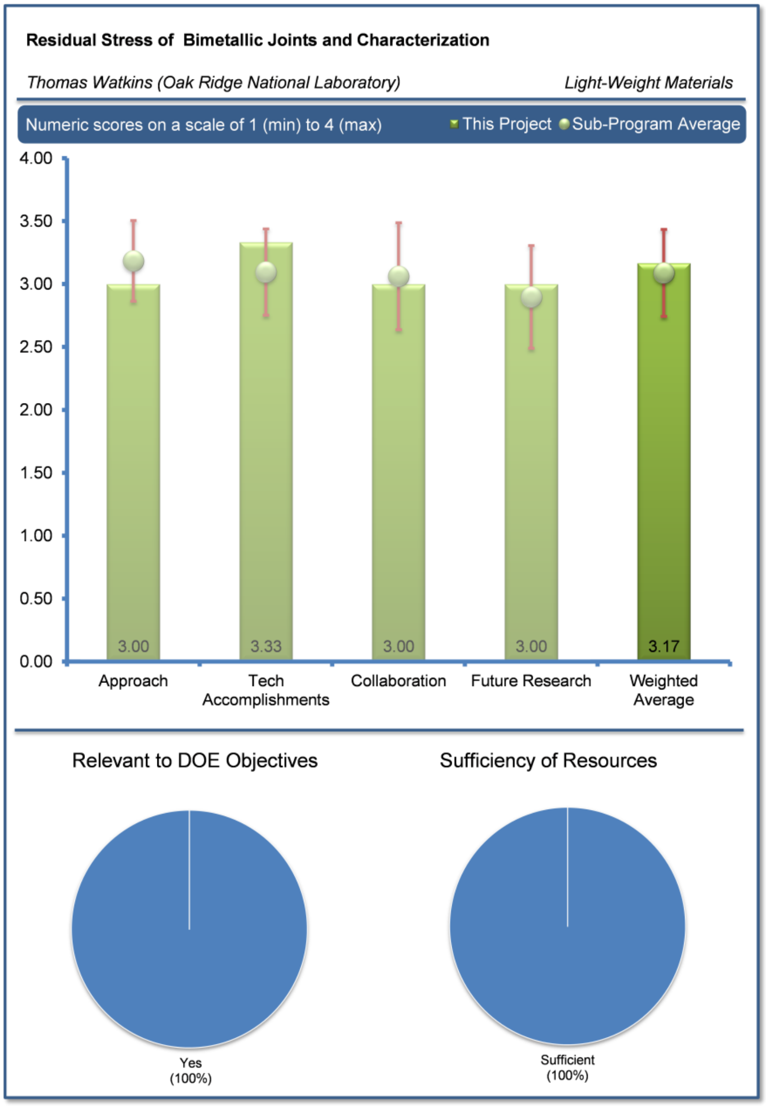
Reviewer 1:

The reviewer said that the resources appear sufficient. The reviewer added that clearly resources limit the scope that can be addressed, but at the same time they are large enough to make significant advancements and achieve the VTO goals.

Reviewer 2:

The reviewer claimed that it is not feasible to develop all of the technologies required and to demonstrate them for the $10 million of DOE funding awarded.

Residual Stress of Bimetallic Joints and Characterization: Thomas Watkins (Oak Ridge National Laboratory) - lm073



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this project is very important work, appears to be very well organized and progressing well despite the complexity of the tasks being undertaken and the number of participants. The reviewer would suggest that a slide like Slide 10, which lays out the program, be converted to a graphical format rather than a list of words. This makes it easier to see how the various tasks and project components fit together.

Reviewer 2:

The reviewer commented that the work plan is sufficient to address the need; however, more work can be performed. For example, the reviewer said the nature of the interface needs to be explored further. Even though it has been told that the interface is a simple mechanical bonding this has to be confirmed.

Reviewer 3:

The reviewer asked if there is any experimental data with which to validate the phase property modeling. The reviewer also asked if there was a constitutive model used for the two-phase (mush region) to account for the fact that below the coherency temperature in the Al that the material starts to accumulate strain upon solidification. The reviewer wanted to know if there were any comparisons of theory with experiments on the thermo mechanical property predictions.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said that once again, it appears to be a very well organized and worthwhile piece of work that is making excellent progress. The reviewer added that further progress on the topic of these bimetallic joints could enable them to worm an essential component of the future MMLWV, which will be critical to making corporate average fuel economy standards and ensuring safe and durable vehicles.

Reviewer 2:

The reviewer commented that the residual stress has been measured and then modeled; some agreement has been observed between model and measured values. Also, the team has tried to develop a heat treatment cycle to improve the yield strength of the aluminum alloy. The reviewer wanted to know what the impact of this treatment was on the stress distribution. The reviewer asked what the impact of heat treatment was on the interface structure. The reviewer added that in general the work is very simple characterization which had provided some data for simulation; however, more data is needed to improve the simulation capabilities.

Reviewer 3:
The reviewer remarked that the modeling work is very comprehensive. The reviewer asked why the project team meshed substantially triangular elements (these tend to stiffen the structure). The reviewer wanted to know why the project team did not use quads. The reviewer would like to see more comparisons with experimental data at the various modeling steps. The reviewer added that the example of experiment/theory of residual stresses is interesting even though there is a disparity between the two.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the team appears to be working smoothly and harmoniously, it seems that the program is making very effective use of the resources available.

Reviewer 2:
The reviewer pointed out that the collaboration is with a single partner. The reviewer added that it would help to draw in a potential end user of the technology being developed for advice on how to implement to mass produce parts.

Reviewer 3:
This reviewer observed that only one Tier 1 supplier is on the team. Also, the reviewer commented that CRADA restricts the dissemination of data. The reviewer pointed out that the actual contribution of the partner needs to be presented in dollar terms.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer said that the proposed future research was nicely presented and the future path seems logical and worthwhile.

Reviewer 2:
This reviewer indicated that this is the last year of the project and the plan for remaining fiscal year is good.

Reviewer 3:
The reviewer wanted to know if there are any plans to bundle up the computer codes and the experimental process parameters to give to someone who can use this information to make parts for vehicles.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

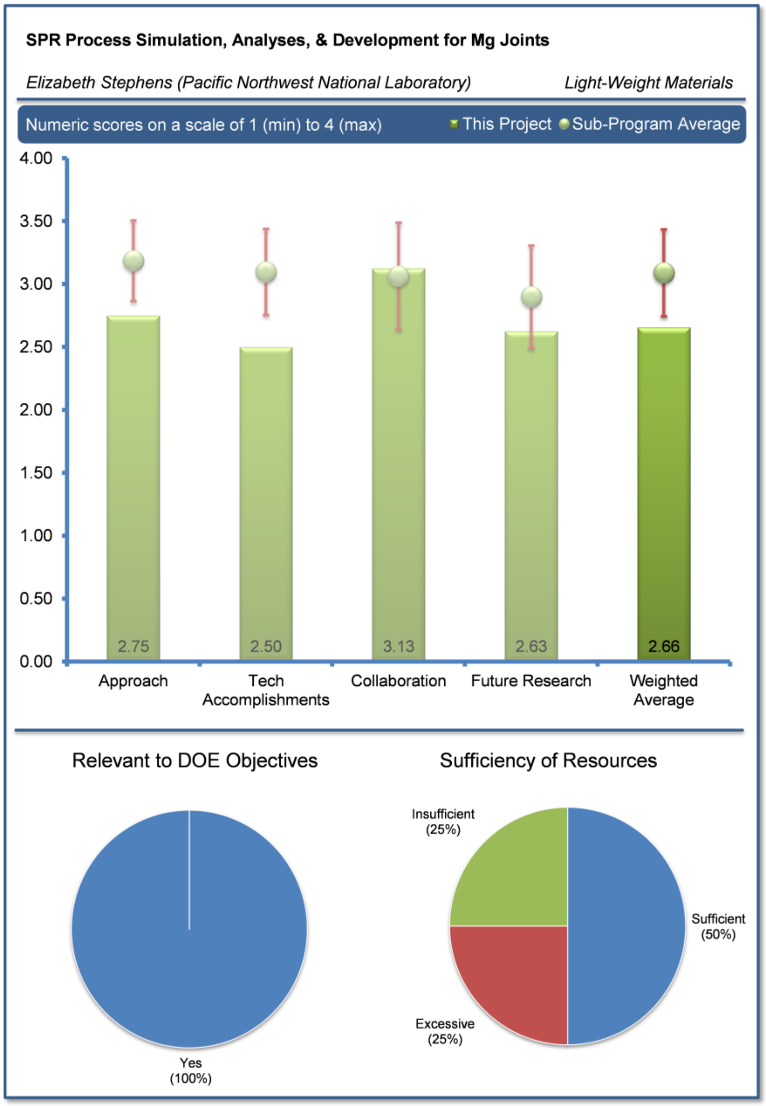
Reviewer 1:
The reviewer indicated that this work is fully aligned with vehicle light weighting goals which contribute directly to petroleum displacement.

Reviewer 2:
The reviewer asked if the PIs have discussed the proposed heat treatment process with any end user, for example, in the automotive industry.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that funding appears to be fine and that there are no issues with funding.

SPR Process Simulation, Analyses, & Development for Mg Joints: Elizabeth Stephens (Pacific Northwest National Laboratory) - lm074



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated the project team had a very pragmatic approach to surface plasmon resonance (SPR). The reviewer pointed out that the emphasis on the simulation tool development is the best part of the project. The reviewer added that while the process parameter determination based on empirical experiments is standard procedure within the industry for almost any process, the use of those experiments to validate the simulation results is the preferred method.

Reviewer 2:

The reviewer commented that the research appears to be creating a competitor for Bollhoff. The reviewer added that the approach does not include a new method or technology.

Reviewer 3:

The reviewer indicated that the thermal modelling could be valuable, if proven to be accurate; however, the current technique used to make the joint test coupons appears to be very empirical. The reviewer added that the heating system does not appear to have good control over the amount of heat generated in the test pieces, and there does not appear to be a way to accurately assess the temperature reached or the temperature of the sheet during the SPR process since the pieces are heated and then manually moved to the riveter.

Reviewer 4:

The reviewer stated that the methodology is good, but effort appears to be timid. The commenter voiced that this is important work that should be continued with wider applications and more resources.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the project team has made good progress both on the simulation models, process development, and experimental validation. The reviewer added that the technical results seem to be consistent with other projects in the VTO Mg portfolio.

Reviewer 2:

This reviewer indicated that progress has been made in producing the induction heating coil, die modifications and testing a number of samples produced with various rivet and die combinations; however, that seems like work that did not require the skills of a national laboratory to complete. The reviewer added that last year's report indicated that there was also work underway in modeling and optimizing mechanical crimping as well as SPR. That work was to be continued this year (as specified in last year's future work); however, the reviewer did not see or hear any mention of crimping in this year's report.

Reviewer 3:

The reviewer stated that the progress with respect to 2013 was significant.

Reviewer 4:

The reviewer commented that there was no benefit relative to existing commercially available technology from Bollhoff.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that there is clearly close collaboration between the industrial partner and PNNL, and this collaboration is the key to the project's success both technically as well as from a transition point of view. The reviewer did not see how it could be improved and the reviewer applauded the performers for working so well together.

Reviewer 2:

The reviewer stated that Stanley appears to be well engaged in all aspects of the project, as would be expected when there are only two entities involved in a project.

Reviewer 3:

The reviewer commented that there seems to be a positive working relationship between PNNL and Stanley. The reviewer added that there was no pathway to commercialization identified.

Reviewer 4:

The reviewer did not understand why the car industry is not involved in this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the most value will come from design guidelines and exploration of alternate rivet materials and interlayers and hopefully that will be emphasized.

Reviewer 2:

The reviewer indicated that the future work plan, as proposed, is the weak part of the project thus far and can be greatly improved. The reviewer recommends the proposer develop a more structured plan on how the team will utilize the virtual tool developed thus far to improve the process with regards to rivet materials, shape and so on. For example, will the tool be used in a designed experimental fashion to determine the optimal material parameters and then find an actual material that is close, or will a set of existing materials be used. If so, the reviewer asked how the materials will be selected. The reviewer also asked what the materials represent. The reviewer also wanted to know if the rivet geometry will undergo any topology optimization. The reviewer also asked how the optimization task will be formulated. Lastly, the reviewer commented that a great number of structured experiments with regards to crack formation were conducted, but these experiments were not statistically analyzed. The reviewer suggested that since these experiments represent a significant investment, that the data be statistically analyzed for additional insight, or further validation of functional relationships between input variables and crack development.

Reviewer 3:

The reviewer pointed out that it is the last year of the project. The commenter hoped that such a research will be continued with a much broader participation of the industry.

Reviewer 4:

The reviewer recommended to “put a bow on it” and to move on to other research areas.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer remarked that identifying an effective joining method for Mg with regards to cost, cycle time, and performance is essential to use Mg in automotive.

Reviewer 2:

The reviewer agreed that any weight reduction is part of DOE's goal of petroleum displacement.

Reviewer 3:

The reviewer indicated that if successful, this project should enable more widespread application of Mg in reducing vehicle weight. The reviewer added that the relevance will ultimately be determined by how widely the information (e.g., user guide and design guide) are distributed and implemented.

Reviewer 4:

The reviewer explained that SPR technology is relevant but project goals do not address nor achieve a fuel savings relative to mass reduction.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that it appears the funding is sufficient thus far. The reviewer could see a situation where with the development of the virtual tool to determine the optimal process might require additional funding, but this might be a future effort or an additional effort under this project. At this time, the funding is sufficient.

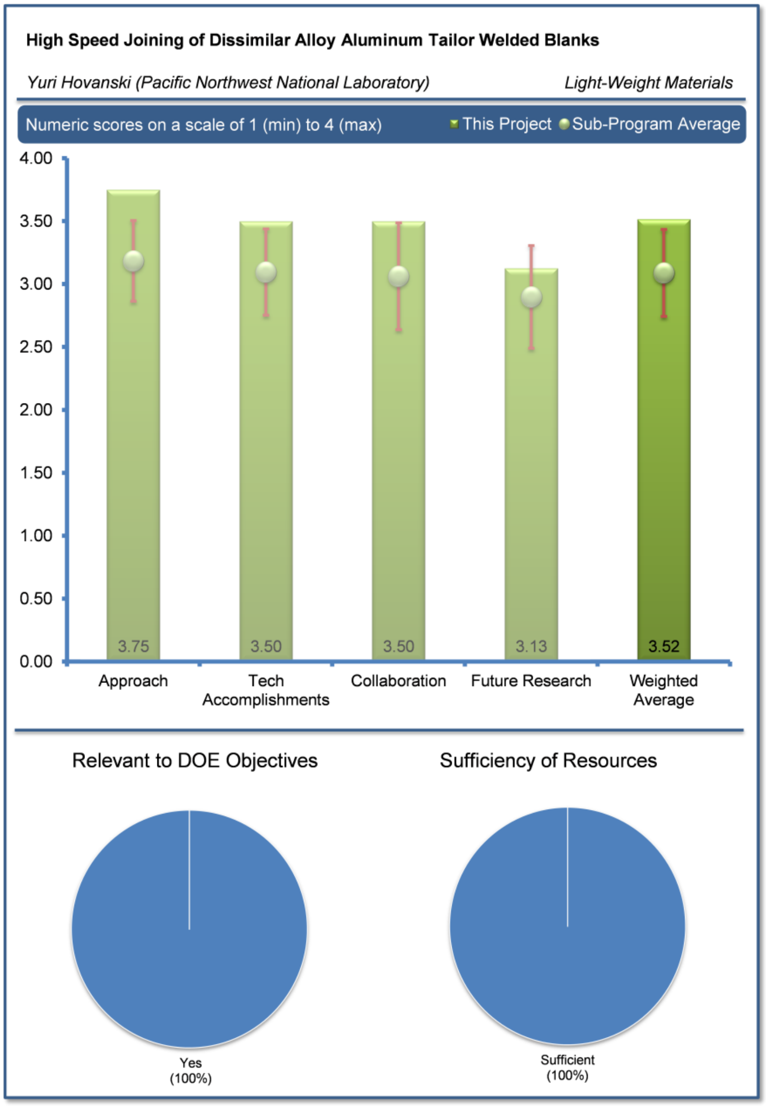
Reviewer 2:

The reviewer indicated that the research effort did not provide tangible benefit, thus resources could have been deployed on other topics.

Reviewer 3:

The reviewer expressed that the effort appeared to be timid, like a preliminary research effort to something bigger.

High Speed Joining of Dissimilar Alloy Aluminum Tailor Welded Blanks: Yuri Hovanski (Pacific Northwest National Laboratory) - lm075



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found this to be one of the most important development projects as an enabler for lower cost Al assemblies. The reviewer suggested keeping up the great work, especially scaling the larger process with tailor welded blanks (TWB) to further develop the friction welding process for high volume applications.

Reviewer 2:

The reviewer stated that this project was a great approach to prove-out Al TWB. The reviewer pointed out that the four tasks adequately address the barriers of development and implementation. The reviewer added that the efforts to investigate, evaluate then develop and prove out are great.

Reviewer 3:

The reviewer remarked that the project was well planned and executed; it met the original objectives of developing a solution for the TWB for Al sheet forming.

Reviewer 4:

The reviewer stated that the project has examined a range of joining technologies available for joining Al. The reviewer added that the project team produced coupons from each of these technologies. The reviewer stated that the friction stir processing was chosen as the method. The reviewer then asked if normalized main effects plots need to be generated for all Al alloys to be welded. The reviewer also wanted to know if these main effects plots need to be generated for each heat/lot, supplier (even if the alloy is the same). The reviewer also asked how many meters of TWB can be welded before the tool must be changed out.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the design of experiments and the forming limit efforts have been outstanding. The systematic approach to the key parameters in friction stir welding has resulted in a robust design for the tool. The reviewer added that running at near production speeds has demonstrated the process. Also, the reviewer stated that the coupon testing and probabilistic forming limit diagram gives the design community what it needs to incorporate tailor welded blanks into components. The reviewer commented that the publication of The Minerals, Metals, and Materials Society (TMS) and Society of Automotive Engineers (SAE) papers was a great effort to disseminate the information.

Reviewer 2:

The reviewer said that the project was very detailed and focused on what we would develop if this were an industrial research project. The reviewer added well done.

Reviewer 3:

The reviewer stated that the welding process has been optimized to provide the TWB aluminum sheets; the whole gamut of the variables including tool materials, geometry, feed and speed and others were considered and studied in depth. Also, the reviewer pointed out that the joints were characterized and optimized. The reviewer added that the availability of TWB aluminum for further working is the validation for the project team.

Reviewer 4:

The reviewer asked what "high speed" means regarding the high speed welding development. The reviewer also wanted to know what the approach is to predicting weld failures. The reviewer asked what is meant by a weld failure, and if there has been experimental validation of FE model predictions of any bench scale test.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that there was excellent collaboration with the auto company and weld producer along with materials supplier. The reviewer asked if the PIs are working to get these disparate groups to work together, communicate, share information, etc.

Reviewer 2:

The reviewer remarked that the project had an excellent scope and breadth of collaboration partners.

Reviewer 3:

The reviewer indicated that there was great vertical integration through the supply chain. The reviewer added that the partners all contribute to the project success.

Reviewer 4:

The reviewer stated that the project has developed a process supply chain for the TWB of aluminum; this is quite significant and will contribute to the faster implementation of the aluminum sheet technology in automotive structures.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that moving to the 7xxx alloys is a good target and future direction; continue to focus on mixed aluminum products (i.e., 5xxx to 6xxx to 7xxx).

Reviewer 2:

The reviewer stated that the project is in the last year. The reviewer added that the plan for the remaining period is satisfactory. The reviewer stated that in future the coating and corrosion performance of the TWB sheets can be evaluated.

Reviewer 3:

The reviewer observed that it was unclear how the weld predictive design tools will be handed off to the OEMs. This must include some type of fracture prediction, but none has been discussed. The reviewer wanted to know if constitutive models of the FWS weld zones will be developed based upon the unique material properties in the weld zones.

Reviewer 4:

The reviewer commented that the single statement of ‘Complete Technology Transfer,’ with only two points beneath, was way too simplified. The reviewer had hoped to see more details on these plans. The reviewer added that hopefully the oral presentation would give more details.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that this project is truly a lightweight enabler.

Reviewer 2:

The reviewer reported that having the flexibility to use Al tailor welded blanks for stampings will enable further light-weighting of body and closure stampings. The reviewer added that the reduced weight will displace petroleum use.

Reviewer 3:

The reviewer stated that Al is being used currently to meet the immediate energy efficiency. The reviewer added that more Al can be used if the process cost is reduced for wrought Al. The reviewer noted that this project has developed a technology for the sheet Al and it will increase the use of Al sheets in future vehicles.

Reviewer 4:

The reviewer remarked that friction stir welding instrumentation is more costly than spot welding instrumentation. The reviewer wanted to know if the authors have considered this. The reviewer also asked how much friction stir welding is done in automotive manufacturing at the present time. The reviewer also asked if the component manufacturing and the availability of the TWBs is going to offset cost of installation of new friction stir welding joining equipment.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

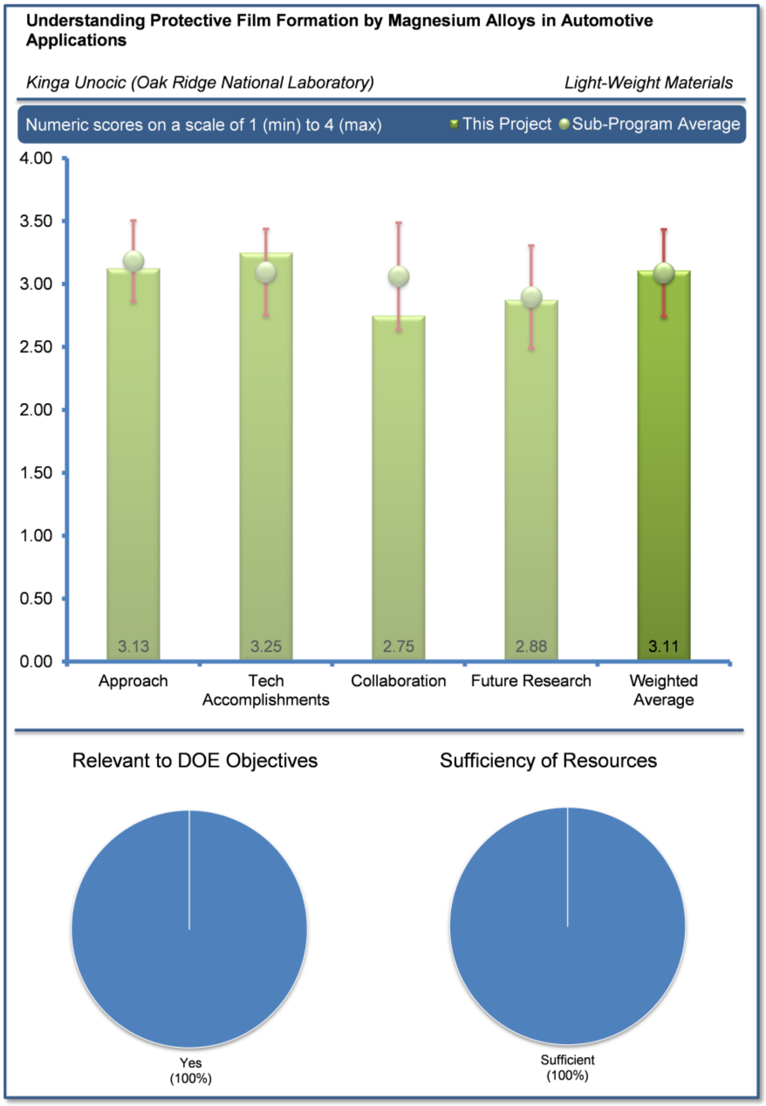
Reviewer 1:

The reviewer indicated that good progress indicates adequate resources.

Reviewer 2:

The reviewer said that the project was appropriately resourced and that no changes are needed going forward.

Understanding Protective Film Formation by Magnesium Alloys in Automotive Applications: Kinga Unocic (Oak Ridge National Laboratory) - lm076



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the overall approach seems to be quite reasonable but the reviewer found the statement "milestones focused on publications" to be rather odd. The reviewer stated that effective commercial exploitation can be impaired by open publications (although the reviewer may have misunderstood this aspect of the approach and project aims). Overall, the reviewer would say that too much time was spent on the chemistry of the corrosion solutions and very detailed explanations of test results, while too little attention was given to what the results mean and how they affect applicability of the material to actual vehicle components.

Reviewer 2:

The reviewer indicated that this project had a strong characterization approach for understanding chemistry of films (corrosion) that develop on two Mg alloys (MgAZ31B and Neodymium (Nd)-bearing Mg). The reviewer wanted to know if the PI is sure that Nd actually diffuses. The reviewer stated that it seemed that the Nd solubility is very low.

Reviewer 3:

The reviewer mentioned that the surface condition of Mg was evaluated using various techniques. The reviewer added that two Mg alloys were evaluated and that the plan is good.

Reviewer 4:

The reviewer said that the project provided a very good academic study of Mg corrosion. The reviewer suggested that the project team continue to focus on bulk crystal structure corrosion and oxidative studies, but try to migrate to corrosion of grain boundaries and determine the corrosion rates at micro-cells typically found at GB and PPt where localized corrosion initiates.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer said that this type of micro characterization is neither easy nor standard so keep up the good work and expand into other areas. The reviewer did like the thought of evaluating the Alodine 5200 and the various e-coat systems.

Reviewer 2:
The reviewer indicated that this project is using state-of-the art experimental methods to determine chemistry of films that develop two different Mg alloys. The reviewer added that secondary-ion mass spectrometry (SIMS) is particularly interesting, along with scanning electron microscope and X-ray photoelectron spectroscopy (XPS). Also, the reviewer stated that the PI presented many results, a single slide summarizing these results and their implications for manufacture of Mg alloys.

Reviewer 3:
The reviewer stated that the project appears to be making good progress in building an understanding of coating that form on magnesium, which will be crucial to applying this material to real-world components.

Reviewer 4:
The reviewer commented that the characterization involves exhaustive study of the Mg corroded surface using XPS, SIMS and other techniques. The reviewer also added that most of the time the findings are reported without making efforts to analyze the results and the significance of the findings.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the collaboration with BASF, Henkel, McMaster and others is noted; expand this effort to include industrial partners for more real world corrosion situations that are significant challenges.

Reviewer 2:
The reviewer would like to have seen some more detail on collaboration with Magnesium Elektron, University of Manitoba and McMaster University.

Reviewer 3:
This reviewer noted that only a material supplier and two universities are listed as collaborators. The reviewer added that for a basic research project this will be the minimum but not enough. The reviewer suggested that efforts should be made to discuss with other experts both academic and industrial ones.

Reviewer 4:
The reviewer remarked that the PIs need to think about what the project team can do with all of the information generated. For example, the reviewer asked if the project team has been in contact with any industry that may be a large-scale user of Mg, wherein corrosion is significant barrier towards wider scale implementation of Mg alloys.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said good, solid studies, continued progress.

Reviewer 2:
The reviewer reported that more analysis is being proposed; also the effect of coating is being tested. The reviewer stated that if possible discussion with other experts should be initiated.

Reviewer 3:
The reviewer asked if there was any planned linkage with the theoretical modeling community. The reviewer commented that it seems that this project has developed a wealth of information that could benefit those in the theoretical community who are trying to model Mg corrosion. The reviewer wanted to know what is planned along these lines. The reviewer also asked what the project team considered about the corrosion at grain boundaries and precipitates.

Reviewer 4:
The reviewer stated that the project team had good focus on core issues but the reviewer would have appreciated a somewhat higher level treatment of future work. The reviewer observed that in the talk, there was a very strong focus on micro-photographs and detailed explanations of corrosion films that formed in various environments, but the reviewer would suggest bringing the project talk back to how these results relate to in-service corrosion (and thus, how commercialization will be affected). Having said that, the reviewer indicated that the talk was unfortunately cut short by the time limit and so perhaps the above comment would have been addressed by the latter portion of the talk which was not reviewed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that enhancing our understanding of the performance of Mg in service is a critical element in how this material is applied to real components.

Reviewer 2:
The reviewer indicated that corrosion is a significant barrier towards wider scale implementation of wrought Mg alloys in a variety of industries. The reviewer pointed out that understanding the nature of corrosion files is an important first step towards developing strategies to minimize or eliminate this problem in future Mg alloy chemistry. The reviewer then asked if the conversion coatings being explored would be cost-prohibitive in mass-produced Mg components.

Reviewer 3:
The reviewer commented that this is basic research evaluating the corrosion mechanism of Mg alloys. The reviewer indicated that it is necessary to understand the corrosion of magnesium so that better protective mechanisms can be developed. The reviewer added that as magnesium is proposed as the potential material for weight saving improving its performance in service will accelerate its use in structures.

Reviewer 4:
The reviewer said that corrosion protection and mitigation is still an important element of implementing Mg for automotive applications.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

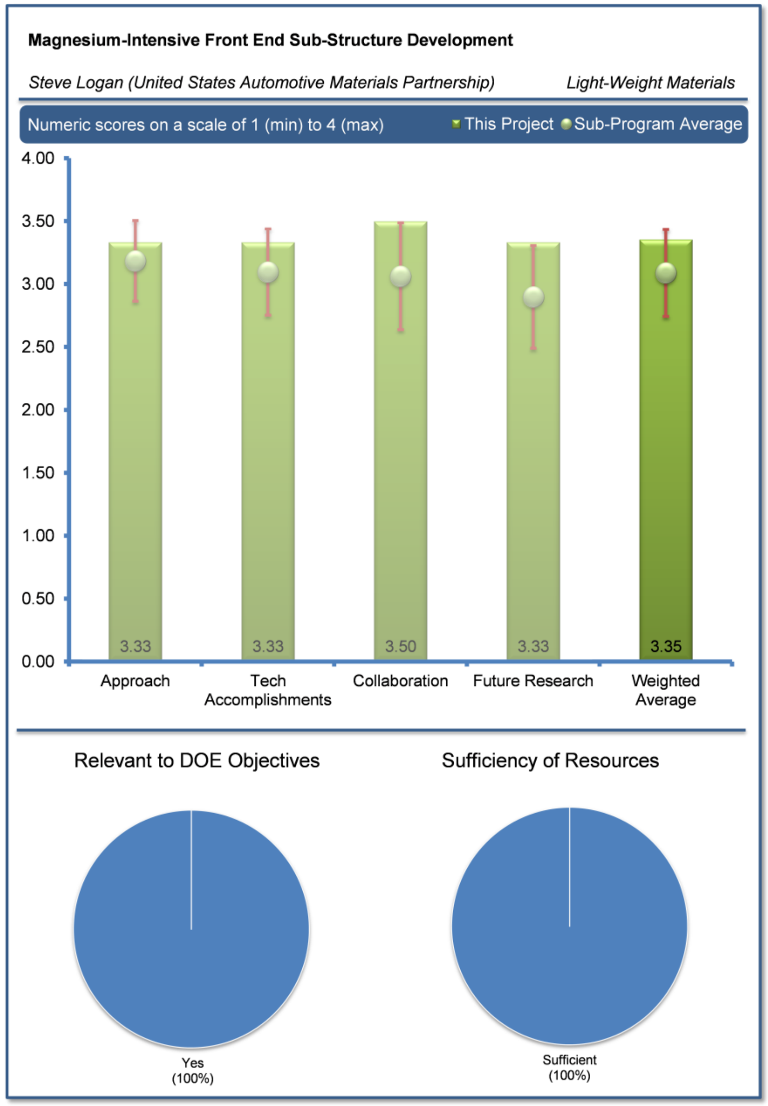
Reviewer 1:
The reviewer said that the funding seemed okay.

Reviewer 2:
The reviewer asked where all of the data is being generated in this project being collected. The reviewer wanted to know if there is a SharePoint site somewhere that can be accessed by those in the technical community who may need the data. The reviewer also asked if all of the data will only be available in various publications. The reviewer asked if the PIs have communicated with Mg material suppliers to discuss possible changes in processing to minimize or even eliminate corrosion effects in their materials.

Reviewer 3:

The reviewer indicated that the project is appropriately funded, maybe a little on the high side.

Magnesium-Intensive Front End Sub-Structure Development: Steve Logan (United States Automotive Materials Partnership) - lm077



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said the approach is a pragmatic empirical approach. The reviewer added that it sacrifices scientific generalizability for industrial transition ability. It also mixes several research issues as follows: new material development and evaluation; joining of dissimilar materials; and design, modeling, and forming of Mg casting. The reviewer stated that the advantage of this approach is all three tasks are relevant to industry adoption and reflect the major issues the industry would face to adopt Mg. The results should indicate where existing gaps to commercial adoption exist. The reviewer also remarked that it is unclear the degree to which the results and methods will be generalizable to other areas of a vehicle.

Reviewer 2:

The reviewer indicated that this appears to be a huge project with as many project management challenges as technical ones. Also, the reviewer said that there is a genuine concern that so many unique applications on a single test configuration may result in some unusual failure mode that will mask the true performance of the Mg structure. The reviewer added that while it is appropriate to consider the joining, coating, and extruding it really complicates the study. The reviewer observed that given the growth in Al body-in-white structures this year Mg will really be challenged by the OEMs in those structures.

Reviewer 3:

The reviewer explained that this is generally an important project, with broad potential applications and particularly for the car industry. This time, however, the reviewer did not have the impression of a strong drive towards meeting DOE's goals, but rather, and even though work is progressing, of a time of reflection, some kind of a pause. The reviewer asked for a confirmation or explanation of these observations.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the team has been very active and has made excellent progress towards their goal (completed design, created ICME models of joints with joining processes, conducted a variety of experiments in load, shear, fatigue, and corrosion to validate ICME models). That said, the reviewer remarked that the project team has recognized major issues that still need to be addressed (corrosion and joining, fatigue performance). Whether the team is going to be successful is an open question.

Reviewer 2:

The reviewer stated that the cracks in the free castings from Canmet show the complexity of this project. The reviewer assumed one could study shock town designs for some time before properly optimizing for both manufacturing and in vehicle performance. The reviewer would be concerned if the final structure testing highlights an area known to be a problem in manufacturing rather than accurately demonstrating the performance of the material in this application. The reviewer added that this is definitely a tradeoff when working on only demonstration parts rather than on an actual vehicle program with full vehicle validation efforts.

Reviewer 3:

The reviewer thought that there was some fatigue among the participants of this large program. The commenter hoped that participants will regroup and find a new wind.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer emphasized that it looks like a monumental task to keep all the involved agencies and supplier partners working to the same objective.

Reviewer 2:

The reviewer noted that on a project of this size coordinating with multiple countries, close collaboration between everyone is not necessary, cost effective, nor manageable. The reviewer cautioned that the key is to have clearly defined roles and responsibilities and ensuring everyone meets their co-dependent deliverables on time. Further, the reviewer said that clear communication between those organizations that are tightly coupled in their work is essential, but that degree of communication is not necessary across the entire group. This reviewer believes the collaboration between the performers is appropriate and excellent based on the results presented thus far.

Reviewer 3:

The reviewer noted that yes there was collaboration, but suggested that it would be better if Europeans would be included in such a large project. On the other hand, the reviewer acknowledged that the participation, as it stands, may be too large already.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project is moving along and the future work addresses the plan. Although acknowledged in the presentation and the slides, this reviewer is concerned with the remaining technical barriers that have not been successfully resolved (corrosion, joining, high performance casting). Specifically, this reviewer would have preferred to see a plan on how these technical barriers would be addressed with a potential risk assessment and abatement plan for the rest of the project over the future work that was presented. The future work was generic and not focused on the technical barriers.

Reviewer 2:

The reviewer commented that it may be difficult to get all the work completed by the mid-2015 target completion date.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer indicated that this project is extremely important in addressing at a systems level the issues that an OEM may face in dealing with integrating advanced, crash critical Mg castings into a multi-material structure. The reviewer added that the variety of technical challenges from modeling, through forming, and joining are becoming clearer and will help focus future research investments.

Reviewer 2:

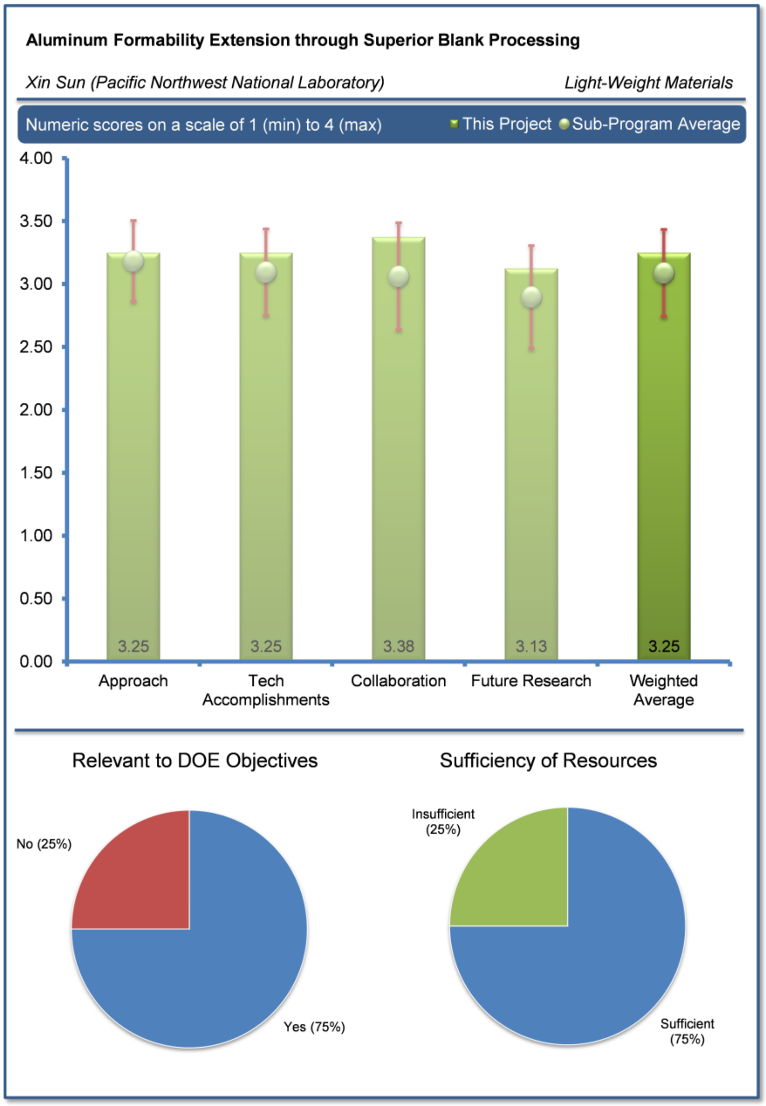
The reviewer remarked that it is not a super strong relationship between Mg and petroleum displacement, but this demonstration may provide the necessary validation for use in future vehicle platforms.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources to complete the plan are sufficient. The reviewer added that given the barriers and technical challenges, the project may not be "successful" in resolving all the remaining technical barriers. Also, the reviewer said in this case future resources focused on overcoming those barriers may be necessary.

Aluminum Formability Extension through Superior Blank Processing: Xin Sun (Pacific Northwest National Laboratory) - lm078



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the project appears to effectively integrate modeling and experimentation to develop and validate models that should shorten future process developments.

Reviewer 2:

The reviewer explained that the approach is a good and common applied research project. The reviewer suggested that the project team conduct a literature review, collect data to determine the nature and magnitude of the problem (potentially developing new metrics), conduct engineering analysis/simulation to controlling variables that appear to be relevant, conduct experiments to validate the simulation results, develop new process based on the new validated understanding of cause and effects, construct process and experimentally validate the process performs as predicted. The reviewer pointed out that the presenter claimed the approach is different. It may be different than some industry trial and error processes (which are becoming rarer even in industry), but it is and has not been, an uncommon approach in research/industry projects. The reviewer explained that within the limits of the project (material type, stamping based trim processes) the research is sound. The results are likely not generalizable beyond the limits mentioned. That said, the reviewer stated the methodology and metrics developed here will accelerate the analysis of trim operations with other materials, such as third-generation (3G) AHSS and Mg sheet.

Reviewer 3:

The reviewer said that the project goals are investigative and do not include potential product application to realize DOE goals.

Reviewer 4:

The reviewer inquired about how the sheet preparation process, if critical, could be implemented at a reasonable cost in factory floors. To this person, the criticality of the preparation process goes against production improvements; one part of the research is missing here.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer expressed that the results are very significant and will help the industry.

Reviewer 2:
The reviewer stated that there was good progress on achieving goals and understanding of high rate forming.

Reviewer 3:
The reviewer noted that a lot of experimental and analytical progress (including development for measuring safe/fail strains) has been made.

Reviewer 4:
The reviewer indicated that the technical results are good. The reviewer added that the Oakland University method for generating the large strain rate curves was innovative. Also, the reviewer said that the experimental validation of the finite element analysis results is notable and closer than many other similar experiments the reviewer has seen in other projects. Ford’s fluid dynamics (FLD) map for trimming is also interesting, albeit completely empirically based and difficult to generalize.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that there appears to be a close working relationship and integration of efforts between PNNL, Ford and OU.

Reviewer 2:
The reviewer agreed the collaboration is good, but cautioned that it is too limited.

Reviewer 3:
This reviewer is concerned that Ford's work is in direct competition with the PNNL modeling work. They seem to be different approaches to attack the same problem. During the Question and Answer (Q&A) period, the reviewer was gratified to learn that PNNL was able to duplicate the results with their ICME models. The reviewer commented that this means they now have developed a process that could be generalized to trim operations for other metals that results in validated FLD like diagrams that are operationally useful. The reviewer stated that this is perhaps one of the most significant outcomes of the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that the future work is straightforward completion of the project. The reviewer does not see any major issues of concern.

Reviewer 2:
The reviewer indicated that future plans address work that needs to be finished to bring the project to a reasonable conclusion; however, dissemination of the information should be explicitly stated in the future plans list (even though recognition of its importance is implied).

Reviewer 3:
The reviewer pointed out that this is the end of the project, but the reviewer hoped that it will be continued with a better integration of the process into the factory floor.

Reviewer 4:
This reviewer said that the project is in sunset phase.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer claimed that improved stamping of Al would enable more widespread use of Al in reducing the weight of vehicles.

Reviewer 2:
The reviewer agreed the project purpose has the potential of helping reduce the weight of vehicles.

Reviewer 3:
The reviewer said yes, with reservation. The reviewer reported that the application to Al shows that the Al team is improving the quality of Al stampings, which will increase the adoption of aluminum. This reviewer does not have sufficient insight to determine whether trimming is a major bottleneck over other quality or manufacturing issues, such as joining or corrosion. In other words, the reviewer asked will improving the trim quality of Al sheet yield an increase in Al use, or are the other barriers, such as steel to Al joining or the cost of Al sheet, the reasons that really keeps Al out of vehicles.

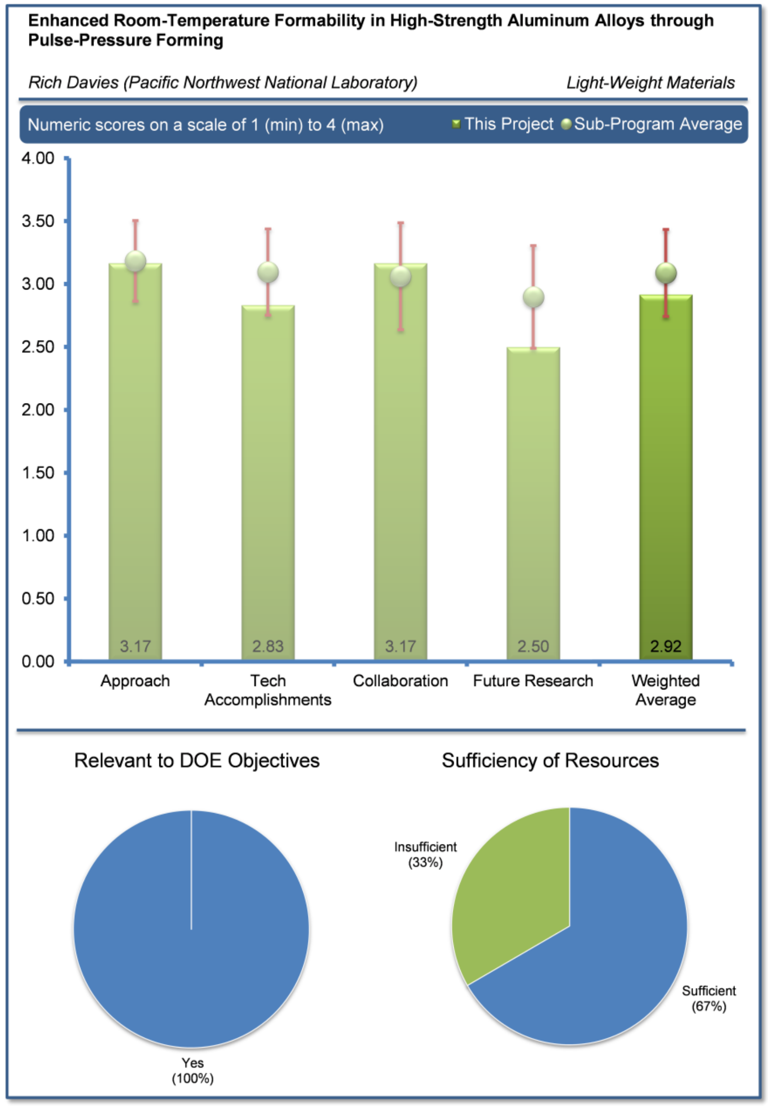
Reviewer 4:
The reviewer said that the project does not provide tangible application to realize fuel savings.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that resources are sufficient. The reviewer added that Ford’s increase in cost share is a sign of industrial acceptance and project success.

Reviewer 2:
The reviewer asked if the sheet preparation process was critical, then how could it be implemented at a reasonable cost in factory floors. To this person, the criticality of the preparation process goes against production improvements; one part of the research is missing here.

Enhanced Room-Temperature Formability in High-Strength Aluminum Alloys through Pulse-Pressure Forming: Rich Davies (Pacific Northwest National Laboratory) - lm079



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the approach is straightforward and appropriate for this project. The reviewer added that starting from readily available material grades and gauges that are typical for automotive components gives the project a strong chance of acceptance if the goals are achieved. The reviewer stated that the novel experimental techniques and material characterization are valuable results from this work.

Reviewer 2:

The reviewer indicated that the room temperature formability of Al sheet alloys was investigated. The reviewer added that the work plan is good and all the variables are taken care of. Also, the reviewer recounted that the metallurgical factor, effect of precipitates and micro structure, is not studied in detail; however, the project has produced enough results to transfer the technology to the next step.

Reviewer 3:

The reviewer asked if the electro-hydraulic forming process is limited to small parts (e.g., cups, vehicle trim, etc.). The reviewer wanted to know if the electro-hydraulic forming process could be used to make structural components b-pillars and rockers, or closures such as doors, hoods and deck lids. The reviewer also noted 0.14 post-deformation strains for Al alloy 7075 may limit this process to specific parts. The reviewer said that there are different methods for measuring failure strains in forming limit curves using DIC. The reviewer asked what technique has been used here and why.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer recounted that various aluminum alloys, 5xxx, 6xxx and 7xxx were evaluated. The reviewer stated that this provides a comparison on the capability of the process and makes it easier for the companies to see the advantages. The reviewer added that the experimental method and the analysis are well planned and executed.

Reviewer 2:

The reviewer indicated that the forming technique appears to be work as well as DIC method with high speed cameras for deformation measurement at strain rates in excess of 2000/s.

Reviewer 3:

The reviewer stated that for the past year the accomplishments are satisfactory. The reviewer was concerned that the project was extended from a third quarter 2013 finish date reported in the 2013 AMR to the current third quarter 2015 reported this year. Overall, the reviewer said that there appears to have been only a bit of work reported on 7075.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the project had good direction from an OEM, material from Alcoa, and interaction with American Trim.

Reviewer 2:

The reviewer recounted that there was good collaboration with General Motors and American Trim. The collaboration with Alcoa was unclear. The reviewer would be surprised if Alcoa does not already have stress-strain data and constitutive relations for 7075.

Reviewer 3:

The reviewer pointed out that the supply chain is involved with the OEM, part manufacturer and the research institution. The reviewer added that if the commercialization efforts are successful, then it can be used by many more companies.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that commercialization is the proposed future work and it is good that the project is paving way for more commercial use.

Reviewer 2:

The reviewer wanted to know if the material models can be implemented into commercial CAE codes, accounting for the rate effects in the Al alloys of interact, be generated and validated in this project. Also, the reviewer stated that costs associated with scale up of the electro forming process are likely to be quite high. This reviewer asked whether these costs would outweigh the benefits of forming Al at room temperature, and lead to standard room temperature of steel stamping remaining the best solution. The reviewer added that it may be the case that automotive OEMs will simply buy electro-pulse formed parts from a supplier (as is the case for hot stamped steels).

Reviewer 3:

The reviewer indicated that the plans are vague to achieve Milestones 5 and 6. Also, the reviewer is concerned that there is not more effort on more realistic part geometries. Finally, the reviewer said that the limited discussion of the path to commercialization is troubling. The reviewer then asked what path to production the project team sees with GM and American Trim.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

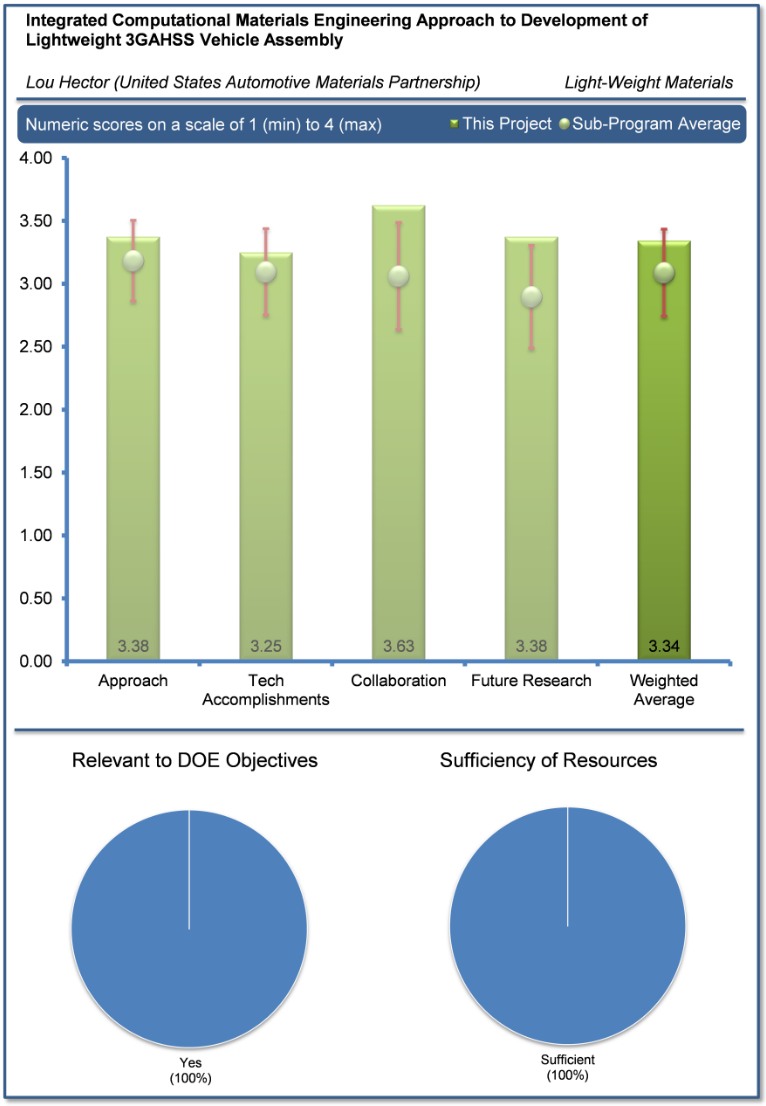
The reviewer commented that Al is widely used in current vehicles and its role will increase to meet the fuel efficiency standards in the near term. The reviewer added that to make Al more attractive to vehicle manufacturers it is necessary to improve the wrought alloy forming especially high strength alloys. Also, the reviewer stated that these alloys are currently processed at high temperatures and the cost is high. Reducing the process temperatures will be a good strategy to reduce the cost.

Reviewer 2:
The reviewer indicated that if high strength Al can be formed at room temperature it will be more readily used in vehicles, thus saving weight.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the project end delay and limited results from FY 2013 might indicate a lack of resources.

Integrated Computational Materials Engineering Approach to Development of Lightweight 3GAHSS Vehicle Assembly: Lou Hector (United States Automotive Materials Partnership) - lm080



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that this project appears to be an excellent effort on an important problem. The reviewer commented that the group includes the right people and organizations. The project appears to be well designed and thought through and looks to be making strong progress. The reviewer added that the key thing now is to get adequate supplies of these new 3G steels into the supply chain to enable their widespread adoption in real parts.

Reviewer 2:

The reviewer indicated that the project has just been initiated; the work plan as presented is reasonable but involves many players and multi-level tasks. The communications and the feedback are important for the project to move in a smooth manner. The reviewer added that the presentation provides the pathway forward and it is reasonable to assume the progress will be made.

Reviewer 3:

The reviewer applauded the team for selecting the correct program metrics, namely percent accuracy (ICME models), weight reduction and cost (material development). Also, the scope to include the variety of material models and the empirical validation is excellent. The reviewer noted, however, that the weight reduction and cost goals are confounded with the specific design and questions the degree to which these targets can be reproduced in other areas of the body. The reviewer also lauded the use of a large number of research institutions to develop the models. While the communication burden is great, and some of these institutions have duplicative capabilities, the massive parallel model development effort is the key to achieving the aggressive program goals in such a short time frame. One point of clarification regarding Task 4 is needed. On Slide 8, Task 4 is an assembly and joining task, presumably of the different body components and addresses the weld-ability of the 3G AHSS; however, on Slide 9 it appeared Task 4 is primarily about assembly and integration of the various ICME models, which will only include forming and not include welding or other joining processes. Further the reviewer added that on Slide 11 there is reference to assembly and joining processes in reference to Tasks 5 and 7. The reviewer asked that the team please clarify Task 4 as well as the assembly and joining processes of the body components (not ICME models) and make the slides consistent. The reviewer's impression is that Slides 9 and 11 are more accurate and Slide 8 is a bit misleading.

Reviewer 4:

The reviewer agreed that this is a good and important project; however, the reviewer found the approach of Slide 10 to be too complicated. The commenter proposed that the project would be better served by having a more straightforward approach slide. The commenter agreed that the strategy of where these new AHSS's fit within the grand scheme of things for the auto-industry, so deserves a slide with specs (e.g., physical properties, chemical properties, desired time for implementation) and the corresponding estimated weight saving. The reviewer remarked that time estimates for certification were missing although the reviewer also explained that every factory will run its own suite of tests before using a new material. The commenter noted that heats were mentioned during the presentation, but asked what kind of heat size, laboratory size, intermediate (as there could be several steps used), and/or industrial size. The reviewer highlighted that each size presents its own series of thermodynamic problems.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer had no criticisms or comments, all seemed to be going well.

Reviewer 2:

The reviewer indicated that very good progress was achieved between Year 1 and Year 2 of the project.

Reviewer 3:

The reviewer stated that given the relatively short time of the review (less than eight months of effort) and that a significant amount of time must have been spent on executing and improving the communication process, the technical accomplishments are excellent. The reviewer added that the project team has mostly revolved around using the existing models and technical expertise of the various research institutions to parameterize the QP980 baseline material. Also, the reviewer indicated that it would have been nice to see some example of how this characterization could be used to understand formability modeling to provide a preview of what is to come. The reviewer requested an update for next year on progress to prediction uncertainty of the ICME models (goal is 15%) and a risk assessment as to whether the project team will be able to meet that goal.

Reviewer 4:

The reviewer stated that during the first year of the project, which is only six months long, the project team and tasks were put together; the objectives are well planned and the role of project teams are defined. The reviewer indicated that with the actual work that has begun only in the second year the progress can only be assessed in next review.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project seems to be making good use of the collaborations and relationships among the participants.

Reviewer 2:

The reviewer observed that the team is well represented by the various stakeholders whose work is well integrated with the roles of each stakeholder are well defined.

Reviewer 3:

The reviewer asked whether foreign participation was considered.

Reviewer 4:

The reviewer noted that the initial coordination appears to be going well. Given the amount of funding executed thus far, the reviewer suspects there were some initial hiccups in operationalizing the planned communication and that there will be significant improvement as the project progresses, especially as the development of the models progresses and the interdependence of the modeling effort between the institution increases. Also, the reviewer said that the major metric will be the degree to which the project remains on schedule and budget. The reviewer added that poor communication will likely result in delays and under budget performance.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that there was a very nice presentation on this aspect of the project.

Reviewer 2:

The reviewer indicated that the selection of two alloys is a good start. Also, the reviewer commented that the development of new models to predict the microstructure and performance is important.

Reviewer 3:

For the future work, the reviewer suspects some of the Tasks are with respect to the new 3GAHSS and others are with respect to the QP9980. Specifically, validation of the fracture and forming models do not specify which material models will be validated. Further, there is no mention as to any potential concerns with regards to "extrapolating" from the QP980 to the new material models. This reviewer would like a bit more clarification on the technical barriers expected in the future work and any risk mitigation plan, as opposed simply a list of tasks and targets from the proposal. This is a highly ambitious, important, complex, valuable, and expensive project. It deserves critical scrutiny at a greater level of technical detail. This reviewer suggested adding the technical detail slide and during the AMR focusing on the technical and glossing over the task detail slide.

Reviewer 4:

The reviewer would like the approach to be revisited.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer strongly stated that of course the project addresses DOE's goals.

Reviewer 2:

The reviewer pointed out that this work is highly relevant and central to DOE VTO goals. The ambitious nature of the project is to really shorten the time from material development to implementation through the use of ICME tools. The reviewer stated that this project may become a model for future material development work, and concluded that it is really quite astonishing.

Reviewer 3:

The reviewer remarked that given the cost issues and property/manufacturability challenges with most, if not all of the non-traditional automotive materials (e.g., Al, Mg, and CF), it is virtually certain that high performance steels will continue to be a vital material for vehicle structures. For that reason, the reviewer indicated that work on new advanced alloys of steel is extremely important and is of absolute central importance to the DOE objectives.

Reviewer 4:

The reviewer indicated that AHSS are important for the weight reduction of the vehicles without compromising the safety. The reviewer added that the development of these new alloys will contribute to the knowledge.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer cautioned that it is too early to say whether the resources are excessive or sufficient. This reviewer has already discussed the low burn rate and the potential difficulties that may delay the project or result in a reduced burn rate. If significant technical difficulties arise, then costs could increase. But, frankly with the caliber of brainpower the Auto/Steel Partnership has assembled, this reviewer finds this scenario to be unlikely.

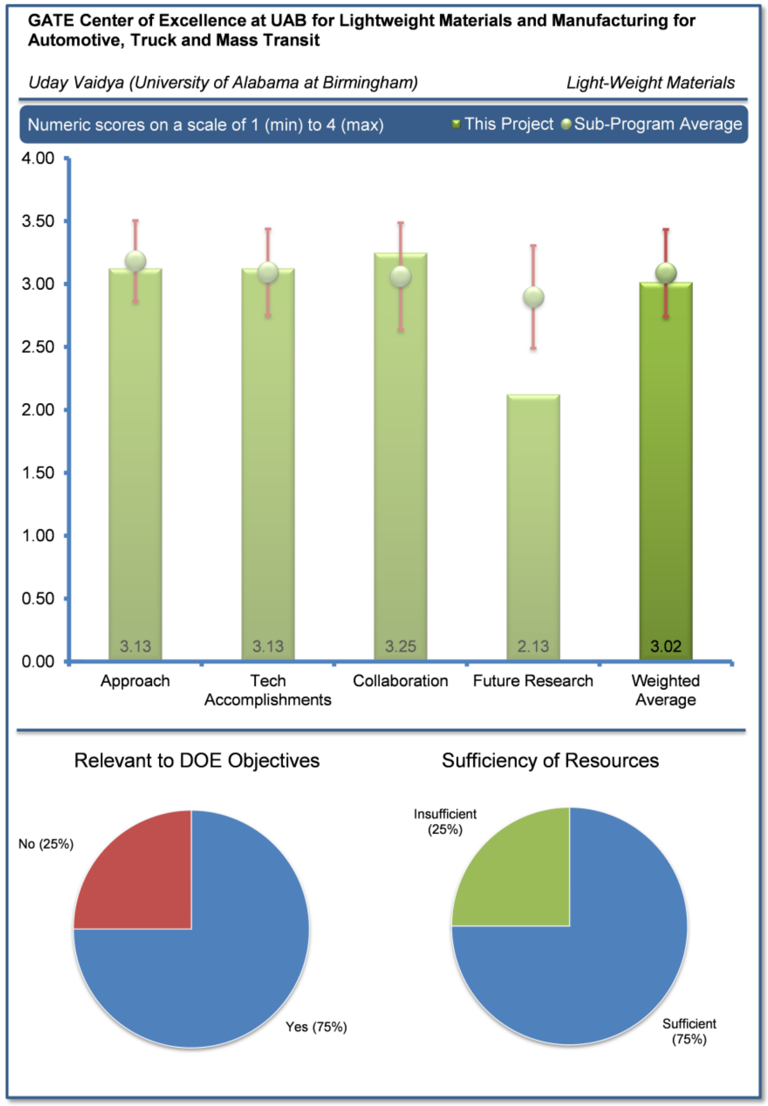
Reviewer 2:

The reviewer said that resources appear to be okay.

Reviewer 3:

The reviewer explained that it really depends on the size and the number of heats, which they did not see any relevant indications of.

GATE Center of Excellence at UAB for Lightweight Materials and Manufacturing for Automotive, Truck and Mass Transit: Uday Vaidya (University of Alabama at Birmingham) - lm081



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that it appears that the work of this program is clearly focused on applications and skills development with rapid transition to industry.

Reviewer 2:

The reviewer recounted that the program is an educational program in automotive lightweighting with a variety of research projects that appear to operate as a graduate level co-op like experience. The reviewer added that the approach is fairly straightforward, although not particularly innovative. University of Alabama-Birmingham (UAB) is leveraging other investments, for example the National Science Foundation (NSF) quite effectively. The reviewer’s major criticism is that the barriers mentioned on Slide 2 have no bearing on the stated program goals listed on Slide 3.

Reviewer 3:

The reviewer indicated that the little seed money project for a few students a year is a satisfactory approach to increasing the GATE efforts. The reviewer added that the efforts for education, while worthwhile, are difficult to defend as reducing petroleum use.

Reviewer 4:

The reviewer said that it is difficult to put this educational program on the same footing of the technical programs. It appeared to the commenter to be a very good higher educational program that was tailored to the automotive industry, which is particularly well-represented in Alabama. The emphasis seemed to be primarily on carbon fibers composites. The reviewer understood that the University of Alabama has limits as to what it can offer to students but, in the reviewer’s mind, this was somewhat too restrictive.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

This reviewer observed that there was good progress in teaching students in areas of interest and importance to the automotive industry.

Reviewer 2:

The reviewer stated that the technical accomplishments, in terms of the numbers of graduate students and the quality of the research, are satisfactory. The reviewer added that there appears to be little leveraged funding for GATE students from the Alabama auto companies. If these exist, example projects should be outlined.

Reviewer 3:

The reviewer indicated that the educational side has improved (more students, new course). The reviewer pointed out that the project team needs to update student graphs. Student support and participation is qualitatively explained and targets exceeded. There are no quantitative research targets, although much of the presentation focuses on the research. The reviewer thought it was unclear how the research projects are developed and selected or transitioned. The reviewer remarked that it was difficult to assess how the research projects fit together, if at all. The reviewer said that it was difficult to understand whether the university is also receiving funding from the supporting companies/organizations. The major positive accomplishment that is excellent is the shift in focus on external partnerships, which was lacking in the FY 2013 review. This reviewer would like to see more on the educational side and less on the research side. Specifically, the reviewer asked if this is a program to create the next generation workforce in vehicle light weighting, what is the institution doing to grow the program beyond VTO funding. The reviewer wanted to know how satisfied the employers are and if the graduates are really doing lightweighting work at their current employer or are they simply hired because they are good students to meet some other engineering need.

Reviewer 4:

The reviewer stated that it was difficult to put the technical accomplishments on the same footing as that of technical programs. For example, the reviewer inquired about how graduating 5 of 10 students would be perceived (e.g., outstanding, excellent, good, etc.).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said that there was very good integration with the ORNL CFTF and a number of commercial firms that sponsor students.

Reviewer 2:

The reviewer highlighted that the University of Alabama is lucky to be in the middle of such a concentration of automakers.

Reviewer 3:

The reviewer said kudos to the team for engaging community colleges, ORNL, and industry. The reviewer was surprised it was not more prominent in FY 2013. The reviewer stated that the degree of interaction is still a bit unclear. The reviewer wanted to know if the students work at ORNL, also the reviewer wanted to know if ORNL is simply making the CF. The reviewer asked what exposure the students get to the partners. The reviewer stated that internships are an effective model. The reviewer wondered if GATE requires co-op/internships. The nature of the industry interaction (funding, student-industry interaction metrics, degree to which the industry engages, adopts solution, benefits, etc.) for this program is, in this reviewer’s opinion, more important than the specific research results.

Reviewer 4:

The reviewer pointed out that there were lots of logos on the slide but little evidence reported of outside companies, suppliers or national laboratory support. Advisory board meetings are little but not great collaboration. The reviewer stated that briefings to OEMs are far from collaboration.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed future research appears to be continuation of current activities.

Reviewer 2:

The reviewer indicated that there appears to be little evidence of future plans to accelerate and expand the program.

Reviewer 3:

The reviewer reinforced that carbon fibers composites are not the only thing in lightweighting

Reviewer 4:

The reviewer stated that the proposed future research was not presented, the future plans are unclear. Given the significant change between FY 2013 and FY 2014 regarding industrial participation, this reviewer believes that the UAB team has future plans, but has not presented them regarding research or the education program or the overall GATE program through FY 2016. The reviewer asked if there are plans for future growth and student attraction. The reviewer also asked if the research plan has any strategy or if it is purely opportunistic and driven by some ad-hoc industrial need. The reviewer added that in the Q&A the student retention and attraction question, although stated as part of the DOE GATE program is apparently funded through the NSF and other programs. This is good, but this reviewer would like to see more about how the performer is planning on meeting or exceeding the program goal of "To provide a new generation of engineers and scientists with knowledge and skills in advanced automotive technologies." The reviewer wanted to know what the plans are to increase student participation at the undergraduate and graduate level. The reviewer also asked what the future plans are with regards to curriculum development. Additionally, the reviewer asked what the plans are regarding expanding industry collaboration and leverage. The reviewer also wanted to know where the risks are and what metrics are being collected to help UAB figure out how to improve (as opposed to simply "satisfy" DOE reporting requirements). The specific research objectives, in this reviewer's opinion, while interesting and indicative of the quality of the work, are simply not important as "future work" goals.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that increasing the number of engineers capable of designing and manufacturing automotive systems with new lightweight materials contributes to the commercial adoption of these materials the DOE goal of lightening vehicles to decrease petroleum use.

Reviewer 2:

The reviewer commented that it is crucial for the automotive and transportation industry to have talented engineers and researchers from diverse backgrounds trained in technologies that are important for vehicle lightweighting.

Reviewer 3:

The reviewer simply stated that the project definitely addresses DOE's goals.

Reviewer 4:

This reviewer indicated that this is a stretch to say that education efforts displace petroleum.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer is actually very impressed with the amount of research being conducted and the number of students being supported for the amount of funding. The reviewer added that this is a very good investment. Additional funding would presumably increase student participation and grow the program. The reviewer suspected many of the results reported are from mingled funds from various sources (leverage) and not completely attributable to the VTO investment. The reviewer said it was unclear whether an increase in DOE investment would result in increased leverage from other sources. The reviewer added that this possibility should be explored and clarified with UAB.

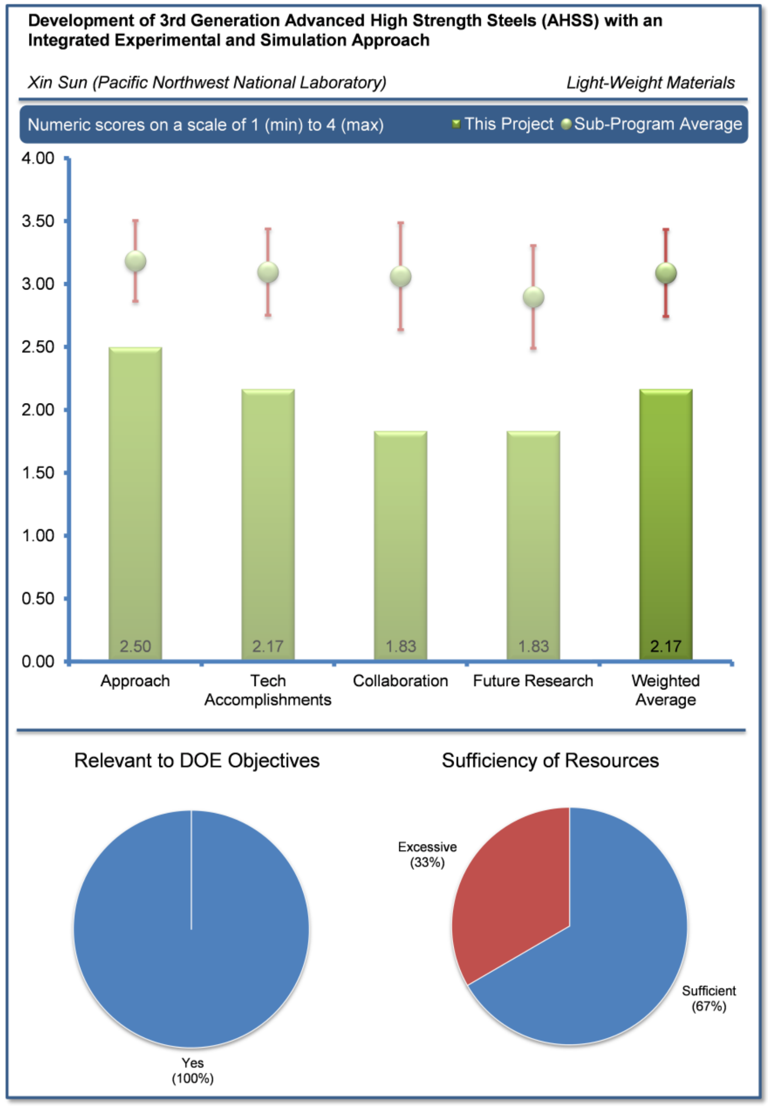
Reviewer 2:

The reviewer would have liked to see the program to be more encompassing of all aspect of lightweighting.

Reviewer 3:

The reviewer remarked that $120,000 per year is sufficient to fund this effort.

Development of 3rd Generation Advanced High Strength Steels (AHSS) with an Integrated Experimental and Simulation Approach: Xin Sun (Pacific Northwest National Laboratory) - lm082



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer said that the project team had a thought-out work plan and executed it well.

Reviewer 2:

The reviewer claimed that the approach was investigative to improve ductility of 1500 mega-Pascal material samples. The reviewer added that the result was unsuccessful.

Reviewer 3:

The reviewer observed that this is worthwhile work and appeared to be conducted in a reasonable manner but to be honest, the reviewer found that the graphics on the slides were simply not informative and did not really add to the quality of the information presented (particularly Slide 4). Also, the reviewer mentioned that the graphics were too small and/or too faint to be easily readable and this also took away from the information being presented. The reviewer said that a much stronger presentation should be prepared for future reviews. From what the reviewer could gather from the presentation and slides, it appears that the project is going okay, but more data on outcomes and how the deliverables outlined at the outset and some words about costs of the new 3G steels would have been welcome. Finally, the reviewer commented that some slides (notably the one feedback from past reviewers) were flashed up and down off the screen so quickly that no discussion or learning was possible from them, while other less useful slides (such as the micrographs and the slides with five or six tiny little plots on the same slide) were discussed at length.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the project is aimed to develop data for the modeling efforts; the selected alloy was fabricated and tested while the models were developed. This process is designed in feedback loop to improve the modeling accuracy. Hopefully this learning will help in the future efforts in developing new steels.

Reviewer 2:

The reviewer stated that it seems that things are happening as expected, but it was not that easy to tell to be honest.

Reviewer 3:
The reviewer claimed that the project team had a poor project approach, lacking technical basis to achieve the project goal. The reviewer added that the characterization of phase fraction and evaluation of tempering is technically quite shallow.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed that only a research institution and organization with steel makers are involved; however, their contribution to the project is significant.

Reviewer 2:
The reviewer indicated that relatively little was said about this topic and so the reviewer can only conclude that the collaboration is not that strong.

Reviewer 3:
The reviewer stated that collaboration seemed non-existent. Colorado School of Mines provided samples; PNNL characterized and tempered, and UM was not mentioned.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer claimed that this is the end of the project; however, the partners are involved in the next AHSS project and the knowledge will be transferred to that project.

Reviewer 2:
The reviewer noted that some information was provided on future work, but it was not that clear and it was difficult to relate it to the stated deliverables of the project. The reviewer added that the supplementary answer provided by the colleague in the audience was much more helpful than either the slides or the main presenter's talk.

Reviewer 3:
This reviewer pointed out that no recommendations were provided to realize the project goal to improve ductility.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that AHSS are needed to reduce the weight of the structures without compromising the safety and increasing the cost; however, many new steels are too expensive due to alloy additions and efforts are being made to produce steels with moderate strength and low cost. The reviewer added that this project is aimed to understand the process-property correlations so that the steels can be used in many applications.

Reviewer 2:
The reviewer stated that there is no question that reducing weight is a key factor in displacing petroleum. Also, the reviewer reported that steels will form a major portion of vehicle structures and components in the future and so work on advanced stronger alloys is very important.

Reviewer 3:
The reviewer remarked that the subject is most relevant to DOE objectives; however, the reviewer warned that the execution is suspect

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

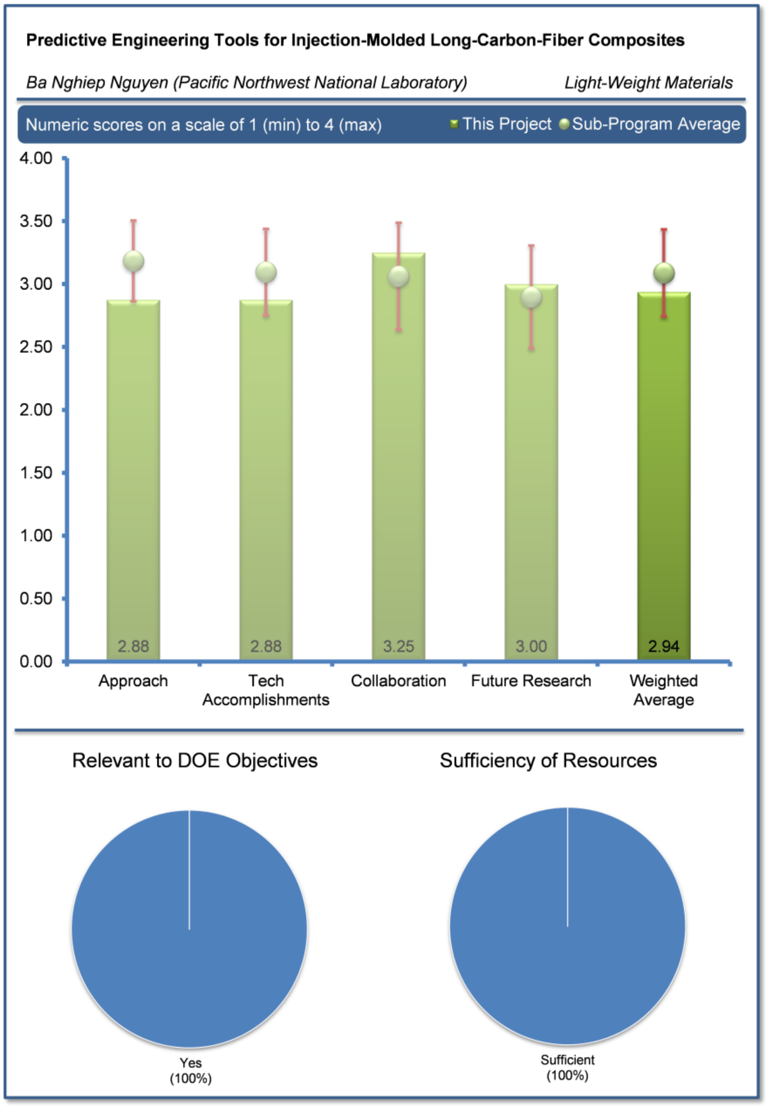
Reviewer 1:

The reviewer indicated that it is hard to say, little was said about the budget or progress as it related to resources during the presentation.

Reviewer 2:

The reviewer opined that the project achieved nothing of value, whatever resource was expended did not contribute to the basis of knowledge.

Predictive Engineering Tools for Injection-Molded Long-Carbon-Fiber Composites: Ba Nghiep Nguyen (Pacific Northwest National Laboratory) - lm083



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the approach to this work is well grounded in the prior work done with long glass fiber composites. The reviewer added that improving the mold flow's ability to accurately predict CF filled, injection molding grades is needed, as well as standardized material properties for modeling both process simulation and structural analysis.

Reviewer 2:

The reviewer stated that this is a field in which there is significant related work already completed in in the public domain. The reviewer thought more attention has to be paid to material selection. Not all polypropylene (PP) and polyanhydride (PA) resins are equal. The reviewer added that CF is not really designed for those resins and needs to be optimized. The sizing, etc. may not be a good fit and that can have implications on rheology and mold flow as well as mechanical properties.

Reviewer 3:

The reviewer claimed that there needs to be a better tie-in between plaque moldings to three-dimensional (3D) molded parts. The reviewer suggested that CAE evaluations of 3D complex parts need to be done in-phase with the simple geometries to avoid having to fine tune model parameters for planar part that may not be appropriate representation for 3D complex geometry.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that some significant advances have been made, but there are also some significant holes in the study. The reviewer explained that fiber orientation and fiber length have always been challenging in CF to quantify and this program seems to have made significant strides there. The reviewer added that this is a key part of any model, but the resin properties and the sizing/interface seem to have been ignored or simplified and that is a deficiency in the model.

Reviewer 2:

The reviewer observed that technical accomplishments failed to describe key outputs from fiber orientation and length measurement studies. The reviewer indicated that the material characterization studied did not adequately describe key rheological differences between molded materials at different levels of long carbon weight concentration. Also, the reviewer said it would be rather important to link the process simulation outputs to structural simulations. The reviewer added that very little time was discussed regarding the importance of this linkage.

Reviewer 3:

The reviewer indicated that this project is just getting started. The reviewer noted that the plaques have been molded and the mold flow has been run. This reviewer has a concern over the warped, center gated part shown in the presentation. The reviewer asked if steps were taken during the processing to minimize this warping. This reviewer is also concerned that "small" (7"x7") plaques may not be sufficient to capture steady state flow field in flow and cross-flow directions. Finally, this reviewer suggested keeping an eye on the end result, the physical properties. Fiber length and fiber orientation are the intermediate steps to the physical properties, so a transfer function needs to be developed, and process to develop.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that this team is well balanced across the supply chain, including material supplier, molder, tier, OEM, research institutes and software provider.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that overall the future research seems to be a good plan, but more attention should be paid to the material choices and formulations.

Reviewer 2:

The reviewer mentioned that the outline for 2014 and 2015 future work is well thought out. This reviewer is looking forward to the results. This reviewer suggests evaluating both continuous (direct long fiber thermoplastic and discrete (long fiber thermoplastic (LFT)) fiber length materials as the industry would benefit from both.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer indicated that this work is the next logical step following the research work in modeling long glass fiber, injection molded composites and will benefit the future modeling work in continuous fiber composites. The reviewer added that by combining the benefits of continuous fiber composites (impact, strength, stiffness) with the benefits of parts integration that comes with injection molded composites, this work will help OEM engineers develop lightweight automotive applications that can meet current and future fuel economy and greenhouse gas emission regulations.

Reviewer 2:

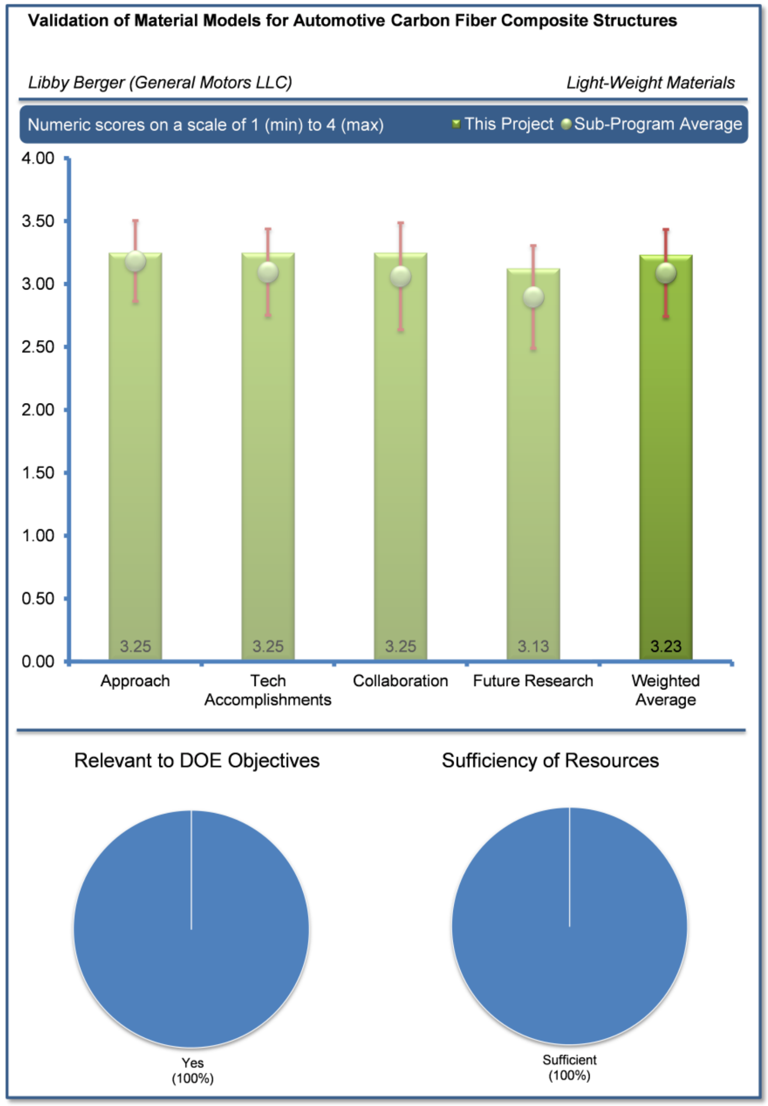
The reviewer remarked that long fiber glass fiber composites have already had a significant impact on the automotive industry and LFT carbon could have a very significant role to play. The reviewer added that the models and general understanding have to come first.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the resources seem sufficient along with the commitment of the collaborators.

Validation of Material Models for Automotive Carbon Fiber Composite Structures: Libby Berger (General Motors LLC) - lm084



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer pointed out that establishing the steel benchmark was a good method for controlling geometry effects. The reviewer mentioned that the overall plan is comprehensive and readily understood. The reviewer added that the basic approach is fairly standard. It covers multiple modeling techniques and utilizes state of the art technologies. Leveraging previously developed codes is an excellent way to accelerate the project. The reviewer remarked that while many projects often state they will utilize previously developed code, it is often not practiced for various reasons. The reviewer noted that adding NDE for understanding composite part failure is also a high priority, and it was great that it is incorporated here.

Reviewer 2:

The reviewer stated that the approach was benchmarking against a current commercial steel crush can, and using that information as the baseline for performance is solid. It was unclear whether this was a commercial crush can tuned for a specific vehicle. The reviewer added that it was also unclear as to the target peak loads, and asked whether the rails are capable of carrying more than 140 kilo newton as shown in the force/displacement curve.

Reviewer 3:

The reviewer reported that it is important for the project team to develop a set of comprehensive project risk factors, the rating of the risk factors to success of the project, and an appropriate risk mitigation plan. The reviewer added that the linkage between university based material damage models to implementation of the models with existing commercial software was not described in detail.

Reviewer 4:

The reviewer commented that crash models will be required before CF composites will be fully accepted into the automotive industry. The reviewer would have liked to have seen information on how this expands the knowledge base from what is already known with the BMW i3 and also testing done in auto racing where CF composites are already used.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer noted that the crash testing of the steel crush cans is complete and that the material property matrix was completed. The reviewer also stated that the selection of material and process system was completed. This reviewer suggested that the auto industry would benefit from both thermoset and thermoplastic systems.

Reviewer 2:
The reviewer stated that this project seems to be achieving their stated goals on schedule.

Reviewer 3:
The reviewer remarked that the project is significant and well thought out. The milestones are logical and one can see how they build on each other. The reviewer pointed out that understanding the design of composites for energy absorption was excellent. The reviewer added that the learning, correlation of models with simulation, and communication of the results was excellent. The initial work on NDE is good; however, the reviewer would like to know what the NDE goals are. The reviewer also asked what degree of defect resolution with regards to defect type and accuracy/precision is needed and targeted for this project. The reviewer pointed out that aspects of the project two years in are up to six months behind schedule. The reviewer warned that the project should continue to be monitored for future delays.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the partners seem appropriate and well established.

Reviewer 2:
The reviewer noted that each subcontractor has a clear task in the project. The interaction is pretty clear based on the logical interactions that are necessary. The reviewer added that the project had clearly defined roles and responsibilities.

Reviewer 3:
The reviewer said that this project has a good representation of OEM's, modeling company, tier and research organizations.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the proposed work looks good. The reviewer would like the project team to clarify what “acceptable results” will look like for the composite front bumper crush can. As previously mentioned, this reviewer suggested that the industry would have an interest in both thermoplastic and thermoset composite solutions.

Reviewer 2:
The reviewer indicated that the technical risk appears to be well understood. The reviewer stated that the Project plan is driving the future work. There are not many options for change to address the technical issues. In the future, the reviewer would like to see more detail specifically on the next year of work. The reviewer wanted to know what the technical issues are that will be addressed. The reviewer also asked what the concerns are, where the risks are, and what the mitigation options are, if there are any.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that this work supports the DOE's objective of reducing petroleum usage for vehicles through the development of modeling methods for composites that allow vehicles to be produced that are lightweight.

Reviewer 2:

The reviewer explained that vehicle lightweighting is one of the key technologies for improving vehicle fuel efficiency. Understanding how composite structures behave in a crash and being able to model that behavior is a requirement to ensure commercial adoption of this lightweight material.

Reviewer 3:

The reviewer pointed out that good baseline data and models are necessary for the industry to have the confidence to push forward.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

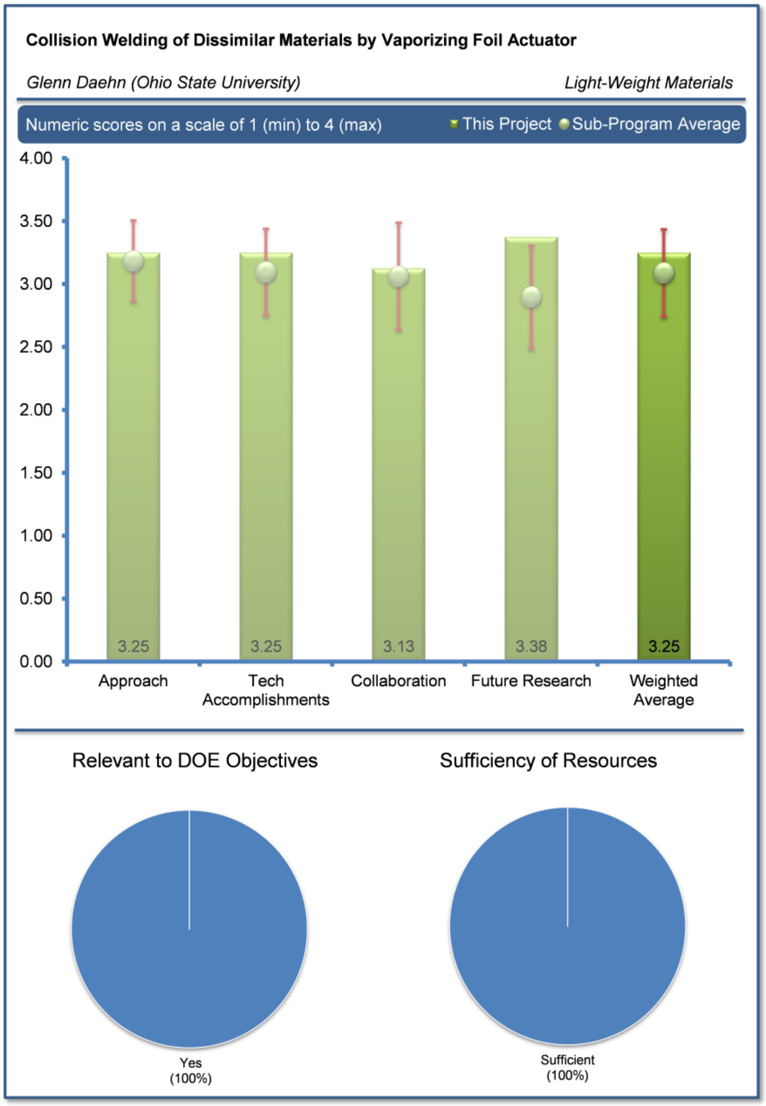
Reviewer 1:

The reviewer claimed that the resources outlined appear sufficient to complete the task.

Reviewer 2:

The reviewer acknowledged that the resources were sufficient; however, the reviewer had one concern. Some milestones are already slipping after the first 12-18 months of a 4 year project. The reviewer then asked how additional slips will affect the project team's ability to keep their academic partners engaged and coordinated with the rest of the team.

Collision Welding of Dissimilar Materials by Vaporizing Foil Actuator: Glenn Daehn (Ohio State University) - lm086



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer thought the grooved approach to evaluate multiple angles in a single experiment was clever and creates very efficient experimental work.

Reviewer 2:

The reviewer concluded that this appears to be a well-constructed proof of concept project.

Reviewer 3:

The reviewer reported the project team had a very good approach. Subject is in early stage; however, investigation was broad base and objective.

Reviewer 4:

The reviewer confirmed that this is an important subject. However, the reviewer explained that the project is not a breakthrough; similar technologies have been developed more than 10 years ago and it is regrettable that no mention was made of them.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that although, just getting started, the project team seems to be off to a good start. The project team seemed to be doing the right set of experiments early on and presenting the results in a way that are easily understandable. The reviewer added that the angle versus velocity table with micrographs is a great way to understand the bonding regions and parameters.

Reviewer 2:

The reviewer stated that the team has identified a number of critical issues and devised plans to explore and address them.

Reviewer 3:

The reviewer indicated that there was good technical accomplishment and a significant level of understanding has been realized.

Reviewer 4:

The reviewer pointed out that this was a new project, but progress appeared to be on track.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that partnering with an OEM (Honda) and material supplier (Alcoa) provides a connection to both ends of the supply chain.

Reviewer 2:
The reviewer stated that there appears to be active engagement with Honda and Alcoa in selection of materials and processes.

Reviewer 3:
The reviewer remarked that the project does not include a significant amount of collaboration; however, findings are published and disseminated.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the research plan addresses the key process parameters and variables needed to develop this process into a robust joining method for dissimilar materials.

Reviewer 2:
The reviewer mentioned that the plan is logical and comprehensive to demonstrate the feasibility of this technique and of potential corrosion mitigation techniques.

Reviewer 3:
The reviewer explained that the project team had a good approach to the future. The reviewer added that the project team was looking for a commercial application to apply high rate joining process.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked that the project is very relevant to DOE goals. The reviewer added that the joining of dissimilar materials will enable significant mass reduction and fuel savings.

Reviewer 2:
The reviewer stated that multi-material joining is a key technical hurdle in greater utilization of lightweight materials in vehicles and this project seeks to develop novel techniques that could be used in select applications.

Reviewer 3:
The reviewer agreed that yes, the project is relevant to DOE, adding that the results can be applied to other applications to enable technology.

Reviewer 4:
The reviewer indicated that the auto industry needs viable and novel techniques for joining of dissimilar materials in various combinations. The reviewer added that it currently appears that this technology may have limitations in the size and shape of parts that can be joined effectively, but it serves as a good proof of concept, that can be developed for more challenging applications if successful.

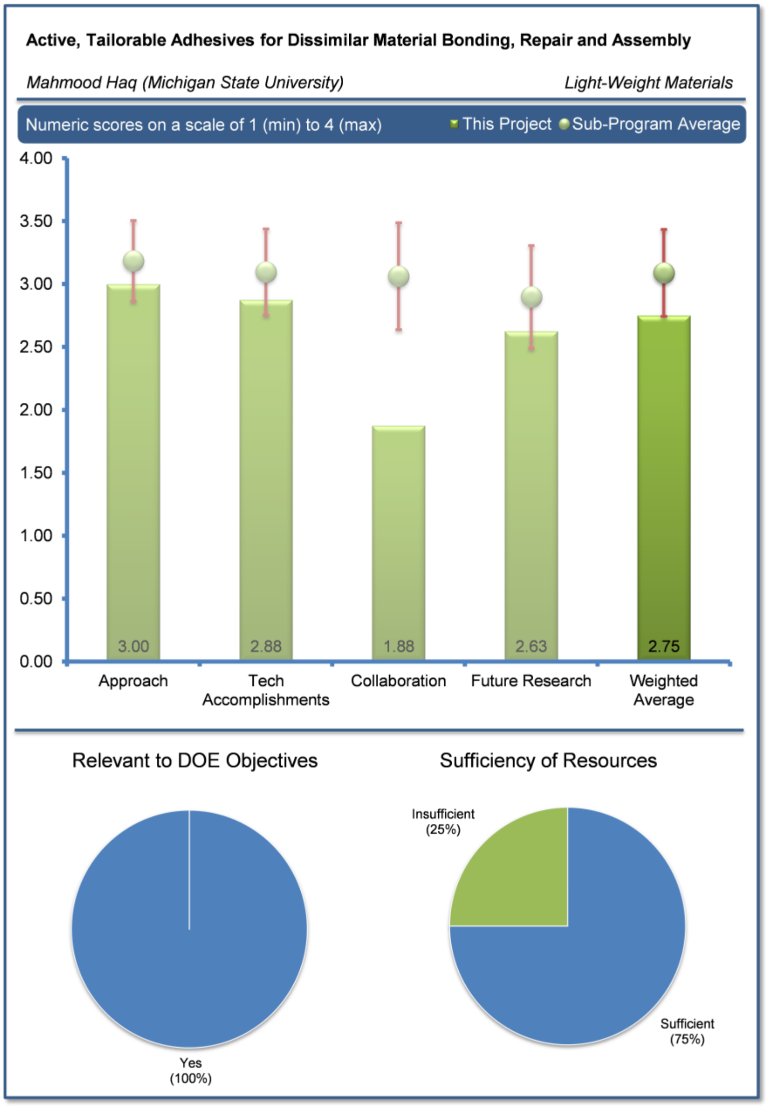
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that funding seems appropriate for current challenges and scope of work.

Reviewer 2:
The reviewer noted that the project had sufficient resources to continue early stage evaluation.

Reviewer 3:
The reviewer hoped the resources are sufficient, but they were not convinced that they are.

Active, Tailorable Adhesives for Dissimilar Material Bonding, Repair and Assembly: Mahmood Haq (Michigan State University) - lm087



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the project team had a good approach, early stage research focus on Nylon-6 versus automotive materials.

Reviewer 2:

The reviewer pointed out that the approach of offering a low-cost additive to conventional adhesives that could address re-use and replacement is a good idea and may prove to be beneficial to greater adoption of this method by OEMs. The reviewer added that the targeted heating option made available through the use of nano-graphene shows promise and is worth the investment in the feasibility evaluation.

Reviewer 3:

The reviewer stated that the approach to proving the concept is generally sound; however, the reviewer saw no mention of baseline comparison to conventional adhesives. The reviewer also did not have a clear vision of what materials this project wanted to focus on. The reviewer added that most of the information seemed to focus on polymer composites, but the test pieces cited were aluminum-steel couples.

Reviewer 4:

The reviewer affirmed that this is a very important subject. The commenter would have liked to have seen a better structured approach. The reviewer described that this is a new project and, is at its beginning, so especially for this reviewer, they asserted that it cannot be everything to everything. The evaluator proposed that the researchers choose one system, solve it, and then apply it to other material systems that are progressively tougher to work with.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that although just starting in the past six months, reasonable progress in organization and initial evaluation of processing, strength testing and characterization is underway.

Reviewer 2:

The reviewer explained that the early stage of the project revealed reduction in joint strength relative to base material. The reviewer added that the measure needs be relative to alternative adhesives. The reviewer noted that the Al/steel joint was subjected to 250°C and the project team needs to consider impact to over aging Al or inducing stress corrosion cracking. The reviewer stated that the project team needs to revise scope to focus on a few real automotive applications, where the benefit of graphene with a thermoset plastic is of value to facilitate of repair.

Reviewer 3:

The reviewer claimed that the results thus far are limited. The reviewer added that the project shows strong potential, but much more work needs to be done to not only evaluate strength when new, but also after release and re-apply.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that at this stage of development a partner such as Eaton is reasonable to assist with integrating such an additive into commercial products. The reviewer added that partnering with an OEM who would be interested should be a targeted addition in the second half of the projects (Years 3-4).

Reviewer 2:

The reviewer commented that the presentation did not include collaboration partners. The reviewer noted that there was one mention of a turbo charger shaft application with Eaton Corporation.

Reviewer 3:

The reviewer stated that thus far this seems like it is primarily an independent project. It is not obvious that Eaton has contributed to the effort, because this project covers an array of technology gaps (e.g., adhesive bonding, NDE, development of a "reusable" adhesive), it would be good to get some appropriate suppliers involved as well.

Reviewer 4:

The reviewer did not understand why car makers are not directly involved in the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project team has described a reasonable plan for research in the upcoming years.

Reviewer 2:

The reviewer indicated that it appears the project leadership has a good idea of work that needs to be done for the project to be successful (except for the need to include baseline testing and assessment of currently used adhesives).

Reviewer 3:

The reviewer hoped there will be some restructuration of this project.

Reviewer 4:

The reviewer stated that the future work lacks definition and an approach that will be of value. The reviewer recommended that the project team focus on applications that incorporate the benefit of graphene for disassembly/repair. The reviewer also suggested that the project team add an industrial collaborator to provide application and direction.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer remarked that the joining of composites in a way that enables reuse and repair but also eliminates fasteners and stress concentrating holes is addressing a key barrier, joining, to greater implementation in automotive applications.

Reviewer 2:

The reviewer stated that reduction in the use of mechanical fasteners can significantly reduce weight as well as labor needed for assembly. Thus if successful, ability to use adhesive in joints can reduce weight as well as cost, and thereby encourage increased use of dissimilar materials.

Reviewer 3:

The reviewer commented that the joining of dissimilar materials is a means of achieving mass reduction and associated fuel savings. The reviewer added that repair and replacement is the key to commercialization of multilateral structures.

Reviewer 4:

The reviewer agreed that the project addresses DOE goals, and suggested that the method can used in many different fields to enabling technology.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the project scope needs to be increased to include collaborators, possibly 3M or Henkel and a Tier 1 manufacturer of CF body panels. The reviewer added that the concept is good.

Reviewer 2:

The reviewer stated that if the structure of the project remains as is, the resources are probably sufficient. However, if the participation is increased (i.e., adding car makers), it will be grossly insufficient.

Acronyms and Abbreviations

Acronym	Definition
3-D	Three Dimensional
AHSS	Advanced High Strength Steel
Al	Aluminum
AMR	Annual Merit Review
CAE	Computer-aided engineering
CF	Carbon fiber
CFC	Carbon fiber composite
CFD	Computational Fluid Dynamics
CFTF	Carbon Fiber Technology Facility
CRADA	Cooperative Research and Development Agreement
DIC	Digital Image Correlation
DOD	Department of Defense
DOE	Department of Energy
DP	Dual-phase steel
EPA	Environmental Protection Agency
EV	Electric Vehicle
FE	Finite Element
FLD	Fluid dynamics
FSW	Friction Stir Welding
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
HOV	High-occupancy vehicle
HS	High Strength
HVAC	Heating, ventilation, and air conditioning
ICE	Internal Combustion Engine
ICME	Integrated Computational Material Engineering
IR	Infrared
ksi	Kips per square inch
LCCF	Low-Cost Carbon Fibers
LFT	Long fiber thermoplastic
Mg	Magnesium
MMV	Multi-material vehicle
Nd	Neodymium
NDE	Non-Destructive Evaluation
NDT	Non-Destructive Testing
NF	Nanofiber
NHTSA	National Highway Traffic Safety Administration
NSF	National Science Foundation
NVH	Noise, Vibration, and Hardness
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory

Acronym	Definition
PA	Polyanhydride
PACCAR	Commercial Vehicle Manufacturer (Kenworth, Peterbilt, DAF)
PAN	Polyacrylonitrile
PHS	Press-hardened steel
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
PP	Polypropylene
Q&A	Question and Answer
R&D	Research and development
ROI	Return on investment
SAE	Society of Automotive Engineers
Si	Silicone
SIMS	Secondary-ion mass spectrometry
SMC	Sheet Molding Compound
SPR	Surface Plasmon Resonance
TMS	The Minerals, Metals, and Materials Society
TWB	Tailor Welded Blanks
UHP	Ultra high purity
UM	University of Michigan
USCAR	U.S. Council for Automotive Research
UTS	Ultimate tensile strength
VTO	Vehicle Technologies Office
XPS	X-ray Photoelectron Spectroscopy

7. Propulsion Materials

Advanced materials are essential for boosting the fuel economy of modern automobiles while maintaining safety and performance.

Propulsion materials enable higher efficiencies in propulsion systems of all types. For example, many combustion engine components require advanced propulsion materials so they can withstand the high pressures and temperatures of high-efficiency combustion regimes. Similarly, novel propulsion materials may be able to replace the current expensive materials in electric motors and drivetrain components, thus lowering the cost of electric-drive vehicles.

Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the U.S. fleet could save more than 5 billion gallons of fuel annually by 2030.

The Vehicle Technologies Office (VTO) collaborates with industry to improve materials that will increase vehicle efficiency while meeting consumer and industry expectations. It does this through multiple approaches, including working closely with other VTO technology areas to identify and meet requirements for materials needed to develop cost-effective, highly efficient, and environmentally friendly next-generation heavy- and light-duty powertrains.

The major research and development (R&D) goal for Propulsion Materials is:

- Develop high performance, cost-effective materials that solve key challenges that currently limit the performance of propulsion systems (high-efficiency engines and electric drive, and compatibility with alternative fuels).

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: William Joost (U.S. Department of Energy) – lm000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer said yes. The reviewer commented that the overall program was easily understood and well presented. The business case and gaps were clearly articulated and logical in sequence.

Reviewer 2:
The reviewer said yes, and that the presentation showed a good strategy based on feedback from the industry.

Reviewer 3:
The reviewer said that the program covers the lightweighting and propulsion materials. The reviewer said that in the area of lightweighting, all the constituent materials, including aluminum (Al), magnesium (Mg), carbon fiber composites (CFCs), and steels, are well represented. The projects are addressing the identified barriers very well. The reviewer thought that similarly, the Propulsion Materials projects are developing solutions for light-duty and heavy-duty engines; the efforts on electric vehicles (EVs) is just beginning. It is expected that more material issues for EVs will be dealt with in the future as their use increases.

Reviewer 4:
The reviewer said that the Vehicle Technologies Office (VTO) program was clearly explained, the strategy was clear and consistent with the goals.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer said yes, there is a good balance.

Reviewer 2:
The reviewer emphasized yes, there is a balance. The reviewer commented there is an appropriate balance between the mid-term and long-term development and research projects.

Reviewer 3:
This reviewer is impressed with that balance. Appropriately, the majority of projects and funding focus on near-term projects that are industry driven. The reviewer pointed out that there are also several basic technology development projects that may have longer term potential. For example, development of third-generation advanced high-strength steel (AHSS) appears to have a mid-/long-term potential, whereas much of the design and simulation tools have nearer term potential. The reviewer also pointed out the Graduate Automotive Technology Education (GATE) project, which focuses on education. This is clearly a longer term investment.

Reviewer 4:
The reviewer said that as more and more industry partners are involved, the projects may be moving from long-range to near- and mid-term, so a balance needs to be kept with some fundamental aspects of the materials in the portfolio.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer said yes, the challenges were very well identified.

Reviewer 2:
The reviewer said that the issues/gap analysis as presented is very detailed by covering the various aspects as property requirement and performance enhancement are needed in medium- to long-term.

Reviewer 3:

The reviewer said generally speaking, yes. The propulsion materials presented gaps quantitatively with long term goals for each area. The reviewer noted that the lightweight materials (body) program identified focus areas, but did not set quantitative targets. The reviewer really liked the “When it Works" slide for the various materials. This slide summarized and brought into focus the prior slides, which explained the various considerations of lightweighting on commercial automotive.

Reviewer 4:

The reviewer commented that issues and challenges were mostly identified. The reviewer elaborated by stating that there are more broad societal issues that should be mentioned that set the framework for the technical goals and strategies. The reviewer believed that the issues of energy security and the challenges of light-duty vehicle customer expectations should have more of an airing. These help set policy and strategy.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:

The reviewer commented that the plans for addressing the technical issues were clearly identified.

Reviewer 2:

The reviewer said yes.

Reviewer 3:

The reviewer said yes, extensively. The reviewer commented that the currently funded programs were clearly and logically set up to tackle the stated priorities. For this reviewer, the only improvement might be building a longer term trajectory. For example, there is a shift in the composite area from low-cost carbon fiber (LCCF) funding to integrated computational materials engineering (ICME) and non-destructive evaluation (NDE) projects. According to the reviewer, this was great, but it might be a good idea to show what has been accomplished, what the current plans are intended to accomplish, and what is still to be done at some future time.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:

The reviewer found that the presentations from various researchers have shown the year over year progress very clearly.

Reviewer 2:

The reviewer said yes, progress was clearly benchmarked against the previous year.

Reviewer 3:

The reviewer said that the progress highlights were presented clearly. The efforts were proceeding as expected.

Reviewer 4:

The reviewer said no, and elaborated that the accomplishments of the previous year were clearly presented. However, the reviewer observed that it was not shown how that translates into a trend or curve or measures relative to a benchmark. The reviewer noted that the accomplishments were impressive, and that the program is producing significant results.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer said yes. The reviewer commented that the major barriers industry is facing in the area of lightweighting are being addressed in an interesting mix of targeted technology development, such as LCCF and third-generation AHSS, and broader integrated efforts, such as the multi-material vehicle and magnesium intensive front end.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer commented that the projects address the multi-faceted issues and barriers surrounding lightweight materials and technologies.

Reviewer 4:
The reviewer observed that the energy efficiency of a vehicle is impacted by the weight and the efficiency of the powertrain. These aspects are being investigated by the subprograms on lightweighting and propulsion (internal combustion and electrification); while lightweighting is being supported very well, the support for the propulsion materials is marginally lower. The reviewer commented that lightweighting contributes to the short- and mid-term goals and the powertrain may contribute more towards long-term. The funding should reflect this aspect.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer said yes the program area appeared to be focused, well-managed, and effective in addressing VTO's needs.

Reviewer 2:
The reviewer found that the projects are selected to address the priority areas and are well managed.

Reviewer 3:
The reviewer concluded that the program is properly focused with efforts in many material and process systems, joining, corrosion and the computational tools that enable product and component design.

Reviewer 4:
The reviewer responded yes. The reviewer commented that the efforts are not a multitude of diluted efforts across a wide variety of potential performers, but rather focused, integrated efforts targeted at addressing a particular problem. This ensures sufficient resources are invested to address the problem and make significant progress towards a solution. The reviewer commented that it also allows course corrections in future years to address the new problems that are exposed based on the ongoing efforts.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
The reviewer said that the projects are all good.

Reviewer 2:
The reviewer found key strengths to include integrated efforts across multiple performers to address significant issues (ICME of composites, multi-material vehicles [MMV], ICME of third-generation AHSS).

A key weakness is the project that is modeling weight impacts on crashes is not moving towards success. This reviewer's comments of that project have been submitted.

Reviewer 3:
The reviewer commented that there are few projects that are just evaluating existing materials; the data which are being generated needs to be correlated to metallurgical/manufacturing variables so that the data can be used in future. The reviewer cited lm073 and pm038.

The reviewer noted, on the other hand, projects such as lm054 and lm075 are very relevant to industry and have delivered good results. The new projects on ICME based research are having a good start and need to be watched.

Reviewer 4:
The reviewer detailed as strengths the diversity of the portfolio. This reviewer is particularly interested in the high strength aluminum efforts. The reviewer identified as weaknesses end-of-life recycling, especially for CFCs.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer responded yes.

Reviewer 2:
The reviewer commented that there is a healthy mix of evolutionary and revolutionary efforts to enhance the use of lightweight materials in automotive structures.

Reviewer 3:
The reviewer commented some yes, others no. The reviewer thinks in almost all cases the approach taken is appropriate and justified. The reviewer found that the approaches generally speaking do not have major holes, validate everything, and tackle a problem of significant importance.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer commented that the program has successfully engaged OEMs, suppliers, universities, consultants and national laboratories, and concluded good collaboration.

Reviewer 3:
The reviewer commented that the primary partners appear to be the following: Oak Ridge National Laboratory (ORNL), with focuses on carbon fiber and propulsion simulation; Pacific Northwest National Laboratory (PNNL), with a focus on metals; USCAR/ original equipment manufacturers (OEMs), with focuses on integrated and validation projects; and some material suppliers. The advanced topics, such as breakthrough techniques in multi-material joining, are conducted by universities. The reviewer concluded that for transition purposes, these are all the right organizations. That said, the reviewer suggested it may be appropriate to look at what other technologies are being developed by other government laboratories beyond the U.S. Department of Defense (DOD) laboratories, including the National Aeronautics and Space Administration (NASA) (likely simulation), Forest Services labs (have developed a lightweight nano-fiber from wood), and DOD laboratories. The reviewer suggested that particularly in the area of composites, more coordination might be possible.

Reviewer 4:
The reviewer noted that the partnerships in the program, for both lightweight and propulsion materials, is made of many North America producers and Tier 1 suppliers; the presence of other international OEMs is not evident. The reviewer suggested that even though international OEMs may not be investing in R&D in North America, some efforts may be needed to bring them to the program.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes. The reviewer remarked that these laboratories have the specialized facilities, expertise, and industry relationships that make them natural partners for VTO.

Reviewer 3:
The reviewer said yes, and commented that there appeared to be good support, direction, monitoring, and interactions.

Reviewer 4:
The reviewer noted that while some of the industrial partners are contributing heavily through in-kind participation, the quantum of this is not consistent across all the partners/projects.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer said that the program needed more funding.

Reviewer 2:
The reviewer remarked that some of the barriers to adoption are not technical per se, but rather business and design process driven. The reviewer provided as an example qualifying composites has been cited as a barrier, and there have been numerous efforts across the government to address this issue. Yet, this issue still comes up, and it is not clear to this reviewer how it will be addressed in the automotive space. The reviewer asked is this not an issue for automotive, and if not, why not. If so, the reviewer would like to know what its impact is. The reviewer asked about the supply chain, and if there was adequate supply. The reviewer would like to know if the supply chain model is broken, or is industry able to handle this naturally. Technical gaps that came to mind for this reviewer are adhesives and corrosion. The MMV project should help identify the major issues that would prevent the adoption of some of the technologies that lead to a 30% weight reduction. The reviewer would like to know what areas could benefit the most from focused government investment to develop the technologies that would lead to a 50% lighter vehicle.

Reviewer 3:
The reviewer pointed out that sustainability, lifecycle assessment, and recycling needed to be integrated in the projects as new materials are being introduced. The reviewer noted that few existing projects have some of the issues covered but making it another task item will be useful.

Reviewer 4:
The reviewer commented that gaps include recycling of carbon fiber and many composite materials. The reviewer suggested that DOE can be the referee for more standardized composite material and process systems. Designers are still required to pick a raw material supplier, a sizing system, a resin system and then fabric form and part manufacturing all that influence the structural behavior of the finished part. The reviewer noted that designers need to have robust material properties, like DP600 steel or AA-6062-T4 extrusion whose material performance is rather independent of the supplier(s).

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer responded yes. The projects the reviewer evaluated appeared to address the topics adequately to achieve significant progress. The reviewer acknowledged that these projects will not likely solve all the problems. This is in part because it is often impossible to control for geometry and design architecture. The reviewer commented that further evaluations and projects will be necessary within the commercial community to understand the strengths and limits of the technologies. But, within the priorities and gaps outlined in the program, the topics are being adequately addressed.

Reviewer 2:
The reviewer commented low-cost composite manufacturing.

Reviewer 3:
The reviewer commented that there needs to be more attention to end of life and recycling especially for the composite areas.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer commented that the program is focused on supporting the needs of the existing high volume automotive industry. These companies have significant infrastructure to support and are, for the most part, tied to their particular vehicle architectures. The reviewer commented that smaller companies do not have these restrictions and could utilize alternative vehicle architectures. These new architectures might be superior in electric and fuel cell vehicles. The reviewer remarked that there appears to be no significant investment in exploring non-established vehicle architectures.

Reviewer 2:

The reviewer commented that CFCs need more funding.

Reviewer 3:

This reviewer referenced the response given in Question #2. Some fundamental aspects of materials research need to be supported; this should provide a long-term goal for the program.

Reviewer 4:

The reviewer recommended that there needs to be further efforts on end-of-life and recycling, reuse, reclamation of composites, especially CFCs.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer commented that the current approach is good.

Reviewer 2:

This reviewer will have to think about this more before the reviewer can offer significant suggestions.

Reviewer 3:

The reviewer commented that the program must attack composite and CFC recycling and end-of-life. Additionally, DOE should increase efforts on manufacturing aspects, especially joining and corrosion.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer said that even though the scientific community is aware of past development in the area of their research, the industry/government team may not be aware of them. The reviewer commented that it will be helpful to have some experts provide state of the art/reviews. This can provide context to some of the new research themes. The reviewer provided as an example a presentation on the capability of internal combustion engines as evolved through the years will show the light for work on new high-temperature materials.

Reviewer 2:

The reviewer commented mostly good job here. This reviewer suggested focusing on fewer, larger value projects. Work on including all the aspects of a full vehicle performance, especially noise, vibration, and hardness (NVH) and heating, ventilation, and air conditioning (HVAC) requirements into the vehicle systems that are the subject of lightweight actions.

Reviewer 3:

The reviewer did not offer any suggestions to improve the materials technical area. However, this reviewer did offer a suggestion under the EV Everywhere umbrella. Similar to the way the use of EVs are tied to high-occupancy vehicle (HOV) lanes in California to encourage public purchase of EVs, linking EVs to parking benefits in Washington, DC, or other high density urban areas might have significant impact. The reviewer cited as an example that landlords who install charging stations would get some sort of tax or other financial benefit that would have to be partially shared with the tenant through reduced parking fees for some period of time [DOE Program Note: The reviewer's suggestion has been passed to the EV Everywhere team.].

Project Feedback

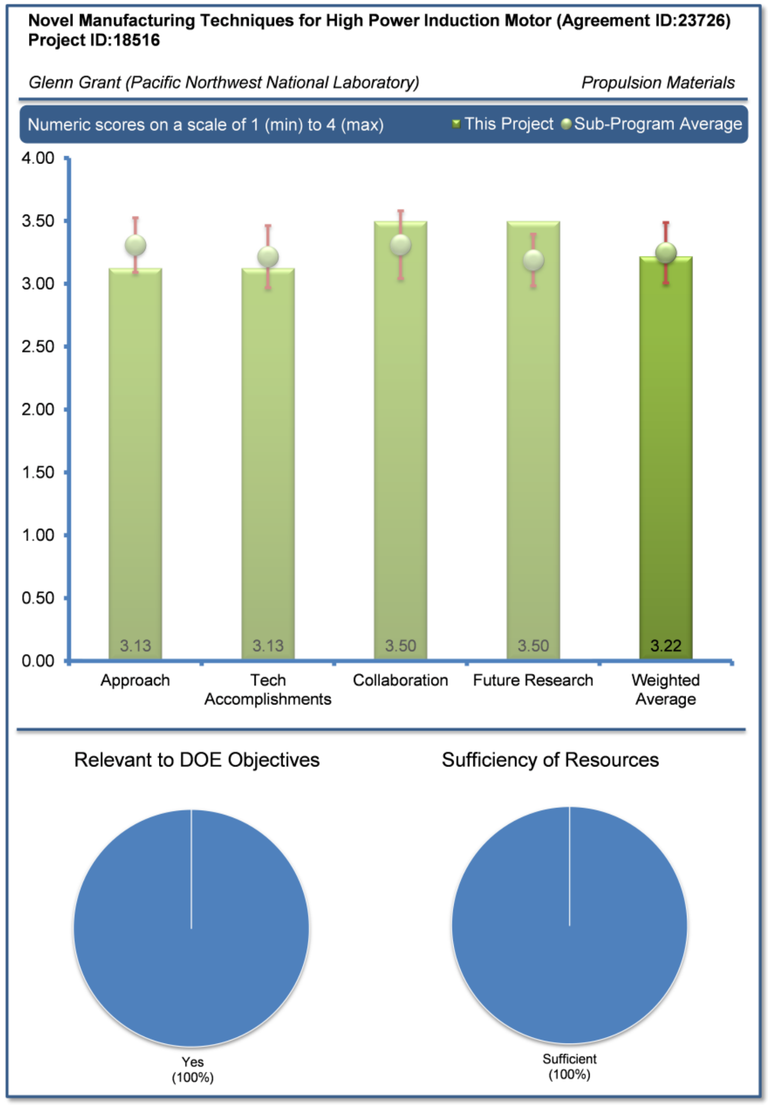
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Novel Manufacturing Techniques for High Power Induction Motor (Agreement ID:23726) Project ID:18516	Glenn Grant (Pacific Northwest National Laboratory)	7-12	3.13	3.13	3.50	3.50	3.22
Materials Issues Associated with EGR Systems (Agreement ID:18571) Project ID:18518	Michael Lance (Oak Ridge National Laboratory)	7-15	3.25	3.25	3.50	3.00	3.25
Durability of Diesel Particulate Filters (Agreement ID:10461) Project ID:18519	Thomas Watkins (Oak Ridge National Laboratory)	7-18	3.30	3.10	3.10	3.20	3.16
Materials for Advanced Turbocharger Designs (Agreement ID:17257) Project ID:18518	Phil Maziasz (Oak Ridge National Laboratory)	7-22	3.13	2.88	3.25	2.88	2.98
† High Temperature Aluminum Alloys (Agreement ID:24034) Project ID:18518	Stan Pitman (Pacific Northwest National Laboratory)	7-25	3.38	3.00	3.38	3.13	3.16
Tailored Materials for Improved Internal Combustion Engines (Agreement ID:23725) Project ID:18518	Glenn Grant (Pacific Northwest National Laboratory)	7-28	3.25	3.25	3.25	3.25	3.25
Catalyst Characterization (Agreement ID:9130) Project ID:18519	Thomas Watkins (Oak Ridge National Laboratory)	7-31	3.30	3.20	3.00	3.13	3.19
Mechanical Reliability of PS Actuators (Agreement ID:13329) Project ID:18518	Hong Wang (Oak Ridge National Laboratory)	7-34	2.70	2.70	3.00	2.75	2.74
Friction Reduction through Surface Modification (Agreement ID:23284) Project ID:18518	Peter Blau (Oak Ridge National Laboratory)	7-37	3.20	3.30	3.00	3.13	3.22
High Temperature Materials for High Efficiency Engines (Agreement ID:26190) Project ID:18518	Govindarajan Muralidharan (Oak Ridge National Laboratory)	7-40	3.20	3.10	2.70	3.20	3.09
Enabling Materials for High Temperature Power Electronics (Agreement ID:26461) Project ID:18516	Andrew Wereszczak (Oak Ridge National Laboratory)	7-44	3.38	3.50	3.63	3.13	3.44
Biofuel Impacts on Aftertreatment Devices (Agreement ID:26463) Project ID:18519	Michael Lance (Oak Ridge National Laboratory)	7-47	3.20	3.40	3.40	3.00	3.30
Characterization of Catalysts Microstructures (Agreement ID:9105) Project ID:18865	Larry Allard (Oak Ridge National Laboratory)	7-51	3.75	3.75	3.38	3.33	3.65
Applied ICME for New Propulsion Materials (Agreement ID:26391) Project ID:18865	David J. Singh (Oak Ridge National Laboratory)	7-54	3.10	2.90	3.10	3.00	2.99
† Alloy Development for High-Performance Cast Crankshafts	John Hryn (Argonne National Laboratory)	7-57	3.50	3.40	3.40	3.50	3.44

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† CATERPILLAR Cast Alloy Development for Heavy Duty Engines: FOA 648 3b	Rich Huff (Caterpillar)	7-61	3.60	3.30	3.80	3.50	3.46
† Ford Motor Company Cast Alloy Development for Automotive Engines: FOA 648-3a	Mei Li (Ford Motor Company)	7-65	3.60	3.40	3.40	3.20	3.43
† General Motors Cast Alloy Development for Automotive Engines: FOA 648-3a	Mike Walker (General Motors LLC)	7-69	3.50	3.30	3.40	3.40	3.38
† ORNL: ICME Evaluations and Cast Alloy Development for Internal Combustion Engines 2012 FOA 648 Topic 3a	Amit Shyam (Oak Ridge National Laboratory)	7-73	3.38	2.88	3.38	3.13	3.09
† Lightweight Heavy Duty Engines (Agreement ID:23425) Project ID:18518	Govindarajan Muralidharan (Oak Ridge National Laboratory)	7-76	3.33	3.33	3.17	3.50	3.33
† International Energy Agency (IEA IA-AMT) Characterization Me (Agreement ID:26462) Project ID:18519	Hsin Wang (Oak Ridge National Laboratory)	7-79	3.33	3.50	3.83	3.17	3.46
Overall Average			**3.31**	**3.22**	**3.31**	**3.19**	**3.25**

† denotes poster presentations.

Novel Manufacturing Techniques for High Power Induction Motor (Agreement ID: 23726) Project ID: 18516: Glenn Grant (Pacific Northwest National Laboratory) - pm004



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the project team had a creative approach to weld near edges with stationary shoulder tool. The reviewer added that the project is adjusting the exit hole approach to use other tip shapes.

Reviewer 2:

The reviewer acknowledged that the objectives are both well described and quantified. The project team's technical approach to reducing motor weight is through the application of friction stir welding (FSW) in the manufacturing process. The reviewer suggested that because the objectives are heavily focused on cost reduction, it would be good to describe in more detail the cost benefits of this approach compared to the current manufacturing process. Because the project team mentioned that casting is a possible approach but defects would not be predictable, the reviewer asked what defects are unpredictable. The reviewer queried whether overcasting the end caps would be a feasible alternative, and if a greater contact area could be achieved.

Reviewer 3:

The reviewer stated that the project is aimed at developing a process to join copper (Cu) end plates for motors and that the solid state joining process for doing this has been chosen. Even though this joining process has its advantages, the reviewer opined that the casting route needs to be explored further. The reviewer added that there are cast Cu rotors in production and encouraged the team to look into some other techniques and evaluate their efficiency, at least from literature review.

Reviewer 4:

The reviewer remarked that the focus of the project appeared to be in a key area of the development needed for induction motors to overcome barriers, and that the project is trying to overcome the disadvantages of current brazed and die cast rotor manufacturing processes by developing a solid state welding process. The reviewer added that the approach overall seems relatively straightforward, although the project delays may have exposed some issues, which indicate that the schedule contingencies may not have been adequately planned for.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that project team's problems were dealt with effectively, such as joining defects. The reviewer noted that the quality and conductivity issues have been addressed for similar metal joining, but suggested that the dissimilar metal joints need to be further evaluated.

Reviewer 2:

The reviewer stated that FSW of Cu has been used for Cu end plates and short bars, and that the project team's technical barriers have been successfully passed. The reviewer added that enough work has been completed and suggested that some preliminary cost estimates should be possible to estimate potential benefits.

Reviewer 3:

The reviewer acknowledged that the end cap weld appears to be a good approach to solve the problem, and that the solution to address temperature boundary control is innovative. The reviewer asked if there were other applications for the stationary shoulder. The reviewer added that the application of the project's technology can apply to other metals and products. The reviewer explained that issues still exist for solving exit holes and was unsure if it will be solved under this project. However, the reviewer noted that the exit ramp approach, although more expensive, can work.

Reviewer 4:

The reviewer commented that project team identified several challenges along the way, which impacted the project schedule. Tool selection, heat, and closing the exit hole were particular problems. The reviewer stated that the project appears to have now developed tool/process combinations that are delivering good welds, including several specialized tools. To address heat issues, the project developed a control algorithm based upon temperature and power requirements. The reviewer noted that the project also appears to have developed one method to address exit holes, though it is still struggling to develop a second method. The reviewer concluded that overall, the project team was finding some solutions, but addressing these challenge issues has impacted the project schedule.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer remarked that the project team had excellent collaboration with a Cooperative Research and Development Agreement (CRADA) developed for commercialization of the product, a strong purpose, and the right partners.

Reviewer 2:

The reviewer commented that one OEM who is willing to take the process to commercial production is more than enough for the success of this project.

Reviewer 3:

The reviewer stated that project involves a CRADA with General Motors (GM) who was clearly involved in key aspects of the project and who has weekly calls and meetings with PNNL. The reviewer also pointed out that from what was presented, GM appears committed to the project and is positioned to take the project results and implement them in commercial EV motors.

Reviewer 4:

The reviewer noted there is 50/50 cost share with GM and that target adopters are based on current GM motor platforms.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer pointed out that the exit from the weld has been proven via the exit ramp approach. However, if a solution is proven for the exit hole via plug welds with taper plugs, a significant production cost savings can be achieved.

Reviewer 2:

The reviewer indicated that the project is nearly done right now, but there may be some applications for tools and processes to be developed in aluminum (Al) part manufacturing and that implementation would be under other projects. The reviewer noted that it appears the project has developed one solution for the exit hole issue, but is trying to succeed with a second solution, which is delaying completion of a milestone. The reviewer added that at some point, the project team will need to decide if one solution is sufficient because the Principal Investigator (PI) seems to think the project is close to succeeding with the second approach. The solution is based upon a commercial process for aluminum and steel, and has potential to be a cheaper process. The reviewer concluded that the project still needs to develop a cost analysis of the final processes selected.

Reviewer 3:

The reviewer remarked that the time for the evaluation of dissimilar joining process may not be enough if the project is planned to be closed by September 2014.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the project is relevant to VTO objectives where it is focused on reducing the cost of induction motors which do not have the materials issues of permanent magnet motors and may be a key component for cost-effective EVs.

Reviewer 2:

The reviewer pointed out that electrification is one of the ways to reduce the fuel consumption in vehicles. This person added that the electric motor is an integral part of the electrification, and ways to reduce the cost and increase the efficiency of motors will improve the probability of electrification.

Reviewer 3:

The reviewer reported that electric motors are becoming an increasing part of light-duty (LD) vehicles and that reducing the weight of the critical systems is important in achieving DOE goals.

Reviewer 4:

The reviewer commented that light and more efficient motors result in increased petroleum displacement.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked that the resources appear sufficient and the project is nearly complete.

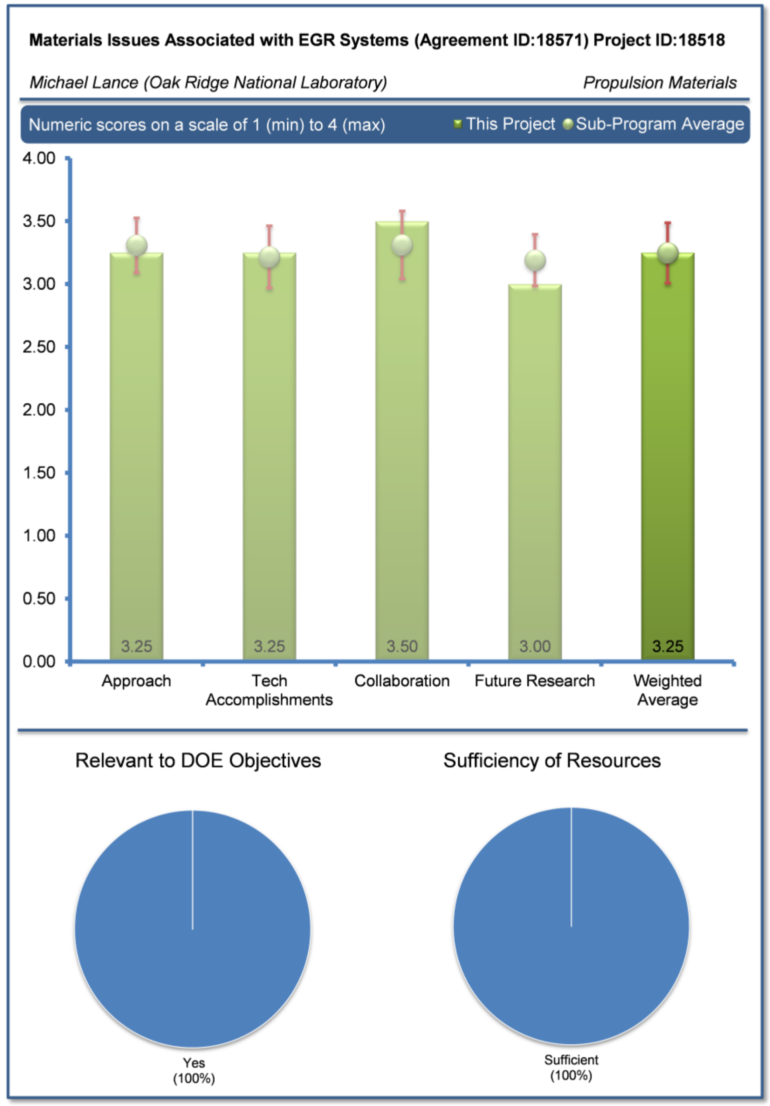
Reviewer 2:

The reviewer reported that the right amounts of Federal and industry resources were applied to this issue.

Reviewer 3:

The reviewer commented that significant work with technical challenges still remains and FSW exit appears to be most critical. The reviewer questioned if current proposed solutions are cost-effective when remaining funding is claimed to be sufficient. The presenter indicated the project end date needed to be extended, but it was not clear what the new proposed project schedule was.

Materials Issues Associated with EGR Systems (Agreement ID:18571) Project ID:18518: Michael Lance (Oak Ridge National Laboratory) - pm009



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the approach of the project to develop experimental equipment for deposit formation and aging, obtain exhaust gas recirculation (EGR) coolers from industry, and to investigate active and passive controls was very good.

Reviewer 2:

The reviewer noted that the project team's approach seemed valuable for identifying the cause of EGR fouling. The team's suggestion to characterize the dew point is promising for improving the operation and identifying regeneration strategies.

Reviewer 3:

The reviewer commented that it was good that the project team's investigations started by listening to the field, but the selection of tools for research seemed a bit like trial-and-error, and stated that perhaps for such a very new problem, there was no other possible approach.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer remarked that technical accomplishments of using industry-provided coolers to determine the origin of plugging and lacquer-like deposits was excellent. In addition, information from the project has been put into the public domain through the publication of two Society of Automotive Engineers (SAE) papers in 2014.

Reviewer 2:

The reviewer pointed out that the technical accomplishment using neutron scattering seemed useful and that having a wide variety of fouled devices may improve the identification of buildup mechanisms as they interact with the geometry.

Reviewer 3:

The reviewer noted that most of the work focused on characterizing materials in fouled EGR systems, where there was little discussion on proposed material solutions that would reduce the EGR fouling. The reviewer questioned if other material could not be identified for side-by-side testing, which could have already started.

Reviewer 4:

The reviewer stated that the following two important mechanisms have been identified for EGRcooler fouling: very fluffy soot cake that contains much air and therefore has very high insulation value and, consequently, poor heat transfer; and the more dense lacquer deposits that do not block heat transfer but can result in clogged channels and, therefore, more pressure drop over the EGRcooler. The project team's explanation of the lacquer effect suggested that the nitrogen oxides (NO_x) level was also a factor, which would be beneficial if it was a relevant factor for typical NO_x levels seen in engines, or that the levels are anyhow enough to deliver the acid needed for the lacquer formation. The reviewer opined that it was a pity that the test with the neutron technique did not give the expected answers, and questioned if it was possible to give some guidance to when this new technology can or cannot be used.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer remarked that the project's collaboration was excellent because the work was coordinated with the entire diesel engine community.

Reviewer 2:

The reviewer explained that the project team indicated good collaboration because the project team obtained fouled devices and had ongoing discussions with the project partners.

Reviewer 3:

The reviewer stated that the collaboration was with all diesel engine manufacturers.

Reviewer 4:

The reviewer commented that OEMs were well incorporated in the investigation, but questioned why the supplier, Modine, was not mentioned anymore as it was in 2013, even though their logo was on one of the final sheets. The reviewer suggested that perhaps the optimal tools for this research could have been determined earlier if there was collaboration with another institute or university.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the project team proposed future work to better understand refreshment strategies, to characterize late-stage deposits, and to continue to address barriers.

Reviewer 2:

The reviewer explained that the project team's use of computational fluid dynamics (CFD) on deposit formation seemed difficult without a mechanism to distinguish the root cause of buildup.

Reviewer 3:

The reviewer acknowledged the contributing factors have been identified. Further, lube oil was not a contributor, but low exhaust gas temperature and unburned hydrocarbon (HC) coming out of the engine have influence. Up to this point in the project, no practical value for the amount of unburned HC, soot, or the ratio between them was provided, and perhaps knowing this value as function of exhaust gas temperature would avoid serious problems. The reviewer suggested the project team should continue to study cleaning mechanisms in order to provide the guidelines on how to avoid these kinds of problems.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that the project's objective to mitigate EGR fouling was relevant to DOE's objectives of petroleum displacement, and that his work will reduce the impact of EGR cooler fouling on efficiency and emissions. The project will address the barrier of improved efficiency in advanced combustion engines that require EGR to operate over a wider range of speeds and loads.

Reviewer 2:
The reviewer explained that EGR helps to reduce NO_x emissions, and without it, the fuel consumption would have gone up considerably. Therefore, all EGR problems have to be resolved in order that this technology remains a stable and efficient NO_x reduction measure.

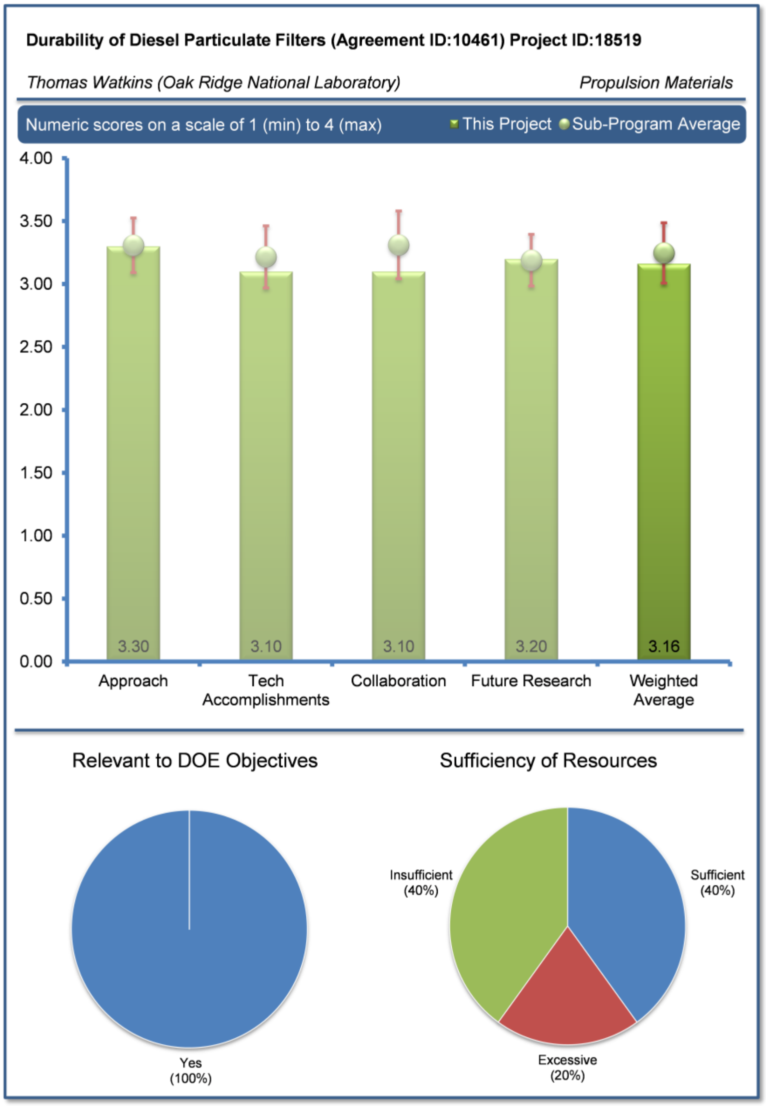
Reviewer 3:
The reviewer expressed that the project attempts to address the fuel efficiency penalty from EGR emission systems, but was not entirely clear what its impact was on fuel efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer mentioned that project had a little more than two years before completion, which was about 25% of the project. Because approximately 30% of the funding remained, the resources should be sufficient to complete the project.

Reviewer 2:
The reviewer stated that more expensive testing will be needed to investigate the relation between EGR cooler fouling and various drive cycles.

Durability of Diesel Particulate Filters (Agreement ID:10461) Project ID:18519: Thomas Watkins (Oak Ridge National Laboratory) - pm010



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated that the project team had an excellent approach, with Cummins providing the materials and performing the in-house testing, ORNL performing mechanical testing and microstructural analysis, and then the team providing these results to the diesel community for model development.

Reviewer 2:

The reviewer noted that the project's work was important to characterize failure mechanisms associated with in-use mechanical and thermal stresses. However, much of the work appeared routine and may not fit the charter of the national laboratories, and therefore, much should be done at the supplier level.

Reviewer 3:

The reviewer noted that the research team effectively implemented the mechanical test procedures to identify properties of an assorted set of filter materials. The project team tackled non-linear (cycle-dependent) properties in the materials and modeled thermal conditions that can help predict stress zones.

Reviewer 4:

The reviewer commented that the project team's approach of characterizing candidate materials was a usual approach in determining the performance of devices such as the diesel particulate filter (DPF) to various road conditions as experienced in diesel engine vehicles. The durability requirements are affected by whether the vehicle is classified as HD or LD. The reviewer noted that for cost reasons, placing a DPF material rated for HD 425,000 miles into a LDV requiring only approximately 100,000-mile durability did not make sense.

Reviewer 5:

The reviewer explained that the project did focus on material property characterization, but the duration seemed too long. The reviewer questioned why DPF manufacturers are not providing funding to accelerate this testing in order to better understand their products.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer mentioned that the project team's technical accomplishments have been good and have helped address the barriers. The measurement of elastic modulus was important because it affects the lifetime prediction of diesel particulate filters. The reviewer noted that if data has indicated that failure is controlled by strain, then aluminum titanate may be considered a good material for higher-performance DPF substrates.

Reviewer 2:
The reviewer expressed that this very long project had grown because of the large number of materials analyzed, including multiple materials, but had led to a material selection and therefore had met the objectives.

Reviewer 3:
The reviewer commented that the project team's progress on technical accomplishments was good, but questioned if the characterizing of porous materials truly represents the actual material or is it dominated by the pore size and distribution. In addition, if the data generated for porous materials does represent inherent material properties, the reviewer questioned how it will be affected when other material properties are measured, and suggested that some indication of the statistical reproducibility of the data should be provided.

Reviewer 4:
The reviewer explained that the failure mode modeling advances derived from this work will help the aftertreatment industry better understand the usage issues and the appropriate placement and use of these substrates. However, the project would have benefited from the inclusion of a supplier partner in the project to perform some of the more routine tasks and analyses. The reviewer indicated that there was only minor interaction cited with Corning.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that Cummins and ORNL were working very well together, not only in supplying materials but in carrying out burner tests and modelling.

Reviewer 2:
The reviewer concluded that the project team's coordination and collaboration with other institutions appeared to be more than adequate because Cummins is recognized as a world leader in diesel engine technology. However, the reviewer suggested that some indication of inclusion and collaboration with materials providers should be addressed, because Cummins would not likely supply the actual materials in its production DPFs being made for its engines.

Reviewer 3:
The reviewer stated that Cummins provided information to the diesel community so that it could be used to update their respective models, but there did not seem to be a great deal of collaboration with other diesel engine manufacturers.

Reviewer 4:
The reviewer acknowledged that the project team had a 50/50 CRADA with Cummins, but questioned why no DPF manufacturers were key partners, and should they not be providing funding to test and characterize their products, or if they were already doing that but considering it as internal intellectual property (IP).

Reviewer 5:
The reviewer commented that the use of substrate suppliers would have been useful for some of the project tasks and the team's insight.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
This reviewer explained that planning for future work in this project recognized that determining one property of a porous material constituted the first step to characterizing the full database of materials properties needed for the DPF models, and suggested that more detail should be provided to enable an evaluation of which properties should be prioritized.

Reviewer 2:
The reviewer emphasized that the project was a long-duration project that had achieved most of its objectives. However, new materials were needed to be characterized as potential alternatives to traditional cordierite or silicon carbide (SiC) substrates.

Reviewer 3:
The reviewer acknowledged the project team’s focus on new zeolite materials which may lead to some improvements in the product technology.

Reviewer 4:
The reviewer noted that future work to continue investigating mechanical properties of zeolite-based substrates, and the initiation of new testing methodologies for evaluating highly porous materials, will help overcome the barriers.

Reviewer 5:
The reviewer explained that the project team would like to include the testing of zeolite material as well, and noted that including more materials in the system is valuable.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that this project, by developing optimized regeneration strategies for DPFs, will increase the acceptance of clean diesel engines, resulting in reduction of petroleum consumption.

Reviewer 2:
The reviewer commented that DOE objectives are also environmental safety considerations, where diesel filtering and catalysis were critical to health and efficiency issues.

Reviewer 3:
The reviewer expressed that the project results were relevant but new information was limited for most of the materials.

Reviewer 4:
The reviewer commented that lowering the quantity of fuel required to chemically reducing the particulate and NO_x loading on DPFs, supports the overall DOE objective of petroleum displacement. The reviewer agreed that there were clean diesels actually capable of meeting emissions levels comparable, or even superior, to gasoline-powered vehicles, and that they would enable a 25-40% reduction in U.S. LD vehicle fuel consumption. Currently, clean diesel vehicles appear to have lower particulate emission levels than comparable gasoline vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that compared to the vast potential fuel economy benefits of transitioning a large percentage of LD vehicle fleets in the United States to clean diesel technology, the resources being expended for this project were miniscule. One only needed to look at the diesel vehicle penetration in Europe to understand the large fuel economy benefits such a transition would bring to the United States.

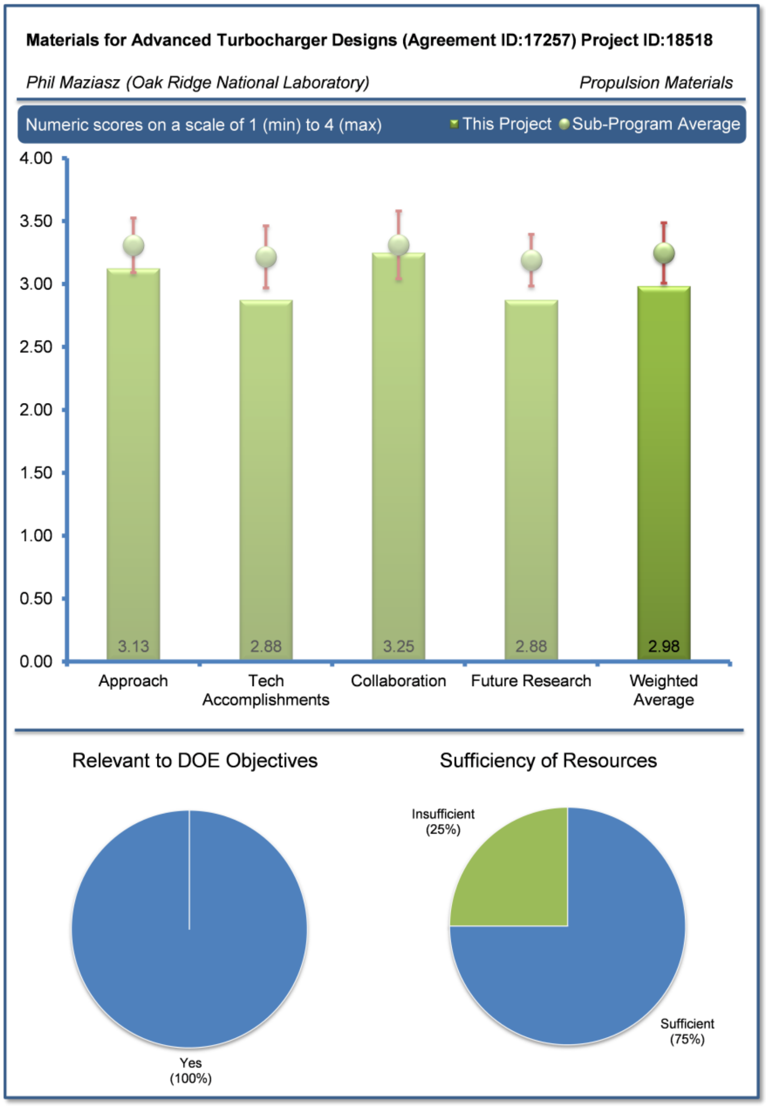
Reviewer 2:

The reviewer commented that the project's resources were sufficient for completion in 2015.

Reviewer 3:

The reviewer pointed out that the project was lengthy and heavily funded, and considering the type of work being performed, it appeared to be somewhat over-funded.

Materials for Advanced Turbocharger Designs (Agreement ID:17257) Project ID:18518: Phil Maziasz (Oak Ridge National Laboratory) - pm038



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the project was following the Honeywell turbo materials approach, and was well defined to assess materials for turbocharger material qualification.

Reviewer 2:

The reviewer pointed out that the project was evaluating one steel alloy, CF8C-Plus, for high-temperature performance including creep, fatigue and oxidation. The experiments were well designed to address the understanding of these behaviors necessary for the use of this material.

Reviewer 3:

The reviewer stated that the project had a reasonable goal to demonstrate the increased capability for a material to meet the higher-temperature properties and performance needed for turbocharger applications. However, it appeared that the approach was simply to evaluate an alloy developed ten years prior using routine testing and characterization activities.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that project team's results for routine tests were showing good results in the target performance region for higher-temperature turbocharger applications.

Reviewer 2:

The reviewer reported that the project team's progress was acceptable based on funding received, but the gap in funding delayed accomplishments.

Reviewer 3:

The reviewer remarked that the project did not receive funding during the fiscal year, but some progress had been reported on the testing. Even though the testing had been done to prove the superior performance of the alloy, the microstructure and metallurgical base for the improved performance was not presented. The reviewer suggested that the study of the metallurgical factors may help to fine tune the alloy for future uses.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer pointed out that the project having a CRADA with industry, or Honeywell, improved the potential for turbocharger material commercialization.

Reviewer 2:
The reviewer noted that the project team had a 50/50 CRADA with Honeywell.

Reviewer 3:
The reviewer commented that one end-user was part of the project and that commercialization was already underway. However, efforts to bring on a manufacturer were being hampered by the non-availability of foundries.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated that completing the Honeywell test procedures would enable the use of CF8C-Plus material for more dynamic applications, such as turbochargers. Industry interest from Ford and Caterpillar, for Solar Turbines, will improve the likelihood for commercialization.

Reviewer 2:
The reviewer mentioned that future work primarily focused on CF8C-Plus, and questioned if there were any alternative Plan B to look at other materials, and also if CF8C-Plus can be further optimized for higher-temperature applications.

Reviewer 3:
The reviewer indicated that more testing of material was being proposed by the project team, but because the end-user is benefiting from the qualification of CF8C-Plus, their contribution to the project should be greater.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that increasing the operating temperature of the engines will improve fuel efficiency, but materials with improved performance would be needed.

Reviewer 2:
The reviewer pointed out that higher operating temperatures will enable more efficient engines.

Reviewer 3:
The reviewer commented that turbocharger temperatures would need to increase for use on higher-efficiency engines, where efficiency targets are clearly defined to increase by 20% over the 2009 baseline efficiency.

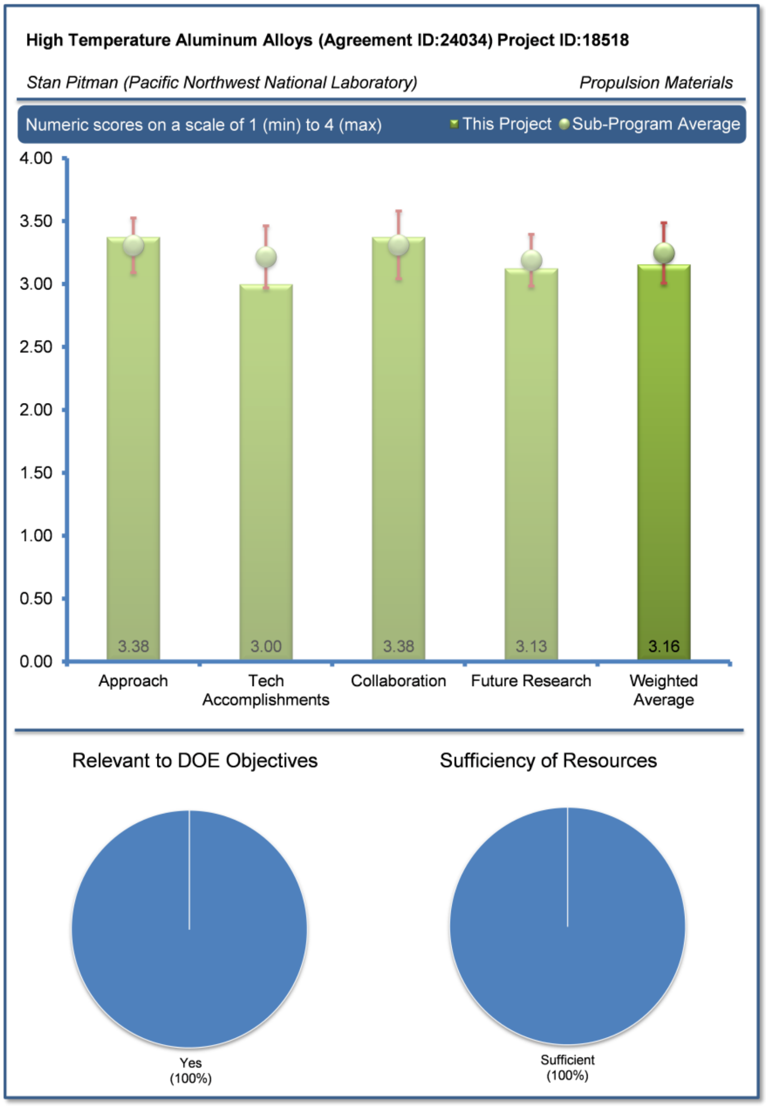
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer observed that the funding decrease had impacted the completion date of the project, where increased funding would allow proper testing to be completed and the project to get back on track.

Reviewer 2:

The reviewer pointed out that project's total program budget was not specified. The project team mentioned funding cuts, but details were not specified, and the impact on program changes was also not described. Remaining testing, such as thermo-mechanical, were likely to be more expensive and time-consuming than the completed thermo-physical testing work. The reviewer emphasized that the program schedule needed to be extended for two more years, but questioned if this schedule could be accelerated when material is readily available from potential production foundries.

High Temperature Aluminum Alloys (Agreement ID:24034) Project ID:18518: Stan Pitman (Pacific Northwest National Laboratory) - pm044



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that the project team's approach was logical for determining the potential for this project's rapid solidification method in creating high-strength, high-temperature aluminum alloys, and the critical aspects of cost and performance were addressed.

Reviewer 2:

The reviewer acknowledged that the project team's approach appeared logical and thorough, in that it called for evaluation of candidate formulations, production of candidate materials, and testing to determine properties. Once evaluated, one candidate will be selected for scaled-up production processes and a demonstration. The reviewer observed that a critical initial performance measure might have been set higher than was actually needed. The industry partner, Cummins, determined that tensile strength of 250 mega Pascals (MPa) was sufficient for the project team's needs, which was different than the project's initial objective of 300 MPa.

Reviewer 3:

The reviewer remarked that project team's approach to develop low-cost alloys was innovative and applicable to the targeted application of aluminum alloy based propulsion system components.

Reviewer 4:

The reviewer explained that the project team's approach was to use two methods that have solidification rates that differ by several orders of magnitude in both extremes, and suggested that a method that could provide a value in between could possibly have added more understanding to the project and helped to create a theory and models that were in combination with the material quality.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the project team had a process which was determined to produce better properties than the current material and that it could be used in mass production of product. Although the project did not meet the original targets completely, the results were attractive to the OEM.

Reviewer 2:
The reviewer explained that the team had worked to overcome problems associated with the consolidation of the aluminum flake, in order to continue exploring the properties of this alloy. It was important that the properties of the material at higher temperatures were still attractive to the industry, and Cummins, despite missing the 300 MPa target. The reviewer concluded that the project's work on this material with DOE funding could result in commercialization of the alloy.

Reviewer 3:
The reviewer stated that the project, overall, had made some interesting progress, in that it developed multiple candidate formulations and, ultimately, down-selected the one with the greatest promise for future scaled-up activities. There had been delays in the project, particularly involving a subcontractor, which extended the project past the original completion date. At this time, the reviewer was unclear as to when all the work would be completed, even though the cause of the delay was resolved. In addition, the reviewer opined that the project, at times, had a bit of good-news or bad-news elements. For example, several materials appeared to demonstrate such high-temperature strength that they exceeded the limits of the extrusion equipment, and thus, could not be extruded. The reviewer mentioned that this issue was resolved, and the mechanical testing was put back on track.

Reviewer 4:
The reviewer indicated that the mechanical properties of the alloy had not yet been verified, for the material supply delay may indicate difficulty of producing sufficient supply of material for commercial production.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the project team had good collaboration, which included co-funding from Cummins and feedback on the usability of the resulting alloys. The inclusion of Transmet was also important because their experience in flake metal processing was directly applicable for this project. The reviewer added that, given the issues with the consolidation of the flake into extrusion billets, the input of Kaiser Aluminum was also valuable, and their input on how to use the flake in developing commercial alloy products, as described in the poster, was also useful.

Reviewer 2:
The reviewer commented that the project is working closely with Cummins under a CRADA. Cummins seemed to have been involved where needed, and had even indicated that the original objective, a tensile strength of 300 MPa, was actually higher than they required. The reviewer added that, ultimately, Cummins would be expected to move forward with using the material in its engines.

Reviewer 3:
The reviewer noted that the project team had a CRADA with Cummins and that the suppliers were in place. However, there was a delay in flake supply delivery.

Reviewer 4:
The reviewer noted that an OEM, an extrusion company, and melt spinning company were involved in the project. The reviewer said perhaps in a follow-up project addition of another research institute or university could be considered to build up the project theory.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer indicated that the project was almost finished with some outstanding tasks still remaining.

Reviewer 2:
The reviewer explained that proposed future work was not applicable, per se, because the project was slated for completion in May 2014.

Reviewer 3:

The reviewer stated that the project was nearing completion, and that material supply issues should be assessed.

Reviewer 4:

The reviewer expressed that the project was supposed to be nearly complete, but it appears that there are a number of tasks still required to be completed due to the delays of the subcontractor. Efforts appeared to be back on track, but it was unclear when the tasks would be completed. The reviewer explained that the remaining tasks, however, were important to the success of the project, as they involve the scaled-up activities for the selected candidate material, which appeared to also be in the phase of the project where greater involvement of the CRADA partner would take place. The PI indicated that Kaiser Aluminum was also involved, but indicated upon questioning that their role was primarily to observe the results of the project and to move forward if the project was successful. Kaiser Aluminum, however, did not actually appear to be involved in the project at all.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that the project involved the study of a lightweight material that could withstand higher temperatures and help to reduce the weight of internal combustion engines, and thus reduce fuel consumption by allowing more payload on HD vehicles and less empty weight for LD vehicles.

Reviewer 2:

The reviewer stated that lighter engine components lead to higher efficiency.

Reviewer 3:

The reviewer commented that the project was focused on improved lighter materials, which resulted in fuel efficiency improvements. In general, the PI indicated that the project's results might be most applicable to specialty applications, and not high-volume applications. The reviewer concluded that the results would be most useful for HD trucks and in military sectors.

Reviewer 4:

The reviewer expressed that the relevance of this project was generally good, in that it could provide lighter-weight HD engines and enable high-strength at higher temperatures, which would improve efficiency. The PI stated that a “diesel engine component” had been selected, but no details were provided, likely to protect proprietary information. The reviewer expressed that it was difficult to judge the relevance in more specific detail.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer acknowledged that the resources appeared to be sufficient.

Reviewer 2:

The reviewer explained that with the cost share from the industrial partner, the funding appeared to be sufficient to complete the outlined work.

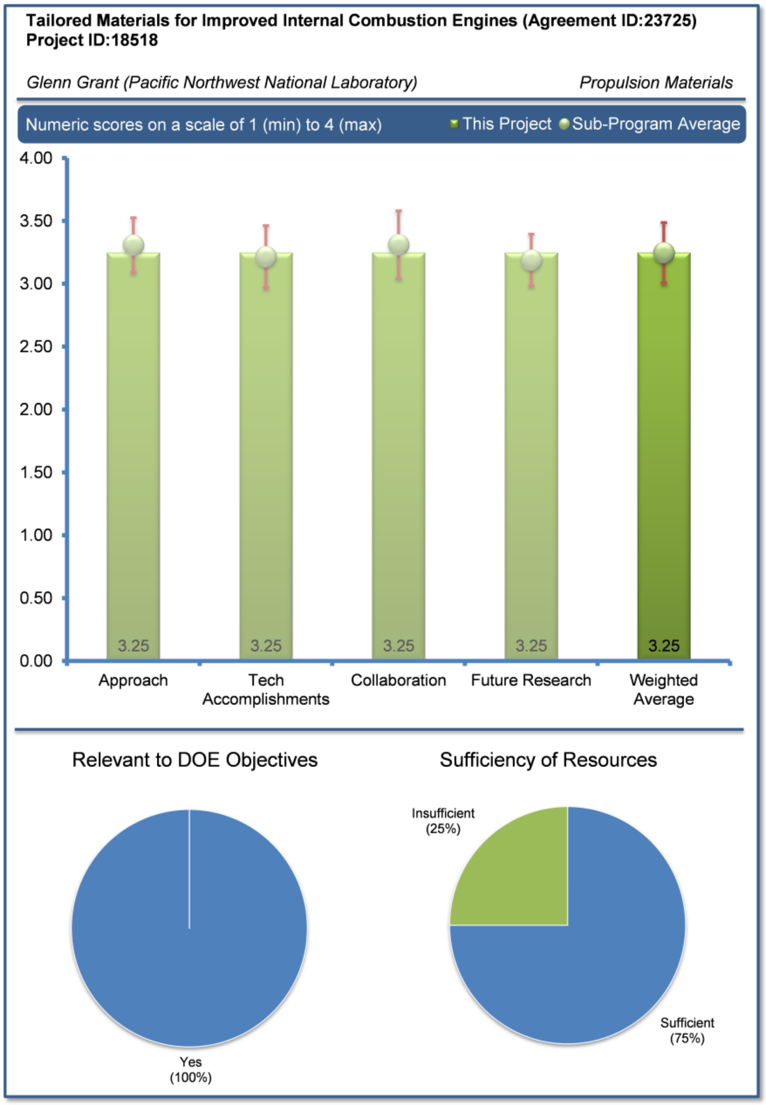
Reviewer 3:

The reviewer indicated that the resources appeared to be adequate.

Reviewer 4:

The reviewer remarked that more resources do not automatically result in better results.

Tailored Materials for Improved Internal Combustion Engines (Agreement ID:23725) Project ID:18518: Glenn Grant (Pacific Northwest National Laboratory) - pm048



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the project approach was very good as to understanding benefits of friction stir welding (FSW) on different engine materials and components.

Reviewer 2:

The reviewer suggested that it was a good idea to look at lower-cost alternatives to improve surface properties for advanced engines, instead of adopting more expensive materials, since cost would likely be a consideration for these new engines and any research to reduce costs would be helpful. Friction stir processing (FSP) had been successfully demonstrated and showed promise for increasing strength at room temperature. The reviewer explained that the approach to start with simple shapes to verify properties at high temperatures, and then moving to more complex real-part geometries, had merit. The reviewer added that it was important that the project team was thinking already about where to apply these surface treatments and how to accomplish this in volume production. The fatigue testing plan was comprehensive and covered the permutations of FSP and no FSP for fine and coarse microstructure cases.

Reviewer 3:

The reviewer commented that the project appeared to be well designed because it had a heuristic approach to improving material properties of vehicle engine components, and noted that a continuing problem with this kind of work was the lack of any baseline cost data. This reviewer understands the approach of seeking to modify the surface of engine components fabricated via casting so as to avoid higher-cost processing steps, but suggested that some data for improvement needed to be presented as soon as possible on actual test engine components with at least some indication as to the cost increment due to the FSW process.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer explained that the project results on higher-temperature testing looked very good, and that the team had identified the best material properties, coarse grain microstructure, to address strength and fatigue life issues. The team was addressing the issue of creep as an important issue at these temperatures, partly in response to previous Annual Merit Review (AMR) reviewer comments. The reviewer commented that the team would need to catch up somewhat on the cast crankshaft work.

Reviewer 2:

The reviewer stated that the project's accomplishments to date showed very promising results, especially on flat aluminum plates, but questioned if the progress will carry over to complex geometries with a stress distribution from complex loading. The reviewer opined that the project team should provide more on the processing costs, with at least some estimates for the targeted first adopters, and comparisons with the current material and process value stream. The reviewer observed that performance improvements could be made and could be significant, but was not clear if there would be a cost penalty. In the last year of the project, some cost modeling should be carried out. The reviewer suggested that some type of cost estimating should have been considered early in proposal and process selection.

Reviewer 3:

The reviewer remarked that the project's technical accomplishments were mostly on schedule but the most difficult tasks were yet to be done, for example, fatigue, creep and actual engine component testing. One item not explicitly addressed was the lack of concern for the depth of the FSW microstructure modification. The reviewer questioned if it was important to know how deep the surface microstructure needed to be in order for the improved performance in engine components to be realized in actual engine operation.

Reviewer 4:

The reviewer explained that application of the project's process on geometry other than coupons may prove to be difficult, and added that additional process variation due to the interface between processed and unprocessed areas may be of use.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the project team had had good collaboration with university and LD vehicle OEM partners, with fundamental work at the university and more practical commercial work at GM. The team was working together to prioritize the most important work first, which was to adjust milestones to address partner focus areas including oil holes.

Reviewer 2:

The reviewer noted that the project team was working closely with GM, who was providing 50/50 cost share and had provided full component samples.

Reviewer 3:

The reviewer stated that the project team's collaboration was satisfactory in that it had a national laboratory, a university, and an engine manufacturer, but noted that some additional benefit might be gained if a material supplier were involved to provide insight to potential material alloying components, which may greatly enhance the FSW improved baseline material.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the project team's future work plan was good, and noted that it would be more complex, time- consuming, and expensive than the current work to date on flat plates. The reviewer questioned if there were any technical hurdles anticipated in attempting the project's process on complex shapes and difficult-to-reach areas, and explained that crankshafts have high-stress regions that could be difficult to reach with FSP tooling.

Reviewer 2:

The reviewer stated that project team's proposed future work was a logical extension of the ongoing work, although its heuristic nature did not appear to add much to the overall theoretical understanding of the FSW process. The reviewer suggested that some small consideration of the thermodynamics and kinetics of alloy formation under FSW conditions could be included.

Reviewer 3:

The reviewer observed that there was quite a bit of work yet to be done despite the project nearing its completion at the end of the calendar year or fiscal year. The creep and fatigue test at 250°C should be very informative. The reviewer applauded the team's work on the feasibility of applying the project's process to more complex part shapes in order to address manufacturing issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer expressed that even though the project's work did support the overall DOE objective of petroleum displacement through potential engine efficiency improvement, it was more likely a cost reduction objective, a main driver of the industry partner.

Reviewer 2:

The reviewer explained that the project activity is relevant to DOE objectives of increasing efficiency through advanced combustion regimes because its method offers potential for lowering cost of these engines while maintaining the necessary material properties for reliability and durability. FSP did appear to be ideally suited to selectively improve material properties and thus would be needed in this application.

Reviewer 3:

The reviewer observed that the project team was focused on improved material properties to reduce component weight, and on improved engine performance, specifically, to study new, higher-efficiency combustion approaches using higher cylinder pressures which will put higher loads on the crankshaft. The team's project addressed improving the structural load capacity of the cylinder head and crankshaft.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the project's resources appeared to be sufficient for the work to be performed, and noted that the project included an in-kind contribution of 50% from GM.

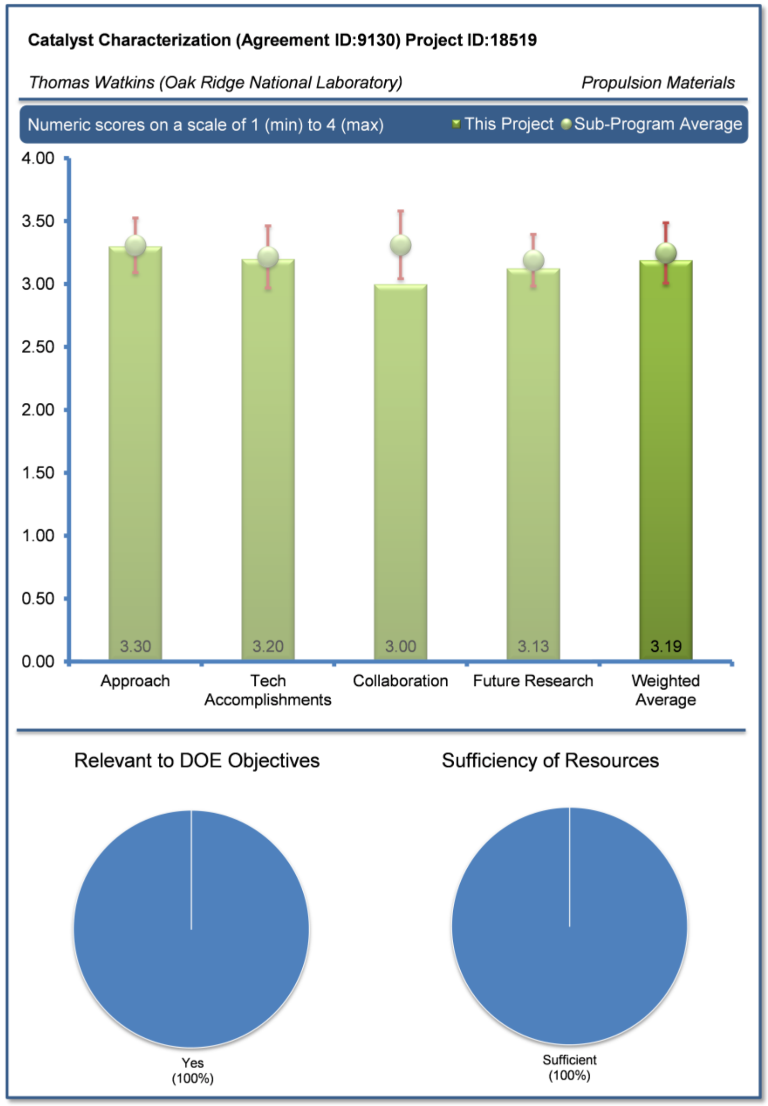
Reviewer 2:

The reviewer observed that the project spending appeared to be about 80% of budget. Most of the testing to date had been on flat plate coupons, where processing and testing would be much more expensive at the component level.

Reviewer 3:

The reviewer remarked that the resources for the project appeared to be sufficient to achieve the stated milestones in a timely fashion. There did not seem to be a strong timeline driver for the project's work to be completed; for example, there did not seem to be a rush to introduce the technology into actual engine components.

Catalyst Characterization (Agreement ID:9130) Project ID:18519: Thomas Watkins (Oak Ridge National Laboratory) - pm049



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that investigators employed a very good approach that incorporated hydrothermal aging, which is a permanent effect. The reviewer said that it would be interesting to understand the transitory effects of sulfur poisoning. The reviewer added that the project had a good and novel use of spectroscopic tools used to characterize the reaction chemistry.

Reviewer 2:

The reviewer explained that the project's approach, with Cummins identifying critical studies needed, and providing samples to ORNL for their advanced characterization in order to understand performance and degradation mechanisms, has worked well.

Reviewer 3:

The reviewer stated that the project's approach to performing the work contributed to overcoming most barriers, given the required assumption of material homogeneity, which generally was not the case in real materials. Repetitive measurements of desired properties in various samples could provide some confidence in the reliability of the results.

Reviewer 4:

Although a lot of work had been done to look at what is seen and how the process can benefit, the reviewer did not see explanations of why it is happening. The reviewer agreed that measuring the behavior observed was useful and could be used to better the operation, but suggested that more of the approach should have been focused to explain the behavior.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the project produced valuable information related to the functioning of new selective catalytic reduction (SCR) materials as a function of thermal aging, but noted that incorporating the effects of sulfur on the product selectivity, including nitrogen (N_2) and nitrous oxide (N_2O), would have been helpful and also very relevant to LD vehicle applications where sulfur was still a component of the market fuels. However, the reviewer said that the project work provided very good insight into the operation of new SCR materials and ways to include ammonia slip catalysts (ASC) into the design of the SCR.

Reviewer 2:

The reviewer acknowledged that the project team's progress had been made in this project to complete the fiscal year (FY) 2013 milestone, which was the evaluation of degradation of commercial ASCs including a model catalyst as a function of operating conditions. In addition, progress had been shown toward completing FY 2014 milestones by the end of the project in September.

Reviewer 3:

The reviewer commented that the project team's progress on technical accomplishments had been good, as it would increase the database relevant to the properties needed to increase catalyst effectiveness. Some work on the indication of the long-term durability of catalyst effectiveness needed to be done and the results presented.

Reviewer 4:

The reviewer expressed that again, the temperature and desorption curves were valuable and the project team had completed many of them, but explanations or models of the curves would have created much more valuable information.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project team's coordination between Cummins and ORNL had been very good, and added that Cummins collaborated with academia and industry research institutions.

Reviewer 2:

The reviewer noted that the project team had one CRADA with one partner.

Reviewer 3:

The reviewer remarked that the project would have benefited from the inclusion of a catalyst supplier to provide additional catalyst copper (Cu) formulations. The Cu loading effects on the observed behavior would have been useful information as well; however, the overall characterization work from collaboration was very good.

Reviewer 4:

The reviewer commented that the project team's collaboration and coordination between Cummins and ORNL had been effective, but questioned whether the project could not be further improved if a catalyst and materials supplier were involved. The reviewer added that perhaps by doing so, the work could have been sped up and cost could have been reduced to each performer.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the work on this project was ending.

Reviewer 2:

The reviewer commented that since the project was ending in FY 2014, there was only some remaining work to finish investigations of the degradation mechanisms of catalyst materials, and to write a final report.

Reviewer 3:

The reviewer expressed that the investigators must also show the effects of sulfur on the activity of the catalyst in order to guide the operation of the catalyst as a function of time and aging and sulfur exposure.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the project was very relevant for development of lean aftertreatment systems that would help reduce the cost and improve the efficiency needed to meet future standards for NO and N_2O.

Reviewer 2:

The reviewer explained that improving catalyst performance and durability, in anticipation of future emissions regulations standards, was a wise action to undertake if a company wished to remain ahead of the curve on stricter standards. The reviewer suggested that the project team might conduct the work, not only on different catalytic materials, but also determine if there are any effects on emissions caused by changes and variability of fuel composition.

Reviewer 3:

The reviewer stated that the project addressed barriers by providing information that is needed for future aftertreatment technologies and that resulted in fuel efficient aftertreatment technologies.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the project would end in September 2014 and had 3% of funding remaining, and therefore there were adequate resources to complete the project.

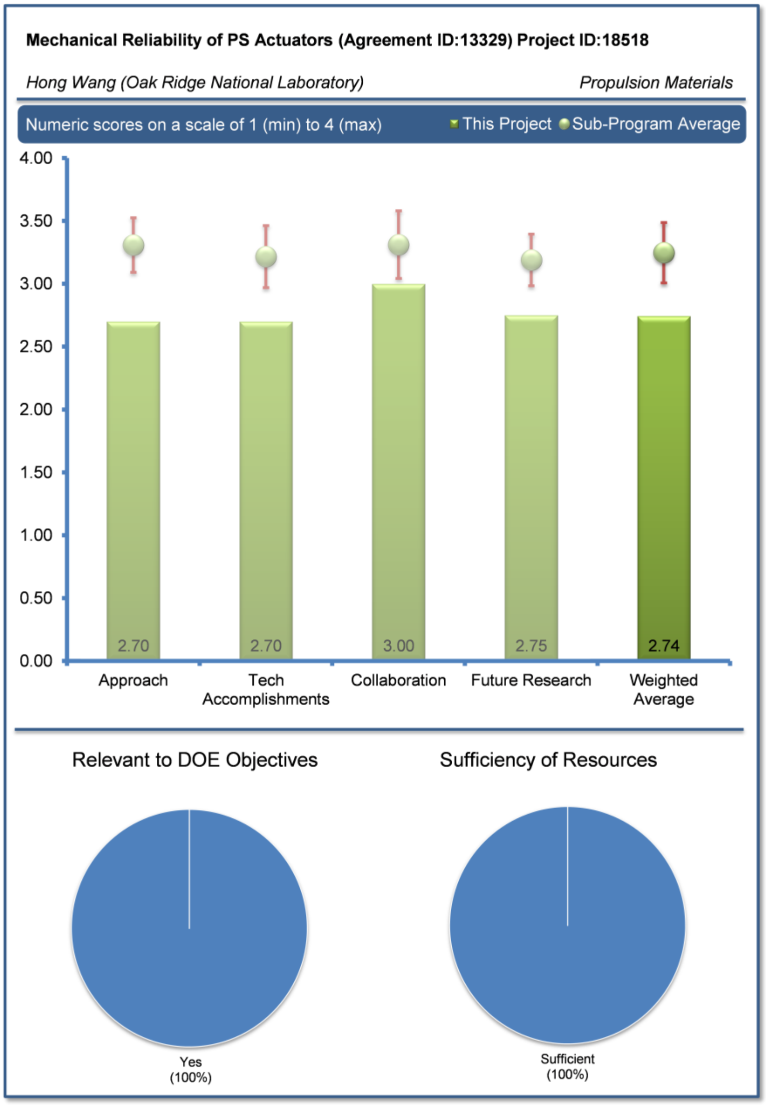
Reviewer 2:

The reviewer commented that the project was appropriately funded.

Reviewer 3:

The reviewer explained that the project resources had been sufficient to carry out the work and generate the results in a timely fashion. It remains to be seen if these data could be incorporated into products or devices to increase effectiveness and durability in diesel exhaust aftertreatment and contribute to future engine efficiency increases.

Mechanical Reliability of PS Actuators (Agreement ID:13329) Project ID:18518: Hong Wang (Oak Ridge National Laboratory) - pm051



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that the project approach was addressing the SuperTruck goal of 50% freight efficiency, which was important to consider given the prominence of the SuperTruck in current HD engine work. As noted in the relevant discussion, piezoelectric injectors can enable better control of fuel spray for improved efficiency and emissions. The reviewer added that the approach was addressing lead zirconate titanate (PZT) material response in realistic diesel engine fuel injector environments. Both mechanical strength and fatigue would be important in this application, and were being explored and addressed, and failure mechanisms were being explored to some extent. The reviewer recommended consulting with Cummins, the HD engine partner, on the areas of highest priority, for example, humidity issues.

Reviewer 2:

The reviewer expressed that the approach to performing the work was good but it was unclear why PZT and its properties were chosen as the ceramic material for the investigation. The project results to date indicated that some damage to specimens occurred during the test procedures. The reviewer expressed that the effects of the damaged PZT materials to piezoelectric activator performance should have been more clearly specified and, if possible, quantified. In addition, other relevant PZT properties should have been addressed to allow judgment as to the probability that use of PZT would enable piezoelectric actuators to be manufactured.

Reviewer 3:

The reviewer stated that the project objective and experimental plan seemed difficult to reconcile in the area of high cylinder pressure combustion. It appeared that the project team implied that the limitation was in the control of the injection cycle. However, the reviewer added that the project did not explore this aspect but evaluated the failure of the material using an accelerated test instead. A single design that evaluated these failure mechanisms in a device would clarify the relationship significantly. However, the reviewer explained that if the proposed accelerated failure mechanism was the same as those observed in practice, the resulting data would be helpful in the design and optimization of the project’s devices.

Reviewer 4:

The reviewer noted that although many techniques were used to analyze the PZT material, there was very little, if any, analysis of the root cause. An example was the project team’s observations of loss of capacitance without explanation of root cause. The team showed electrical burning failures in some of the devices in the stack, but no explanation of why for these specific cells.

Reviewer 5:

The reviewer commented that the project approach needed a better explanation of test conditions versus the actual conditions in the application.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer explained that based on the reported milestone chart, the project's activities were either completed or on schedule to be completed, so the project's progress appeared to be good. There was a good explanation of the significance of the electrical short failures and identification of failure modes, where this appeared to have a significant impact on the life of the injector, and thus, these findings appeared to be very useful. The reviewer added that the team was generating data on the performance of the material relative to the cycle life, and then used this data for computer modeling to revise the configuration of the injector, which became a valuable contribution for the national laboratories to make to support technology development. The data analysis was feeding the computer models, and could be used more broadly outside this project.

Reviewer 2:

The reviewer stated that the progress on the project team's technical accomplishments had been good and on schedule, but again, simply determining the effects of humidity on the PZT material did not ensure it would make a strong candidate for durable and cost-effective piezoelectric activators to be used in more fuel-efficient HD diesel engines. A stronger connection between PZT actuator performance and enhanced engine fuel efficiency needed to be made.

Reviewer 3:

The reviewer questioned how easy it was to change the number of layers of PZT in production, how the material was treated, and whether aging was the only treating of the material that was used.

Reviewer 4:

The reviewer said that because the project team has failed to identify root causes, and because the project is in its final year, the reviewer cannot see how the team will achieve their DOE goals. The reviewer cannot see how the project team will be able to optimize and design the system to reach their targets. The reviewer remarked that this project started in 2008, and it is unfortunate that these issues were not identified earlier and corrected.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commented that the project team's collaboration and coordination with other institutions was excellent. The team included an engine company, a material supplier and a characterization laboratory, which were the three component sets of the expertise needed to carry out this work and generate reliable data to be a possible application to enhance HD diesel (HDD) engine fuel efficiency.

Reviewer 2:

The reviewer acknowledged that the project had a CRADA with Cummins who was providing a 50% cost share, which demonstrated a good collaboration. Successful collaboration was exemplified because Cummins would commercialize the piezo fuel injector technology, as stated in the presentation. The reviewer added that inclusion of a piezo material manufacturer, EPCOS, was also critical to advise the project team on material and electrical issues.

Reviewer 3:

The reviewer observed that although the collaborators did appear to be sufficient - including suppliers of materials and a final customer - the lack of observable progress appeared to indicate insufficient collaboration to achieve final goals.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer acknowledged that the project team's future work was logical in that it extended the currently ongoing activities, including a design optimization step with probabilistic design analysis, which should provide interesting results. The PI stated a need for additional research on stacks and the different performance characteristics of stacks relative to the base material, and therefore should be explored either by Cummins or the research team in order to extend the work's relevance.

Reviewer 2:
The reviewer pointed out that because the project team's work was being concluded this year, an outline of proposed future research had not been given. Future work, if PZT results from this work are encouraging, should include the determination of any other properties and cost estimates for manufacturing piezo activators incorporating the PZT.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked that improved fuel injectors were an enabling technology for improved brake thermal efficiency (BTE) of diesel engines, where piezoelectric control could enable the more complex injection patterns needed by advanced compression ignition (CI) engines. The project's work on fuel injector improvements was relevant because it contributed to the goals of the Advanced Combustion Engines program and SuperTruck initiative.

Reviewer 2:
The reviewer remarked that if PZT should be confirmed to be an advantageous material to be used for HDD engine piezoelectric activators and if such usage could enable more fuel-efficient engine operation, this project would contribute strongly to the DOE overall objective of petroleum displacement. Failing that, the reviewer questioned if perhaps this material could have the possibility of being employed in natural gas HD engines by bringing other advantages to those engines.

Reviewer 3:
The reviewer explained that if PZTs were able to perform as fuel injectors as indicated by the project team, they could improve the efficiency of diesel and maybe gas engines that would help meet DOE objectives of petroleum displacement.

Reviewer 4:
The reviewer commented that high-performance fuel injector technologies are needed to achieve the required future combustion efficiency.

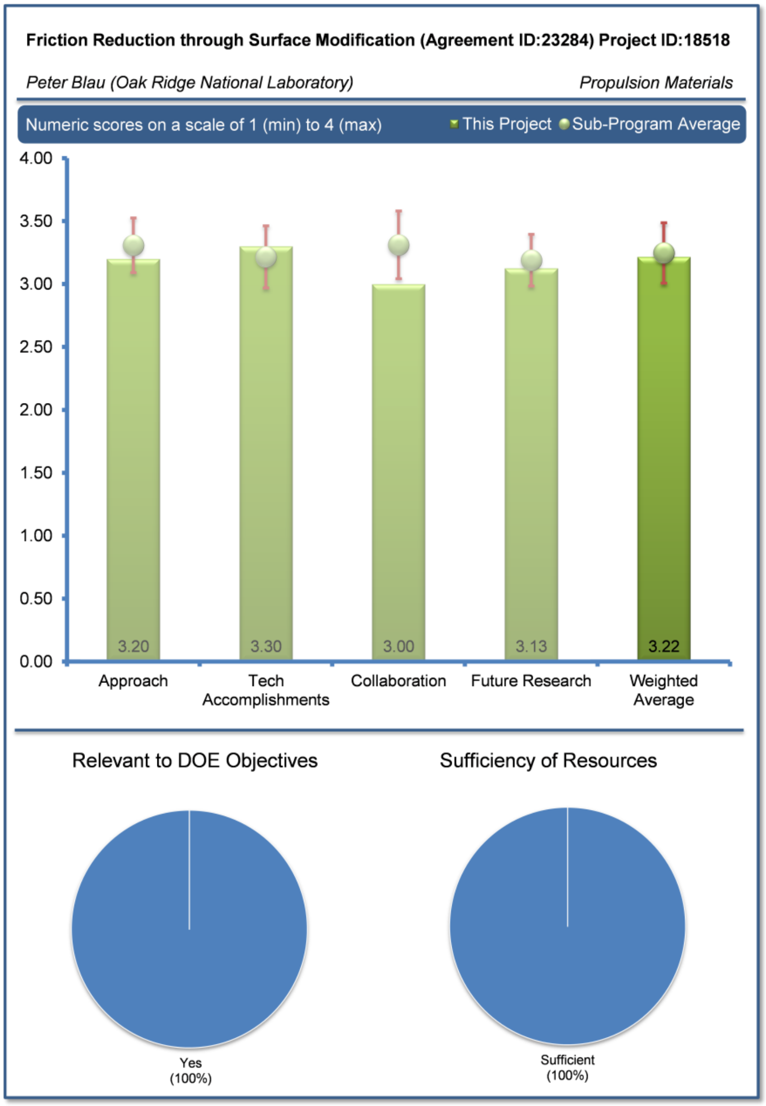
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that the project's resources appeared to be sufficient to complete the work described, and that there were no indications that the project was under-funded or over-funded.

Reviewer 2:
The reviewer explained that virtually all milestones for this project had been achieved in a timely manner and therefore, the project's resources appeared to have been sufficient.

Reviewer 3:
The reviewer pointed out that the project was an eight-year project with $1.54 million of funding, and that this should have been sufficient to achieve the milestones.

Friction Reduction through Surface Modification (Agreement ID:23284) Project ID:18518: Peter Blau (Oak Ridge National Laboratory) - pm052



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer expressed that the project team worked effectively to identify potential opportunities to find areas where friction reduction could be achieved, and was also able to identify potential shortcomings to achieve efficiency targets. Furthermore, the team showed good inventiveness in identifying new means of creating friction reduction methods.

Reviewer 2:

The reviewer explained that the project approach was good and that the team had been targeting the most significant contributors to engine friction (http://www.dtic.mil/dtic/tr/fulltext/u2/a460134.pdf) in the piston rings and engine bearings. Although the valve train friction had been assessed through other analysis to be a lower contributor to friction than rings and bearings, it was still important to explore. The reviewer observed that the team appeared to be addressing the significant factors, which are multiple surface textures, multiple base materials, and debris trapping to avoid wear.

Reviewer 3:

The reviewer commented that the project's approach to performing the work was generally sound. However, as pointed out in the presentation slides, the bench test used to evaluate the performance of the surface-modified engine components could not reliably predict how the surface modification would perform in an actual engine. The reviewer added that there are atmospheres such as oil film, water, and combustion products that could invalidate or interfere with the results obtained in the laboratory test apparatus.

Reviewer 4:

The reviewer stated that the project approach of coating soft bronze bushings with a hard tile coating for friction reduction seemed ill-founded. The question that must be resolved is why bronze is used as a substrate in this case. The reviewer said that perhaps the reduction of friction through surface modification would suggest that other materials could be used in the same application. The reviewer added that it would appear that a parametric study of this system with modeling the expected reduction of friction would be desirable.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer commented that the project team had made good progress on technical accomplishments and the timing on achieving milestones seemed reasonable but again, it was unclear how applicable these techniques would be for use in diesel engines, since no actual tests had been run in engines.

Reviewer 2:
The reviewer stated that the project team's progress was systematic in creating potential friction reduction interfaces and with testing. However, the reviewer indicated that there was suspicion that the floating tile concept on bronze bushing would not achieve the desired outcome and may cause crankshaft wear. However, the project team may still produce valuable results.

Reviewer 3:
The reviewer stated that the project's progress appeared to be good overall, since all milestones were completed or in progress. The team was exploring multiple texturing processes to reduce friction, for this multiple pathway approach was important to reduce risk and demonstrate surface modification for several materials. The reviewer explained that notable friction reductions were achieved from piston rings last year, but the PI noted that this was in the boundary layer and not a major source of friction. It appeared that the team had currently moved on from the piston ring research. The reviewer pointed out that the team had seen more notable friction reduction from the fine mesh technique to bronze, which looked like an interesting and simple method for surface texturing, relative to some of the other methods explored. The downside of the shallow surface features being easily worn away was being explored. The reviewer observed that the use of lower-viscosity oils produced greater percent reductions in friction, but from a much higher friction baseline. The reviewer suggested that the team should qualitatively explore what the potentially broader implications were of using one oil viscosity over another because avoiding negative friction effects elsewhere in the engine would be desirable. A notable accomplishment for ORNL was the design of a new test machine to simulate real journal bearing conditions in the entire lubrication regime, or hydrodynamic to boundary layer. The reviewer concluded that test machine should help the team greatly in their research.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the project team's collaboration with the national laboratory, a university, and Northeast Coating Technologies worked well. However, having a final customer that desired the technology would have been very valuable both to the assessment of the technology and to the barriers that need to be overcome to achieve success. The reviewer suggested that this could lead to additional testing regimes that may have been missed.

Reviewer 2:
The reviewer remarked that the team included collaboration with university and coating industry partners. It was unclear whether the team had yet reached out to any engine or vehicle OEM partners, but it may have been be too early in the research effort for this to be done.

Reviewer 3:
The reviewer stated that the project team's collaboration with other institutions had been satisfactory but could be improved greatly if there were an actual engine manufacturer involved. At this point, there was no indication that there was interest in the results of this work from the diesel engine community. The reviewer added that, given the long history of partnerships between ORNL and engine companies such as Cummins or Caterpillar, it was surprising that no interest from such companies was apparent.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer explained that if funding is available from the Propulsion Materials program, some additional work on piston rings could be explored, as the project deals with a significant source of friction losses in the engine. The use of diamond-like-carbon in a "tile" configuration was intriguing, and it would be interesting to see if the wear coating worked successfully and retained the positive friction reduction aspects of the wire mesh texturing.

Reviewer 2:

The reviewer stated that the work was being brought to a conclusion; the next step would clearly be to proceed to actual engine tests to see if the modified surfaces hold up in an actual operation. This had been proposed and would be a critical step to obtain some interest on the part of a diesel engine partner.

Reviewer 3:

The reviewer noted that the project ends September 2014.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that 10% to 15% energy loss in powertrains was due to friction losses. The project was very good in that it directly linked friction reduction to fuel savings potential.

Reviewer 2:

The reviewer noted that the friction reduction would help achieve the DOE objectives and was a very relevant topic for both gasoline and diesel applications.

Reviewer 3:

The reviewer explained that the project was relevant to DOE and VTO goals for improving engine brake thermal efficiency, where it also contributed to 21st Century Truck Partnership goals for parasitic loss reduction through friction reduction.

Reviewer 4:

The reviewer commented that if this approach were successful in reducing friction in actual engines, it would indeed support the overall DOE objective of petroleum displacement because of the enhanced fuel economy of engines. However, at this stage in the work, it was a moot point; it remained to be seen if the approach would work in actual operating engines. The reviewer added that durability, of course, the hallmark of HD diesels, was also paramount for these engines.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the project's resources appeared to be sufficient to accomplish the work outlined in the presentation, and that there were no indications that the resources were too much or too little to complete the project.

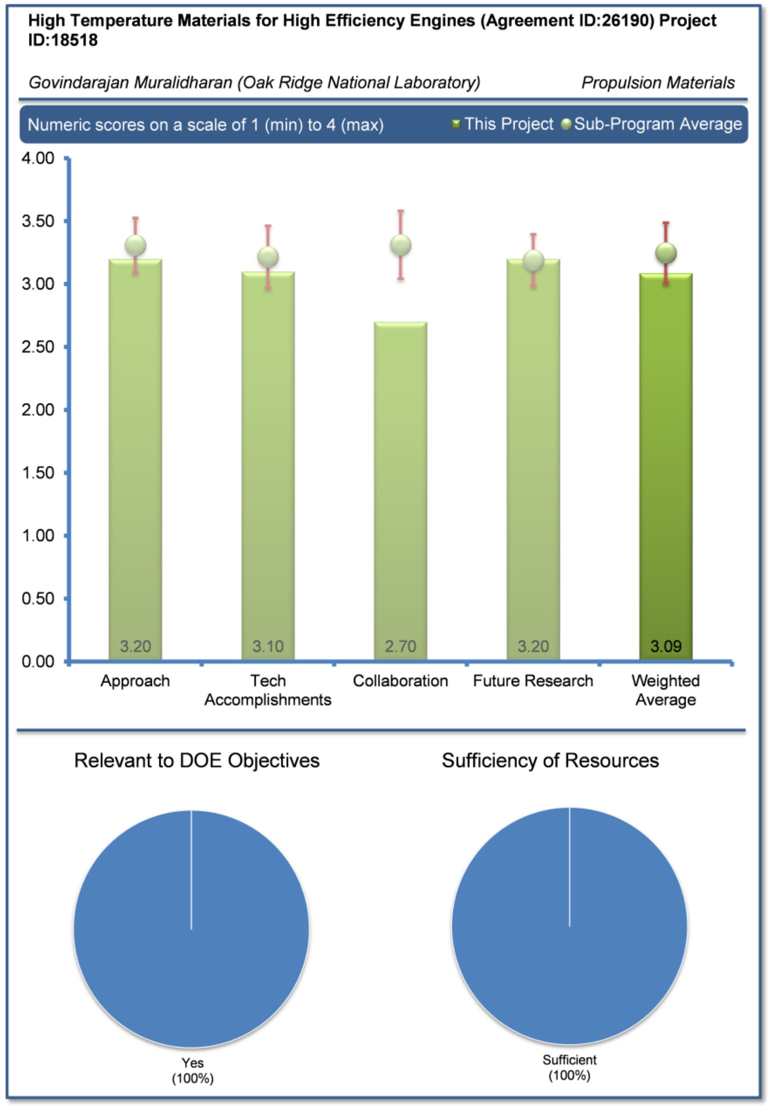
Reviewer 2:

The reviewer observed that the project's resources appeared to have been sufficient to achieve the stated milestones in a timely fashion. Were there a decision to proceed to actual engine tests, substantially larger funds would be required and at that time a diesel engine manufacturer would need to be involved.

Reviewer 3:

The reviewer questioned if all funding was from the DOE.

High Temperature Materials for High Efficiency Engines (Agreement ID:26190) Project ID:18518: Govindarajan Muralidharan (Oak Ridge National Laboratory) - pm053



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that the approach was reasonable and was addressing the major issues, fatigue life and strength, of high-temperature valve trains while keeping cost targets in mind. The computational approach to designing materials was a good application of national laboratory expertise and resources to bridge between fundamental and applied research.

Reviewer 2:

The reviewer reported that this was a new project, and that the technical barriers were well-defined with clear project objectives. The project was considering a tradeoff between strength and cost of new valve materials. The reviewer suggested a desire to see cost integrated into the project objectives, especially during the early part of the project.

Reviewer 3:

The reviewer stated that the project approach to performing the work was good, but only concentrating on reducing nickel (Ni) content may be limiting achieving the temperature performance level desired. It may have been necessary to add other, perhaps high-cost, elemental constituent to achieve the high-temperature oxidation resistance and creep resistance needed for an alloy to perform satisfactorily at 950°C. The reviewer expressed that the holy grail of high-temperature engine components had been thought of as being ceramic components; however, machining and other cost elements have made that difficult to achieve.

Reviewer 4:

The reviewer remarked that the project's approach is good overall, and that using thermodynamic tools and expert knowledge would accelerate alloy development in the project area. The reviewer noted concerns over how results were measured and compared to previous research and what would be considered correct by the industry, but opined that a fortunate correction was possible. For example, if possible, the weight gain of oxygen or the weight loss by flaking could both be resolved by the weight of oxide and the removal of the oxide after each cycle.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that the project was quite new, and to date, the progress was excellent. The identification of potential alloys and the testing at this early stage was excellent and furthermore, the identification of potential weaknesses of impurity levels and overcoming the problem showed that the project was well focused to achieve results.

Reviewer 2:

The reviewer remarked that this particular project was in its first year, so accomplishments are appropriate for this early in the process. This reviewer reported continued work on alloy development for optimizing key oxidation and strength characteristics. The reviewer recounted that the PI stated that the team was making use of traditional alloying processes in the lab, which was good because the findings could be extended to production processes.

Reviewer 3:

The reviewer stated that the project team's progress on technical accomplishments had been good but, to date, there did not seem to be any alloy composition in the series of alloys tried, which had achieved the properties needed for the 950°C performance goals. The reviewer questioned what other approaches to adding alloying elements might have led to the properties needed, and what the cost would have been.

Reviewer 4:

The reviewer indicated that initial alloy concepts were developed, and that modelling and simulation work were both in progress to study the composition effects on oxidation.

Reviewer 5:

The reviewer explained that the results of the initial analysis used both integrated computational materials engineering (ICME) tools to identify candidate alloys, and the anticipated performance using oxidation tests, seemed inconclusive. The reviewer questioned how the ICME had sped the decision of new alloy choices. The chosen materials did not seem to be an improvement on the base alloy choice. The reviewer also questioned if there was room in this system to allow for the higher rate of oxidation as compared to the 751 alloy; there seemed to be many basic questions that had not been addressed.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said the project team's collaboration with the two partners, ORNL and Carpenter, appeared to be going well, but was concerned about the lack of an industrial partner that would be using the technology and could provide critical input on how the alloy should be properly evaluated. The researchers had identified the need and were trying to find this partner. The reviewer expressed that this would be critical to achieving the final goals for implementation of the technology.

Reviewer 2:

The reviewer noted that the collaboration with Carpenter, who had been a supplier of engine valve train materials for many years, was good. The team appeared to be doing the proper outreach and technical discussions with major engine OEMs and others who were unspecified at this point.

Reviewer 3:

The reviewer indicated that the project team's collaboration between ORNL and Carpenter Technologies currently appeared to be satisfactory, but was also encouraged to see that discussions had taken place with Cummins and Caterpillar in an attempt to gain their interest in the work. If the properties necessary for achieving the 950°C performance could be shown to have been achieved, it would be likely that these companies would want to enter into formal collaborations with ORNL.

Reviewer 4:

The reviewer stated that Caterpillar and Carpenter Materials Technology had been involved, but would like to see stronger a commitment to the project from an engine manufacturer, and questioned if the project was also applicable to LD engine manufacturers.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the project team's future work plan was good, as it was working toward alloy compositions necessary for meeting the high-temperature goals of 900°C, on the way, presumably, to the goal of 950°C.

Reviewer 2:

The reviewer explained that the researchers had developed a good plan to move to the development of new alloys. The project has identified procedures for evaluation which although they could be improved as mentioned above, were in the correct direction. Again the weakness going forward is the same as the weakness in the past, specifically the identification of a partner that can identify the test methods that will be necessary to evaluate the alloy before it would be accepted commercially.

Reviewer 3:

The reviewer stated that the project's proposed future work was logical and technically sound. However, it was not clear if other parameters in the alloy compositions would be further pursued, and questioned, for example, what other alloying constituents would make sense to try in order to reduce the Ni composition, and how such an approach would affect cost. Unfortunately, the addition of other trace elements usually seemed to add to the cost, rather than reduce it.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reported that the project addressed a materials need for improved engine efficiency, for, as the PI noted, high-efficiency engines would likely have higher exhaust temperatures which would be a limitation for LD engines in the future and may already be an issue for HD engines. Controlling the temperature of the valves through internal engine means would likely have some impact on efficiency, so avoiding the need for this with higher-temperature valve materials would be very important.

Reviewer 2:

The reviewer expressed that if the performance goals of these alloys were achieved, it would be likely that improvements in diesel engine efficiency could be achieved and the overall DOE objective of petroleum displacement supported. However, it is also possible that these alloys could improve the operating efficiency of natural gas HD engines, which would also support the goal of petroleum displacement.

Reviewer 3:

The reviewer noted that as engine temperatures and pressures increase to achieve performance goals, valve temperatures would increase and require higher-temperature-capable materials.

Reviewer 4:

The reviewer noted that valve materials were a key limiting factor for improved engine operating efficiency.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the resources for the project presently appear to be sufficient to achieve the stated milestones in a timely fashion. Increased resources would be required if a breakthrough alloy composition were developed.

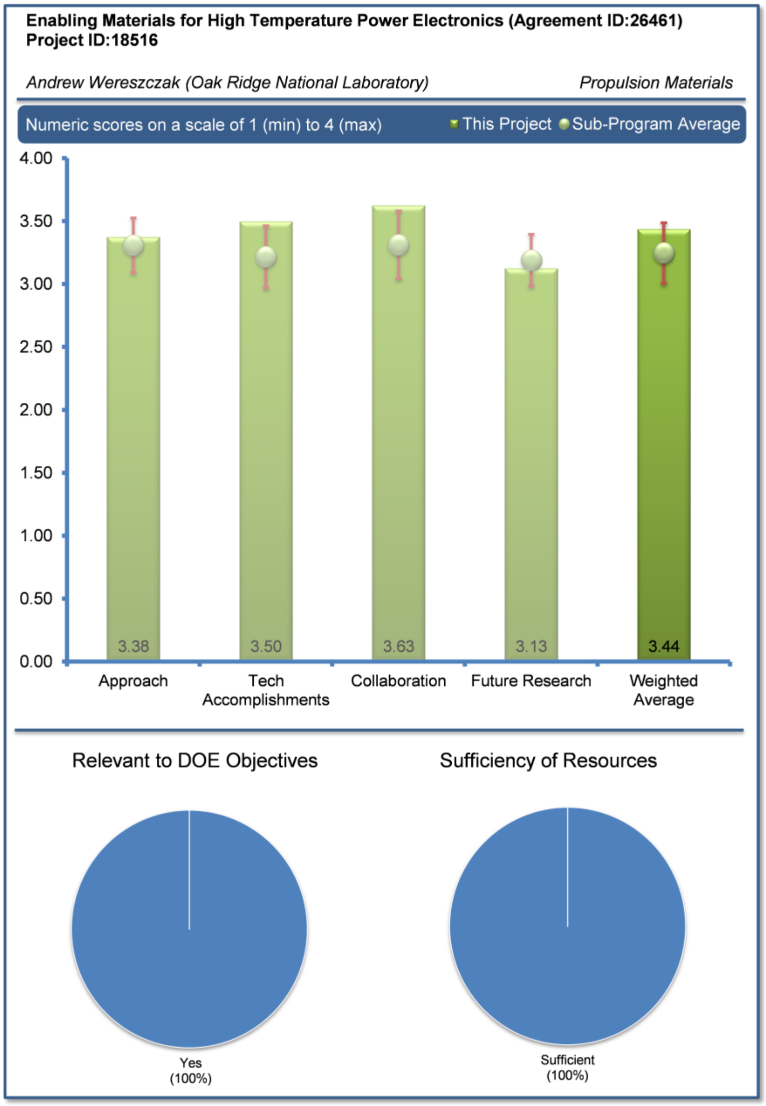
Reviewer 2:

The reviewer noted that the resources appeared to be sufficient for this project.

Reviewer 3:

The reviewer expressed that, unfortunately, the question could not be adequately evaluated because the actual funding was not spelled out in the presentation.

Enabling Materials for High-Temperature Power Electronics (Agreement ID:26461) Project ID:18516: Andrew Wereszczak (Oak Ridge National Laboratory) - pm054



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project team's approach was very focused, with two parallel initiatives being pursued (i.e., silver [Ag] sintering for interconnects, and organic dielectrics) with impressive industry partners. Both are needed to operate in the 200°C wide bandgap (WBG) operating environment, which was a much more efficient temperature.

Reviewer 2:

The reviewer commented that the project team's discussion of the barriers and the ability of the current project to overcome them was well presented. However, the quantum leap of this project - an undertaking to increase the temperature from 105°C to 200°C - was not well explained.

Reviewer 3:

The reviewer stated that cost was the first barrier identified but it was never addressed in the presentation, which seemed like the approach was hitting all other metrics. Cost may have been competitive in a life-cycle approach or performance benefit, but it was never addressed in the presentation.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the project team had made impressive accomplishments to date with limited funding. Other. lower-cost sintering options were not considered but the reviewer understood that this was because of the limited funding received.

Reviewer 2:

The reviewer commented that in a relatively short time since startup, the technical accomplishments were progressing well in multiple task areas.

Reviewer 3:

The reviewer noted that the presentation focused mainly on the work in progress and that there were not many accomplishments, as this was a new project. For a newly started project, the team made great progress on getting work started.

Reviewer 4:

The reviewer explained that the project's design of experiments and their execution was good, with two efforts on interconnects and dielectric material. The interconnect part was progressing well, but accomplishments on the dielectric material were not well presented. Whether the pattern filing was related to this project, or the result of an earlier one, also needed to be clarified.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project team was working with other national laboratories such as the National Renewable Energy Laboratory (NREL) and industry partners, which would improve the opportunity for project success.

Reviewer 2:

The reviewer observed that the team's collaboration with multiple materials providers, process suppliers including Plater, and laboratory partner, the National Energy Technology Laboratory, seemed engaged and involved participation.

Reviewer 3:

The reviewer pointed out that project team included the necessary players to make commercialization possible with major suppliers on the team.

Reviewer 4:

The reviewer noted that the project team was working with several suppliers, although the extent of their involvement was not completely described.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the project's plan was good and that there were no gaps identified.

Reviewer 2:

The reviewer stated that the project's experimental and testing plan seemed to be addressing the critical process parameters, or environmental services issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer explained that higher power electronic operating temperatures could provide the opportunity to increase efficiency.

Reviewer 2:

The reviewer observed that the project was seeking to evaluate the feasibility of pushing the electronics operating temperature to 200°C, which would extend the performance window for EV applications.

Reviewer 3:

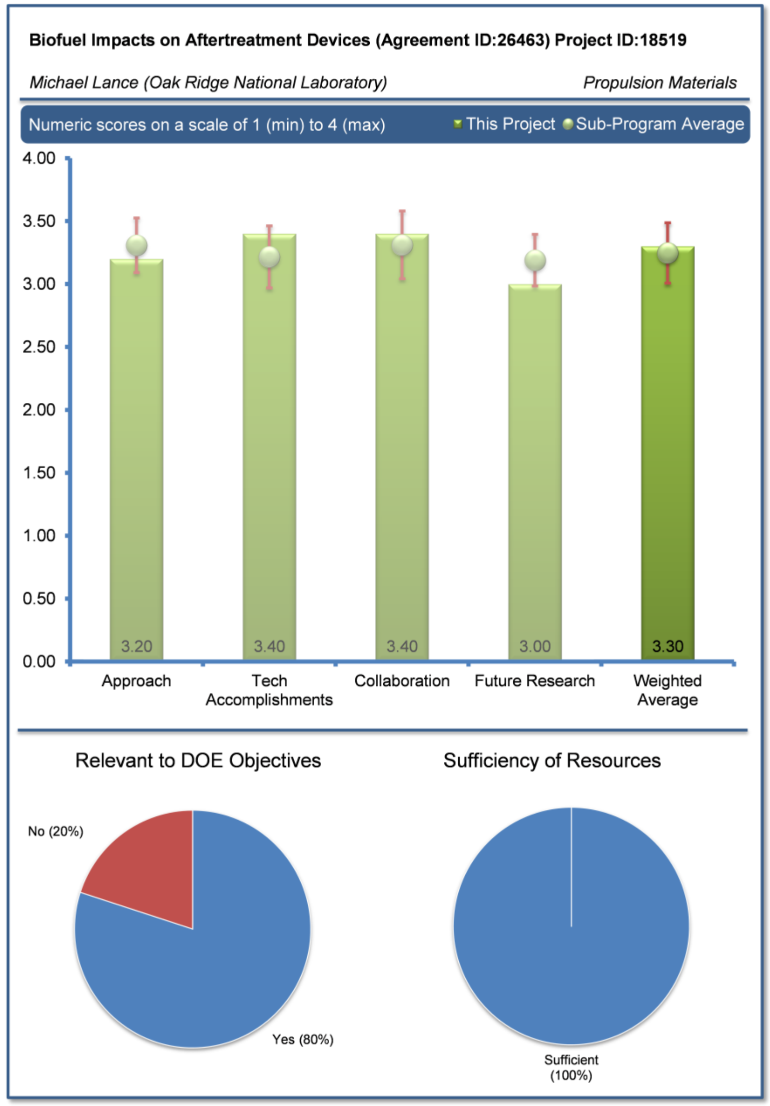
The reviewer expressed that since the electronics were playing more and more of a role on controls in the automotive industry, the efficiency of these components was critical for efficient operation. Improving the temperature capability would improve the reliability of the component.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that if more funding were available, more could be accomplished. However, funding received to date had been sufficient.

Biofuel Impacts on Aftertreatment Devices (Agreement ID:26463) Project ID:18519: Michael Lance (Oak Ridge National Laboratory) - pm055



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer explained that the project team's approach to performing the work was excellent, very straightforward, and likely to quantify the effects of various residual concentrations of potassium (K) or sodium (Na) catalysts used to make the biodiesel fuel.

Reviewer 2:

The reviewer commented that the project team's approach to accelerate test with evaluation was excellent, where identifying the maximum potassium amount that represented a valid test was also very good. The reviewer expressed some concern that the focus was only on potassium and not on other elements or a combination of elements. The reviewer questioned if the other elements would be included later in the project.

Reviewer 3:

The reviewer stated that biofuels were definitely a way to become less dependent on imports of crude oil, but since the ingredients were not exactly the same as fuel derived from crude oil, the impact of those differences needed to be understood. The project research could give answers to some of these questions.

Reviewer 4:

The reviewer noted that this was a new project with clearly defined objectives.

Reviewer 5:

The reviewer opined that this project may not be focused on the correct catalyst poisons related to current biodiesel fuel production. Potassium and sodium fuel contaminants are associated with homogeneous fuel production. The industry is moving toward heterogeneous processes in order to more efficiently produce increased quantities of biodiesel fuel. The fuel-borne contaminants or poisons associated with those fuel production processes would not be the same. Therefore, downstream catalyst contamination issues might be different.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer indicated that because the approach was so straightforward, progress on technical accomplishments had also been excellent. No roadblocks to achieving the proposed technical objectives were apparent.

Reviewer 2:
The reviewer noted that there was good progress on the new project.

Reviewer 3:
The reviewer explained that even though the project was less than a year old, progress was excellent, for in one year the project team had carried out many tests and identified the optimum cycle. However, it cannot be certain, but should be determined, that the same behavior would hold for the other elements.

Reviewer 4:
The reviewer commented that the project had very interesting first results, and was surprised to see that the concentration of potassium did not increase on the catalyst front face very much. It seemed that there was a mechanism that absorbed, but also released potassium, but higher concentrations apparently did not work anymore. The reviewer added that it was also interesting that the concentration at the front of the second substrate was higher than at the end of the first substrate. Perhaps during the next week, these mechanisms could be further explored. The reviewer expressed that although the investigators had not and do not need to do emissions testing as precise as required for certification, the noise should have been reduced. It currently seemed that the NO_x emission was lower with 14 parts per million (ppm) potassium, but these differences were very likely due to noise in the measurements.

Reviewer 5:
The reviewer stated that the project team's technical accomplishments were both consistent with the scope of the proposed project and appropriate. The team demonstrated good use of the facilities, analytical tools, and national laboratory resources.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that project team's collaboration partners were very appropriate for the scope of project work.

Reviewer 2:
The reviewer noted that the project's selected partners seemed very relevant for the proposed research.

Reviewer 3:
The reviewer stated that due to the high interest in the use of non-petroleum diesel fuels such as biodiesel, the collaboration and coordination with other institutions, such as engine companies Ford and Cummins and the National Biodiesel Board, had been excellent and unlikely to be improved upon.

Reviewer 4:
The reviewer expressed uncertainty about whether the project team's collaboration with all partners may be good. However, the interactions between ORNL and NREL appeared to be working well. The reviewer added that it was not apparent what Ford was doing beyond providing a truck or engine.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer commented that the project team had a good approach to the next series of testing with calcium (Ca) instead of potassium, which would be interesting to see if the accelerated aging will fail at a similar high concentration.

Reviewer 2:
The reviewer mentioned that there is good future research being proposed for Cummins, but indicated a concern that element and element combinations were not being addressed, including calcium, magnesium (Mg), and sodium, and questioned if there was certainty that none of these elements were of concern based on potassium.

Reviewer 3:
The reviewer stated that the proposed future research was logical and appeared sufficient to achieve all the objectives laid out in the proposed statement of work for the project.

Reviewer 4:
The reviewer suggested that to represent anticipated failure mechanisms in the field, other fuel poisons should have been considered for biodiesel related projects. The reviewer did not believe that poisons studied in this work were the most relevant for future renewable fuel production. The lead investigators should have surveyed current biofuel processing facilities to determine if other poisons should have been considered before going forward. The reviewer added that biofuels could be derived from many different feedstocks, including waste oil associated with service industries.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that the project supported the DOE objective of petroleum displacement because biodiesel is a fuel made from non-petroleum sources.

Reviewer 2:
The reviewer commented that biofuel can be a one-to-one replacement for imported oil.

Reviewer 3:
The reviewer pointed out the impact of biofuels on the project’s catalyst and filtering systems were critical if biofuels were intended to be used.

Reviewer 4:
The reviewer emphasized that there was limited relevance for going forward and referred to related comments in the Future Work section.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

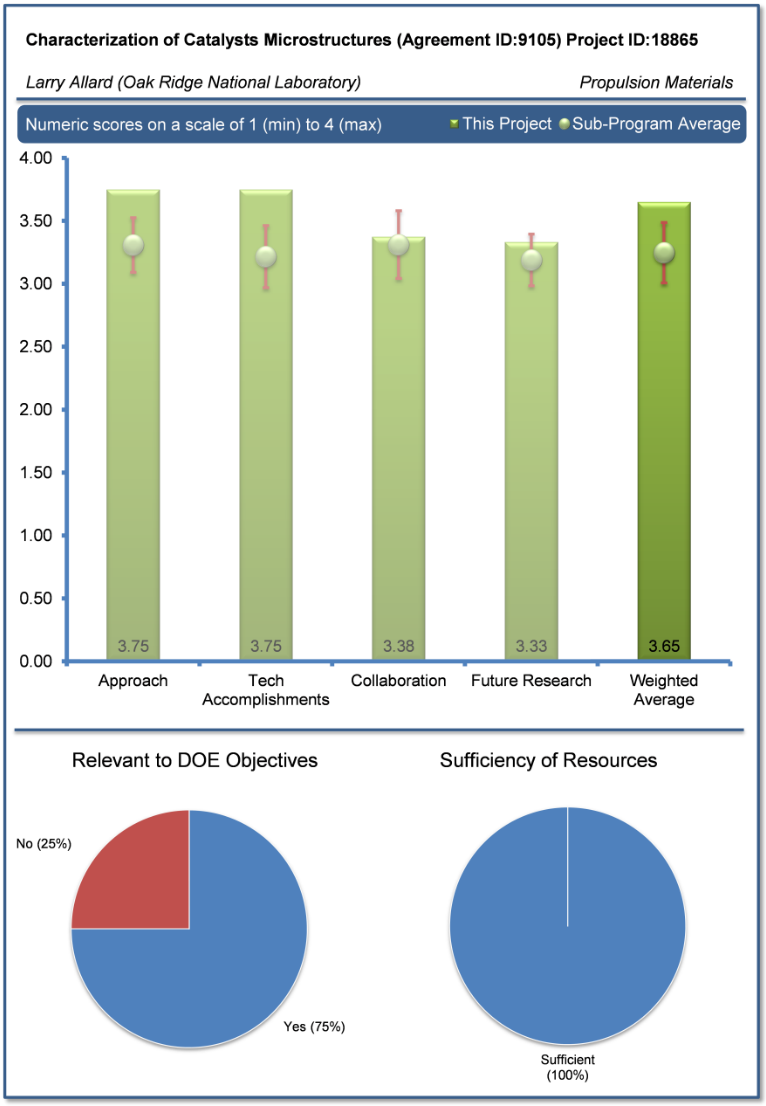
Reviewer 1:
The reviewer stated that the resources for the project appeared to be adequate to achieve the stated milestones in a timely fashion.

Reviewer 2:
The reviewer stated that the project’s funding and resource levels were appropriate.

Reviewer 3:

The reviewer expressed that more resources do not automatically produce better results, for the results obtained so far needed to be analyzed and understood. With additional resources, perhaps an expensive test could be carried out that did not have limited added value.

Characterization of Catalysts Microstructures (Agreement ID:9105) Project ID:18865: Larry Allard (Oak Ridge National Laboratory) - pm056



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the project work continued to produce outstanding and world-class research at ORNL, to push electron microscopy to the limits of its capabilities, and to understand catalytic reactions at the atomic level. The approach was innovative in that it developed a microscope cell capable of containing gaseous reactants and catalytic materials.

Reviewer 2:

The reviewer observed excellent work. The researchers had created a new device to measure catalysis *in situ* in a microscope. The project team had also identified an early weakness of the first-generation device and corrected it, and also added an automated *ex-situ* to the system.

Reviewer 3:

The reviewer stated that the approach had a novel method for characterizing the structure of catalytic materials under reaction conditions. The information obtained from this work, as well as the development of the technique, would help elucidate the behavior of materials *in situ*.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated that the project had made all technical accomplishments and also great technical progress.

Reviewer 2:

The reviewer mentioned that the progress toward achieving technical accomplishments had been excellent, but there remained barriers to overcome, some that were only listed in the Reviewer slide at the end of the presentation.

Reviewer 3:

The reviewer explained that the development of the project's technique could be widely used to further characterize materials and add important knowledge to how materials behave under reaction conditions.

Reviewer 4:
The reviewer noted that the testing was in real-world conditions.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer expressed that the project team had excellent collaboration between ORNL and Protochips on the device manufacturing, testing, and other aspects of the equipment manufacturing. The PI also published papers in highly regarded journals with high numbers of citations.

Reviewer 2:
The reviewer stated that the project team's collaboration and coordination with other institutions, such as universities, electron microscopy companies and others had been excellent and that continuing and expanding collaboration with other institutions as proposed is to be encouraged.

Reviewer 3:
The reviewer commented that the project's university and research collaboration appeared to be well thought out.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer explained that the proposed future research was good in that it proposed to address the barriers to having a fully functioning cell which could be placed in the electron microscope in order to investigate gaseous reactions.

Reviewer 2:
The reviewer said that further refinement and application of the project's technique were required to fully demonstrate the usefulness of the project's approach.

Reviewer 3:
The reviewer noted that the blank project ends September 2014.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the project's work and instrument would provide additional characterization capabilities to the catalyst community.

Reviewer 2:
The reviewer suggested that developing methods to analyze catalysis reactions at the atomic level would help speed up critical knowledge for advancing catalysis development.

Reviewer 3:
The reviewer expressed that while it is very important to be able to investigate reactions *in situ* under the electron microscope, such investigations are one step away from actually supporting the DOE objective of petroleum displacement. This work came under the rubric of enabling technology, which could contribute to other projects that directly supported petroleum displacement.

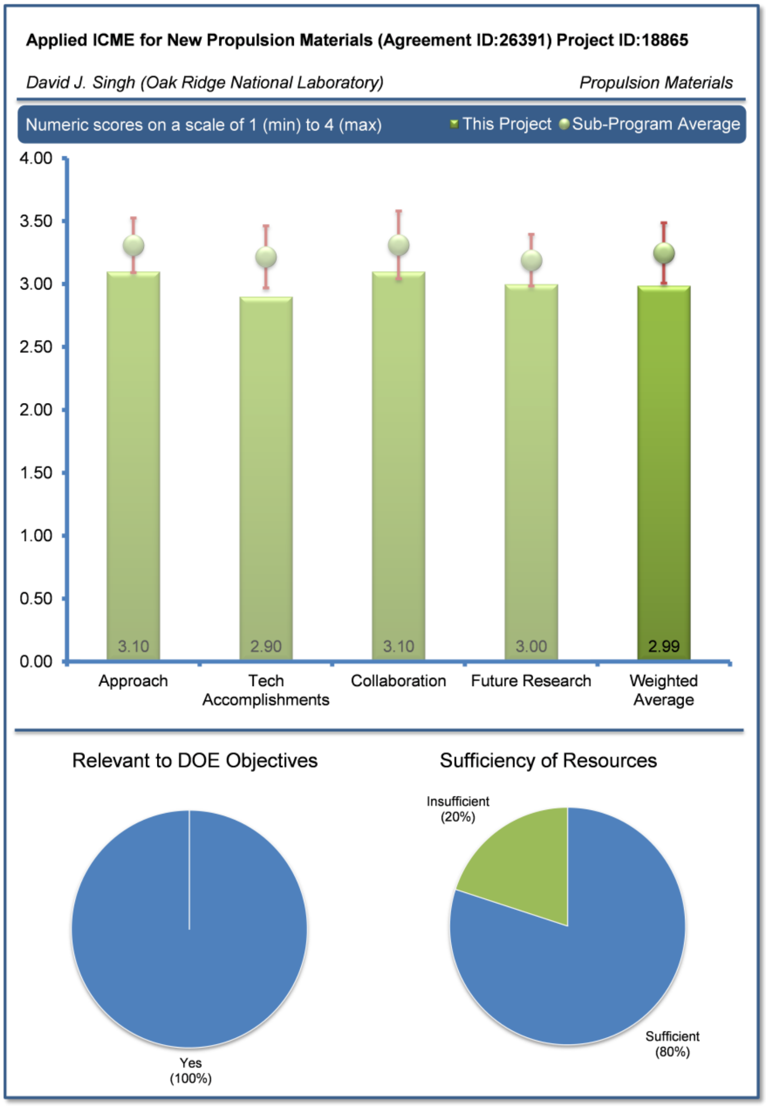
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that the project's resources were appropriate.

Reviewer 2:
The reviewer commented that the resources for this project appeared to be sufficient to achieve the stated milestones in a timely fashion.

Reviewer 3:
The reviewer noted that based on outcomes, the project funding appeared to be sufficient.

Applied ICME for New Propulsion Materials (Agreement ID:26391) Project ID:18865: David J. Singh (Oak Ridge National Laboratory) - pm057



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that proving that ICME could be used to develop specific materials would provide a proven pathway to develop materials with specific properties in a much faster, lower-cost manner. The potential of using this approach to develop the four types of materials investigated was significant. The reviewer added that consolidating these four materials under a single project will ensure consistency in the approach to utilize ICME to develop these materials.

Reviewer 2:

The reviewer commented that the project's approach brings together a number of disparate projects under the banner of ICME. The approaches for the individual projects show different strategies for ICME use, which is a good way to show the capabilities of ICME; for example, modifying an existing material, seeking a completely new material, and examining a material's durability over time. This seemed a reasonable approach to achieving the goal of making material development faster, cheaper, and lower-risk. The reviewer added that the approach combined modeling and experiment.

Reviewer 3:

The reviewer stated that the project approach, being taken into the sub-tasks, appeared to be modeling with experimental or process validation, either by reference or actual demonstration. The model-validate loop was a reasonable technical approach to a modeling activity, but the reviewer opined that it did not constitute an ICME approach that was seen by those who envisioned the idea.

Reviewer 4:

The reviewer indicated the need to understand how gaps in ICME technology were going to be addressed and filled as the project continues, and questioned what could be linked from the smaller length scales to processing simulation.

Reviewer 5:

The reviewer explained that the project appeared to be a combination of four previously supported projects bundled together under a new banner called ICME. By bundling the four projects, this project appeared to now be a model of applying ICME concepts rather than addressing issues and barriers associated with each separate topic. The reviewer added that a more cynical reviewer might have concluded that the ICME banner was attached to these four original projects solely to extend their lifetime, for they were coming to closure. Little or no information was provided on the models employed, what properties they were modeling, and how these properties affected performance, for example, what properties were critical for commercial permanent magnets, such as size, weight, magnetic field, and Curie temperature. The reviewer questioned what critical variables the project team used to control these properties, what the models suggested was optimum, and how the project team validated the results.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer commented that there were several notable accomplishments from this group of related projects. In all cases, new materials or material additions had been identified for further study. The reviewer explained that the non-rare earth magnet materials work should be of particular interest because of the need for such magnet materials to expand electric motor deployment. The confirmation steps shown in the slide were very important, as they illustrated the benefits of the ICME approach and provided confidence in the results.

Reviewer 2:

The reviewer acknowledged that the project team's accomplishments were good, and that it was a continuation of prior projects, for which the project team had a good grasp of the critical parameters that would impact performance, and their publications and IP records reflected that progress is occurring. With each of the four application area projects standing on its own, the project team seemed to be making good progress, but bundling them together under ICME overlooked their individual advances and successes. The reviewer said that it was not apparent how the project team could combine the modeling for the four separate applications into one ICME project, for the models for each application were different and hard to combine into a coherent story.

Reviewer 3:

The reviewer pointed out that the project had some accomplishments to date, starting with the integrated approach for the four materials and research areas.

Reviewer 4:

The reviewer explained that in the individual tasks, progress was being made to predict certain properties for processing-generated property modification. This work seemed to have been consolidated from other project areas and then pulled together into a single project, so much of what was reasonably reported as accomplishments dated to predecessor projects.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted that the project had a very good and diverse group of partners consisting of industry, a university, a materials consortium, and other Federal laboratories that provided the infrastructure with a long-term commercial success.

Reviewer 2:

The reviewer stated that a number of collaborators had been identified for this work from both industry and academia.

Reviewer 3:

The reviewer commented that the project team's collaboration appeared to be excellent, although the roles of the collaborators in the overall project were not stated with sufficient clarity to understand what their contributions were.

Reviewer 4:

The reviewer remarked that other than the stated names of numerous collaborative partners, no description was provided of what the partners were actually doing or providing to the project. As stated, the partners provided $0 cost share to the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer explained that future research could provide a new approach for developing materials with specific characteristics. The plan appeared to be able to achieve the targeted end goals of developing an integrated approach to cost-effective and timely material property development.

Reviewer 2:
The reviewer noted that the future work described in the presentation appeared to be logical and should achieve the goals set forth by the program.

Reviewer 3:
The reviewer explained that with the future activities laid out for each of the four application areas, it was difficult to see how the ICME concept was being brought in on the future activities. The future activities were presented as four discrete research topics, but the ICME activity did not encompasses all four areas.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the project materials would enable higher-efficiency engines, providing the opportunity to decrease petroleum consumption.

Reviewer 2:
The reviewer indicated that PZTs were needed for advanced fuel injection and control systems to improve timing of injection events, and advanced catalysts would benefit the development of improved aftrertreatment devices needed to reduce emissions. The high-performance permanent magnets were needed for compact electric motors, and the thermoelectrics offer potential benefits to recoup waste heat.

Reviewer 3:
The reviewer commented that the project was relevant to the DOE goals of energy efficiency by creating and refining tools for new materials development. If successful, the project could reduce the time required and cost of developing new materials.

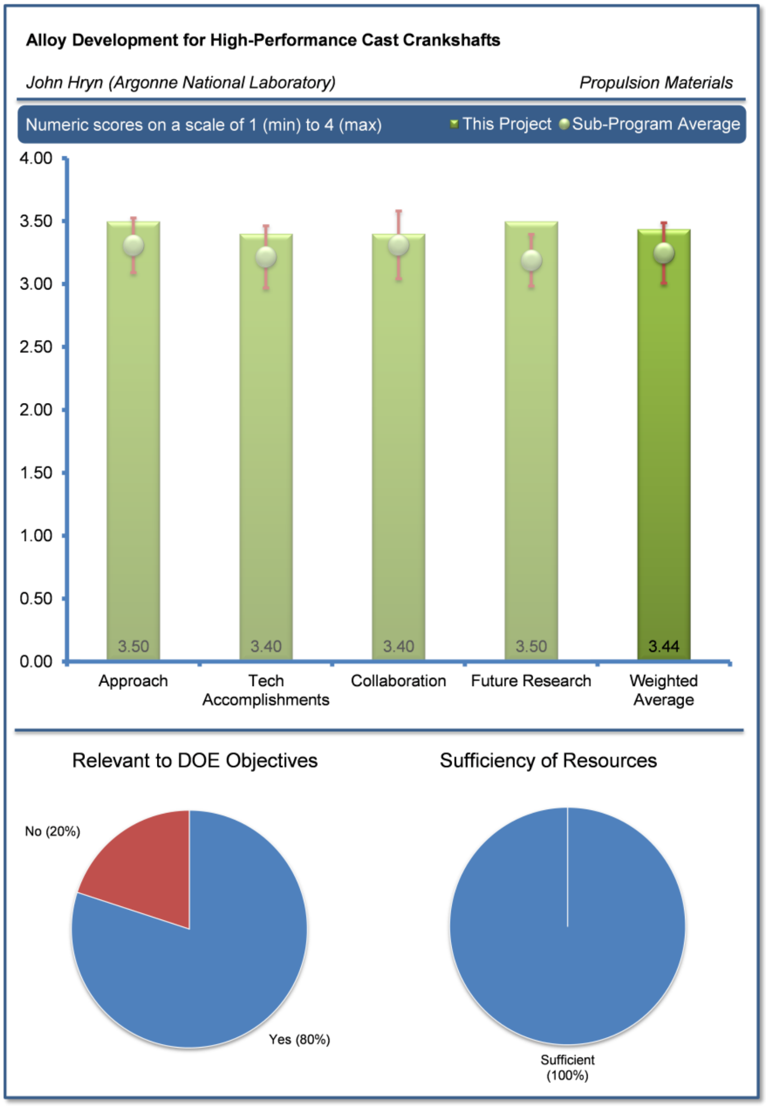
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the project funding appeared about right for this effort.

Reviewer 2:
The reviewer noted that the project’s resources appeared sufficient to achieve the goals set forth by the program.

Reviewer 3:
The reviewer expressed that the project had bitten off too many applications for ICME and should pull back the scope and just focus on one or two areas. The reviewer suggested catalysts and PMs.

Alloy Development for High-Performance Cast Crankshafts: John Hryn (Argonne National Laboratory) - pm058



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer described a very solid approach and recounted the following steps that were mentioned: tomographic study of casting quality and structure; design and develop high temperature apparatus for *in-situ* phase evolution study; evaluation of laboratory sample castings; optimization and characteristics of the high potential alloy; and process concepts used in order to be able to correlate microstructure to processing and mechanical properties to optimize cast alloy for crankshafts.

Reviewer 2:

The reviewer indicated that the project appeared logically laid out, and built upon other projects conducted and tools developed at Argonne National Laboratory (ANL). The results and tools were now being applied to developing more cost-effective, lighter-weight, and higher-performance cast crankshafts. The reviewer added that this project was focused on developing some new systems required for this specific application, such as heating systems and others.

Reviewer 3:

The reviewer stated that the project approach of using ANL’s advanced photon source (APS) as a resource for analyzing material microstructures and DOE’s national laboratory resources was good.

Reviewer 4:

The reviewer observed that the casting appeared to be a better and lower-cost approach to develop lighter materials for engine crankshafts and other applications. Utilizing the ICME approach would permit faster and lower-cost materials development.

Reviewer 5:

The reviewer noted that the researchers seemed unaware of the development in a sister project and were not refocusing their plans accordingly.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer explained that the project results from the X-ray studies of microstructures were very useful. The ability to study microstructure during loading and to see changes was quite interesting, as was the work to study the alloy solidification process. The project work would help in validating and improving ICME models that were being used by a number of teams in this portfolio.

Reviewer 2:
The reviewer commented that the project just started in March 2014, and therefore there was not much at this point to report as far as accomplishments. The identified milestones and approach appeared sufficient, and the project progress was expected to be measured against the appropriate metrics.

Reviewer 3:
The reviewer commented that no mark had been given in order not to downgrade the project. The project just started, so the reviewer noted that accomplishments are naturally minimal.

Reviewer 4:
The reviewer noted that it is still very early in project and that assessment of the accomplishments was based on only 5% of the work.

Reviewer 5:
The reviewer expressed that the progress was difficult to judge since the project was just started with only 5% of the budget spent so far.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer expressed that the partners aligned well with other propulsion materials projects, having strong industry and academic partners.

Reviewer 2:
The reviewer commented that the project was working closely with Caterpillar, GM, Northwestern University, and the University of Iowa, and that the team seemed well developed and defined, with two industry partners sufficiently interested in the results to take project successes and incorporate them into commercial products. It was a bit early to judge the performance of the collaboration or coordination, but the project seemed to be planned to accomplish those elements successfully.

Reviewer 3:
The reviewer stated that the project team’s collaboration was being conducted with both LD and HD OEMs, as well as universities.

Reviewer 4:
The reviewer noted that the project would be carried out with partners from all relevant disciplines.

Reviewer 5:
The reviewer observed that the project team’s coordination was with Caterpillar but there was little knowledge of what other participants were doing.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer reported that the future research plans would be exploring several interesting areas, including precipitate and void formation as a function of the cooling temperature. The team would continue with the alloy development processes, the reviewer said, and the goal of correlating microstructures to optimal properties was good.

Reviewer 2:
The reviewer stated that project team had a good approach.

Reviewer 3:
The reviewer stated that the project team had a good work plan.

Reviewer 4:
The reviewer noted that leveraging relationships, which could lead to commercial development of results, was the key to success of the project.

Reviewer 5:
The reviewer acknowledged that the planned approach for future research appeared to be logically planned, and relied upon previous projects and tool development. Time will tell whether the desired outcomes would be achieved, and thus whether the planned activities actually would make sense.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer observed that the project was targeted at producing cost-effective, lighter-weight, high-performance components for engines in order to increase overall engine efficiency.

Reviewer 2:
The reviewer stated that the project's team was an important part of a larger effort.

Reviewer 3:
The reviewer commented that lighter engine components led to more efficient vehicles.

Reviewer 4:
The reviewer indicated that the cast steel crankshafts could reduce the weight relative to current materials and potentially reduce the cost by eliminating machining steps. In this regard, the project was relevant to the DOE's objectives.

Reviewer 5:
The reviewer stated that project did not directly support the overall DOE objectives, and pointed out that the project was more a (very interesting) cost/price reduction investigation.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that the project's resources appeared to be sufficient to complete the work as described in the project.

Reviewer 2:
The reviewer stated that the resources appeared to be sufficient at this time.

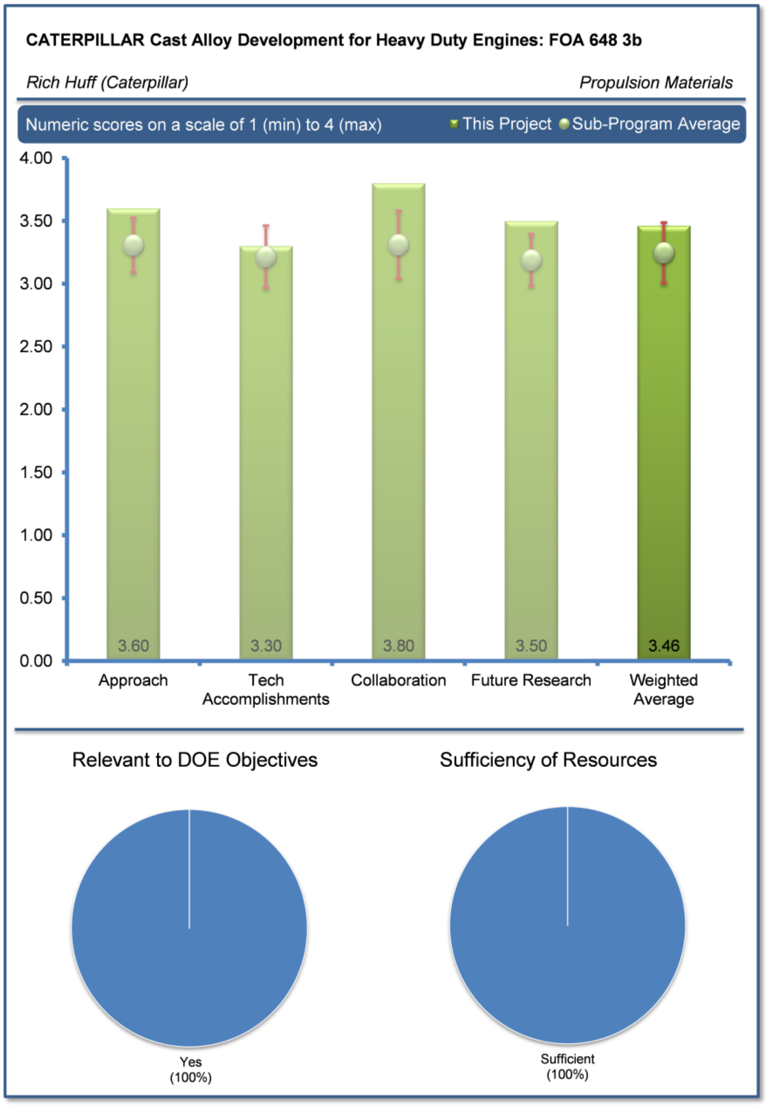
Reviewer 3:

The reviewer noted that the project funding appeared to be adequate.

Reviewer 4:

The reviewer noted that more resources do not automatically lead to better results.

CATERPILLAR Cast Alloy Development for Heavy-Duty Engines: FOA 648 3b: Rich Huff (Caterpillar) - pm059



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the project approach was very complete, with all factors mentioned in the overview, where some had criteria and others had to be judged in combination with other criteria. Machinability was also taken into account. The reviewer added that a new element in the approach was to create a three-dimensional (3D) image and with that new ways can be found for enhanced materials, or ways to avoid problems in existing materials.

Reviewer 2:

The reviewer explained that the project's study of cast iron for HD was a good complement to the LD aluminum work. A unique aspect of this work was using DOE laboratory resources, the ANL APS, to identify the 3D graphite structure material properties. The reviewer added that this was a very interesting approach that took advantage of the unique laboratory capabilities, where initial casting trials were showing good improvements in tensile strength. The project approach seemed logical in general.

Reviewer 3:

The reviewer observed that it was a well-coordinated project that addressed critical goals.

Reviewer 4:

The reviewer commented that the project team's approach appeared logical and demonstrated strong knowledge of the specific barriers needing to be addressed. The project relied heavily upon tools and facilities previously developed and in-place, particularly at ANL and the University of Alabama at Birmingham (UAB). The reviewer noted, in particular, that the industry was leading this project, and had worked to set many of the technical objectives.

Reviewer 5:

The reviewer noted that the project approach was a mix of ICME techniques and APS assessments used to identify candidate materials for specific applications.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer stated that good accomplishments were demonstrated in the project's presentation, where the work focused on microstructure development during iron solidification. Use of the ANL APS to identify nucleates in the graphite network was important and had been used to guide follow-on microstructure work. The reviewer added that the modeling work, for example, the solidification of eutectic alloys, was also adding to the body of knowledge.

Reviewer 2:
The reviewer commented that it appeared that the Caterpillar team had successfully established a baseline to identify and model critical mechanisms that impacted the microstructure formations during cast iron solidification, and that the project remained on target.

Reviewer 3:
The reviewer reported that the project had a few delays, but the causes appeared to have been resolved, and the project was now moving forward, albeit a bit behind in overall schedule. This delay was particularly true for the machinability baseline work, which now appeared to be scheduled for completion this summer rather than the end of calendar year 2013, and delays along the way resulted in scheduling issues for the specific equipment needed to complete the step. The reviewer noted that otherwise, the project appeared to be accomplishing what it set out to technically, and with its work particularly in the area of graphic core chemical analysis, might be poised for what could be some groundbreaking results.

Reviewer 4:
The reviewer noted that the project's progress was good but still in the early stages. The project team was finding cause-and-effect relationships but lacked an understanding of why.

Reviewer 5:
The reviewer commented that inoculant variant showed finer grain in all different thicknesses, which was a desired property. The tensile strength was also higher, but the relation with the grain, as seen as a function of the thickness and the strength, was not very clear. The reviewer also noted that the lower of the inoculant was not clear.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that Caterpillar, the project lead, appeared to be working closely with ANL and UAB in particular, while relying upon QuesTek where needed. The project also associated with key experts at Northwestern University and Bradley University to supplement specific technical areas. The reviewer noted that in particular, the project team's coordination and collaboration was allowing the project to make full use , not only of the required expertise, but of the unique tools and facilities the collective team brought.

Reviewer 2:
The reviewer commented that the project had an excellent team.

Reviewer 3:
The reviewer observed that the team included a good balance of OEM, supplier, and university participants, including a modeling specialist.

Reviewer 4:
The reviewer noted that the project team had a close collaboration with ANL.

Reviewer 5:
The reviewer stated that the project was carried out with partners from all relevant disciplines.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer affirmed that it was a very good project.

Reviewer 2:
The reviewer commented that the future work for this project seemed to be reasonable and continued with the path identified by current work. Additional, the APS work would be useful for the project.

Reviewer 3:
The reviewer mentioned that the project's future plans appeared to be logically laid out and focused on addressing the remaining areas necessary for completion of the project. The reviewer expressed only one concern, namely that most of the modeling and analysis work was still to be completed, and given delays to date, it was currently unclear if all would be completed on time.

Reviewer 4:
The reviewer commented that the proposed future work appeared appropriate, to stay on plan and assess materials through casting trials, and assess the potential for the new materials performance.

Reviewer 5:
The reviewer stated that it was mentioned that the ICME tool was not very usable, but it would make this project stronger if data that could be used to enhance the ICME tool could be generated.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer pointed out that the project was focused on higher-performance and lighter-weight materials for engines. Not only would this result in efficiency increases for the engine due to its reduced weight, but it also would allow for offsetting vehicle weight increases elsewhere due to environmental, safety, and other systems.

Reviewer 2:
The reviewer commented that if the project's aim for weight savings and weight reduction enabled future lightweight vehicles, and/or vehicles with more cargo load capacity, it would therefore be beneficial to fuel consumption reduction, which would lead to reduction of oil imports.

Reviewer 3:
The reviewer noted that the project involved competitive cost and lightweight engine block material, which was an alternative to cast iron.

Reviewer 4:
The reviewer indicated that this project was relevant to the DOE goals of engine efficiency because increased efficiency would likely mean increases in peak cylinder pressure that would have to be addressed with similar material enabling technologies.

Reviewer 5:
The reviewer indicated that engine efficiency could be improved through both lightweighting and allowing operation at higher pressures.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the resources appeared to be sufficient at this time.

Reviewer 2:

The reviewer noted that project's resources appeared sufficient to complete the work as described.

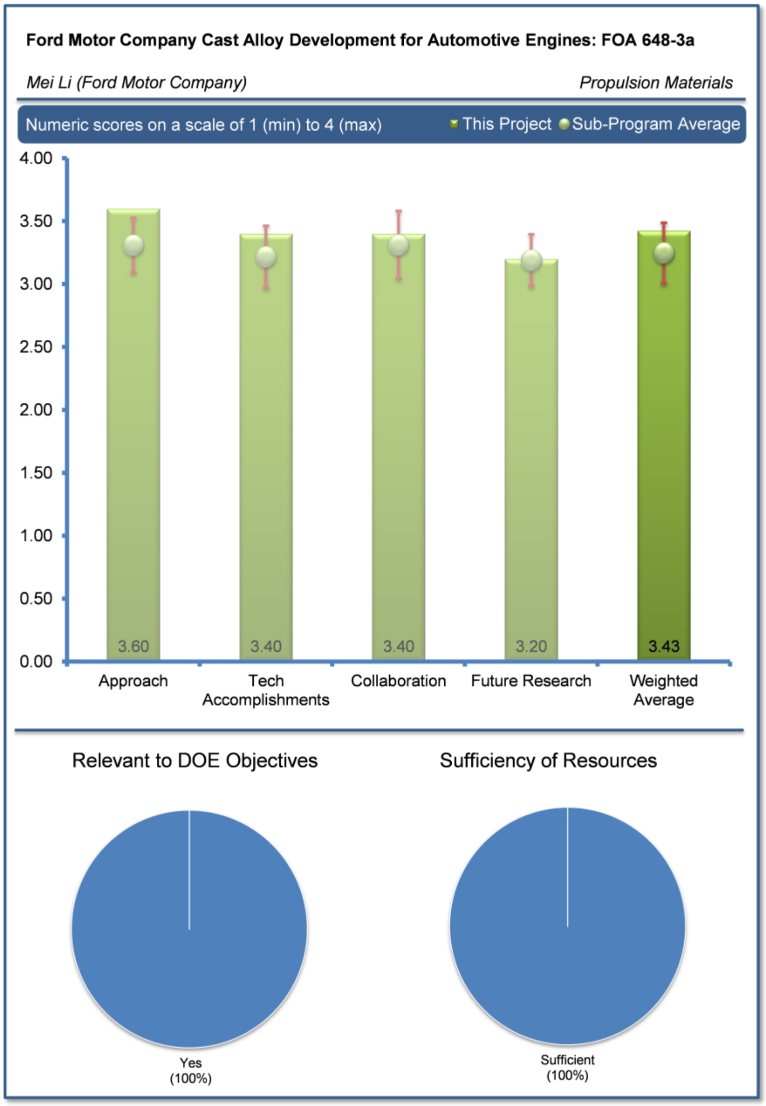
Reviewer 3:

The reviewer described that it appears that the resources were sufficient for this project.

Reviewer 4:

The reviewer commented that more resources do not automatically produce better results.

Ford Motor Company Cast Alloy Development for Automotive Engines: FOA 648-3a: Mei Li (Ford Motor Company) - pm060



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project had a very logical approach dealing with combination of material properties and cost considerations. Making use of ICME connected this project with others in the portfolio, which is interesting to compare the final results across the different projects.

Reviewer 2:

The reviewer indicated that the project had a thorough approach with all cost aspects included by using the "Technical Cost Model - Sand Casting Process Flow Diagram Assumption."

Reviewer 3:

The reviewer stated that the project appeared logically laid-out and focused upon addressing the identified materials barriers, and included not only development and testing of potentially higher-strength materials, but also resolving gaps in modeling tools. The reviewer added that the project appeared to build appropriately upon previously developed material formulations, and to be targeted for addressing specific engine design applications.

Reviewer 4:

The reviewer stated that the project had all pieces in place to develop aluminum alloy for high-performance engines. ICME modeling, cost model assessment, and tech transfer and commercialization were all needed to improve the likelihood of the project's success. The reviewer added that the coordination with GM and Chrysler with ORNL, if possible, should be encouraged, as there might be an opportunity to leverage the work being performed under projects pm061 and pm062.

Reviewer 5:

The reviewer noted that the project's alloy design was lacking.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer explained that a comprehensive cost model had been developed for the casting process. A number of alloy compositions had already been created for the project, and good material properties were already being shown. The reviewer added that the accomplishments were good given that the project was only 30% complete.

Reviewer 2:
The reviewer noted that 13 potential alloys were identified and tested, which had given an indication of a better baseline composition.

Reviewer 3:
The reviewer commented that the project had created 13 alloys to establish a baseline for further research, and with the first promising results produced, the next step can be made.

Reviewer 4:
The reviewer articulated that the project appeared to be largely on schedule, where efforts to date had shown seven alloys meeting DOE yield strength criteria, and the project had already identified several key reasons for these results that were focused on the specific elemental composition of the alloys.

Reviewer 5:
The reviewer expressed that a clear pathway to a marketable alloy is lacking. Many were being evaluated but the information to design a new one was lacking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer explained that the project team was led by an industry member - Ford, and included Alcoa, Nemak, MAGMA Foundry, and the University of Michigan. The project lead appeared to be utilizing the partners where needed, although efforts to date, possibly due to phase of the project, appeared to have focused primarily upon the team lead's activities. The reviewer added that it was expected that there might be more cooperative activities as this project moves along.

Reviewer 2:
The reviewer commented that Ford appeared to be collaborating with a good set of partners, including a partner (Nemak) with expertise in casting of aluminum cylinder heads which are the specific components to be addressed, and a partner (MAGMA) that has casting simulation software. A separate slide on partners with their roles would be helpful to include in future presentations.

Reviewer 3:
The reviewer remarked that, in fact, there were three more-or-less competing projects, like SuperTruck, which meant that there were consortiums formed around every OEM and that it would be difficult for a research institute to collaborate with another institute that was involved in the competing project. All projects had involved a research institute, an OEM with machining expertise, a foundry, a university, and other experts.

Reviewer 4:
The reviewer commented that adding a national laboratory partner would help strengthen team.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that Slide 24 of the presentation showed that the proposed steps were very logical.

Reviewer 2:
The reviewer concluded that the project's future work plan would accomplish the goals of the project, where it was important to develop the cost models to ensure that these alloys would be considered for use in production engines. ICME gap analysis results might assist other projects in using this modeling process.

Reviewer 3:
The reviewer explained that the project's future activities seemed to be clearly focused on completing project objectives. In particular, these efforts should result in optimized alloys, addressing gaps in capabilities of existing technical models, and establishing a cost model.

Reviewer 4:
The reviewer stated that project team was continuing to assess and refine Al-Cu-Mg-silicon-vanadium-zirconium-Ni- titanium-based alloys for strength characteristics. The cost targets of 110% of incumbent alloys costs, appeared to be difficult to achieve using the proposed materials. The reviewer suggested the project team attempt to optimize a new alloy for both strength and cost.

Reviewer 5:
The reviewer noted that a cause-and-effect relationship was being developed between different alloy additions, but it was not a clear if a mechanistic understanding was being developed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that lighter materials led to lighter, more efficient vehicles.

Reviewer 2:
The reviewer indicated that project was focused upon higher-performance, lighter-weight materials for engines, which would result in fuel efficiency improvements. These improvements would be two-fold, including higher-efficiency operation of engines and lighter engines which would result in lighter vehicles.

Reviewer 3:
The reviewer stated that this project was relevant to DOE goals for advanced engine efficiency because materials such as these will be necessary to enable higher-temperature operation and ensure durability while reducing weight.

Reviewer 4:
The reviewer explained that lightweight materials that can withstand higher temperatures can help to reduce the weight of internal combustion engines, and therefore reduce fuel consumption by allowing more payload for HD vehicles, or less empty weight for LD vehicles.

Reviewer 5:
The reviewer stated that this project was relevant to DOE goals for advanced engine efficiency because materials such as these will be necessary to enable higher-temperature operation and ensure durability while reducing weight.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

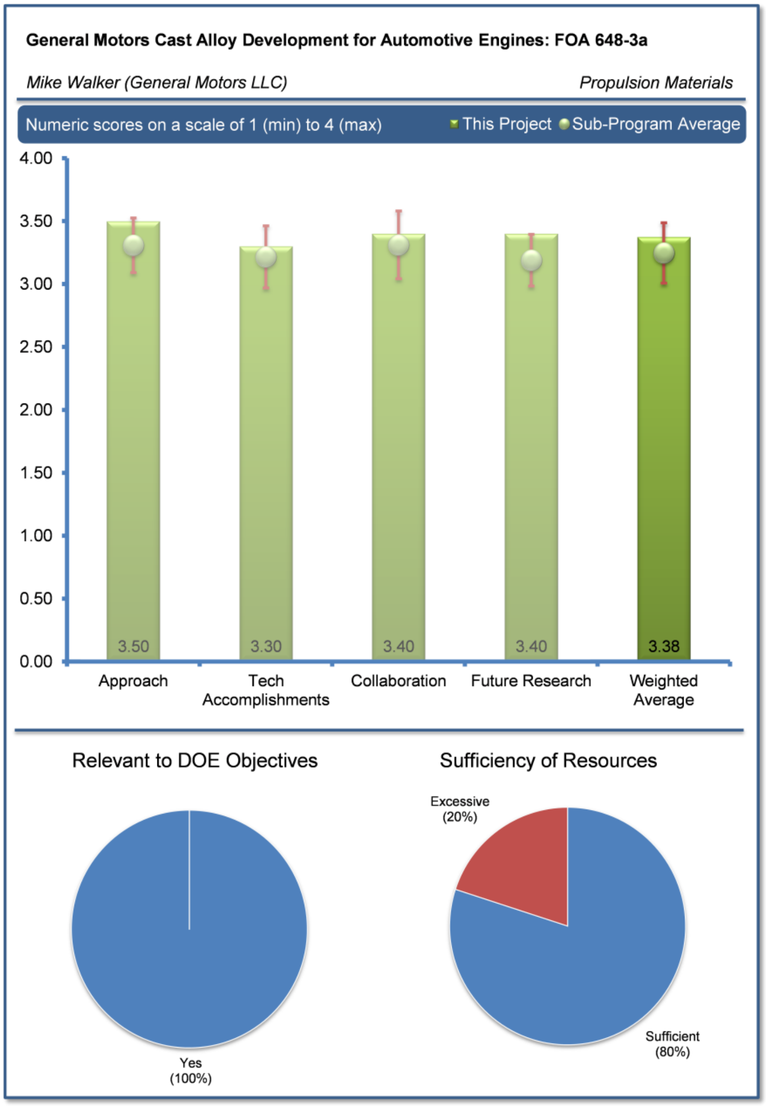
Reviewer 1:
The reviewer concluded that the project funding appeared to be sufficient to accomplish the tasks and was in line with other, similar projects in the Propulsion Materials portfolio.

Reviewer 2:
The reviewer reported that the project funding appeared to be sufficient.

Reviewer 3:
The reviewer commented that the project resources appeared sufficient at this time.

Reviewer 4:
The reviewer remarked that developing and validating a new material was a very costly and time-consuming process, but more resources do not automatically produce better results.

General Motors Cast Alloy Development for Automotive Engines: FOA 648-3a: Mike Walker (General Motors LLC) - pm061



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed that the project team's approach seems very logical and methodical in determining and ranking the most critical physical and thermal properties to meet requirements, then using experts to create alloys to achieve these requirements. The inclusion of cost models was very important, since if these alloys are too costly, they will not be used in large-scale production.

Reviewer 2:

The reviewer commented that the approach for the project appeared to be logically developed and focused on overcoming identified barriers. The project focused on evaluating candidate alloy formulations, developing test materials, evaluating the materials produced, and eventually, scaling up best candidate or candidates. The reviewer added that an additional element of the project was comparing the testing and modeling results, and evaluating existing models for analysis in order to address gaps. The performance objectives for the materials developed came from specific engine applications.

Reviewer 3:

The reviewer stated that the project team had a good approach with Design for Six Sigma tools. The reviewer said that it would have been interesting to know which tool was used in the selection process. In all three projects concerning cast alloys, there was discussion about the requirements that apparently were created by the DOE as outcome of a workshop and were the top ten of the requirements list. The reviewer expressed the need to know if these alloys could also be used for other sand cast Al parts that face high temperature and where current alloys have their limitations. Cast iron is currently being used in certain extreme applications, such as, turbo compressor housings for HD engines, where for LD, they are often die cast, and for boost pipe or additional coolers which have to specified in order to keep temperatures below the critical level.

Reviewer 4:

The reviewer explained that the project had a comprehensive approach for development of alloys, and well-defined performance metrics which allow a clear go or no-go decision. Coordination with Ford and Chrysler with ORNL, if possible, should be encouraged, as there might be an opportunity to leverage the work being performed under projects pm060 and pm062.

Reviewer 5:

The reviewer explained that the focus was on barriers but the approach was an evaluation of what was available and not really the development of new alloys.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that this project had some good accomplishments in its first year, including completion of the material requirement matrix, development of initial alloy concepts, casting of sample alloys, and initial properties testing. The priorities, which were very appropriate in the material requirement matrix, were clearly focused on production-capable materials.

Reviewer 2:

The reviewer reported that the project appeared to be on schedule and had prepared a detailed material requirement matrix, including ranking over 20 properties, identifying seven alloys for study, and conducting some of the analysis and measurements to identify properties. In addition, the PI indicated that the project team learned that it took more effort to identify more candidate materials than initially anticipated, and expressed that it was potentially due to the increased importance of thermal conductivity, which he saw as of greater importance, more than many other researchers had indicated.

Reviewer 3:

The reviewer noted that the project's progress to date was according to plan, which was detailed and well thought out.

Reviewer 4:

The reviewer indicated that seven alloys had been created, of which four had been modelled in a thermodynamic framework, and three had been identified by Density Functional Theory.

Reviewer 5:

The reviewer explained that the evaluation of the current alloys and analysis of the needs was good, but the progress or pathway to a new alloy was lacking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer indicated that the project team had a good list of partners included in the work, including several academic institutions and the American Foundry Society, an interesting addition as a technical advisor. The project team had well-defined roles as was outlined in the presentation.

Reviewer 2:

The reviewer stated that the project was led by an industry member, GM, who was positioned to take the results of this project and move forward. The team also included three industrial sub-partners and two university sub-partners; all chosen to provide specific or unique capabilities to the project. The reviewer added that given the stage of the project- approximately 25% complete - it was unclear how many of the partners had really been needed to date. Given their specific assignments, it was expected that they will be utilized appropriately throughout this project.

Reviewer 3:

The reviewer noted that adding a national laboratory partner would help strengthen the project team.

Reviewer 4:

The reviewer explained that, in fact, there were three more-or-less competing projects, including SuperTruck, which meant that there were consortia formed around every OEM, so it will be difficult for a research institute to collaborate with another institute involved in a competing project. All projects had involved a research institute, an OEM with machining expertise, a foundry, a university and other experts.

Reviewer 5:

The reviewer remarked that the project team was missing a major aluminum company to make the alloy.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project's future's work for 2014 was focused on validating the model findings, refining the alloy composition, and testing these revised materials. All these tasks were appropriate and pushed the work toward the 2014 go or no-go milestone related to model and experiment agreement.

Reviewer 2:

The reviewer commented that the project defines needs but does not yield the answers through the development of a new alloy.

Reviewer 3:

The reviewer noted that a commercialization plan should be developed in the project.

Reviewer 4:

The reviewer explained that the aim to develop better theory and models for optimization of the alloy was definitely the way to validate the alloy concept models through microstructural analysis and mechanical tests, or to develop parametric alloy systems from the validated alloy concepts. It would be nice if the researchers could explain in the 2015 session the link with the introduction of alternate chemical species to further improve high-temperature stability, ductility, fatigue properties and castability with the enhanced models.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that the project was focused on developing improved materials in order to allow higher-efficiency operation of engines.

Reviewer 2:

The reviewer explained that lightweight material that can withstand higher temperatures can help to reduce the weight of internal combustion engines, and therefore reduce fuel consumption (by allowing more payload to the vehicle for HD vehicles, or less empty weight for LD vehicles).

Reviewer 3:

The reviewer commented that this project's work was relevant to the DOE goals for advanced engine efficiency because materials such as these will be necessary to enable higher-temperature operation and ensure durability while reducing weight.

Reviewer 4:

The reviewer noted that lighter materials lead to a lighter and more efficient vehicle.

Reviewer 5:

The reviewer explained that with approximately 75% of the project left to go, there was a great deal of work still needing to be done. It appeared to be logically organized and should be able to address remaining objectives and barriers.

Reviewer 6:
The reviewer opined that a new alloy was needed for the project.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the resources appeared to be sufficient for this project, with GM providing cost share investment for the work.

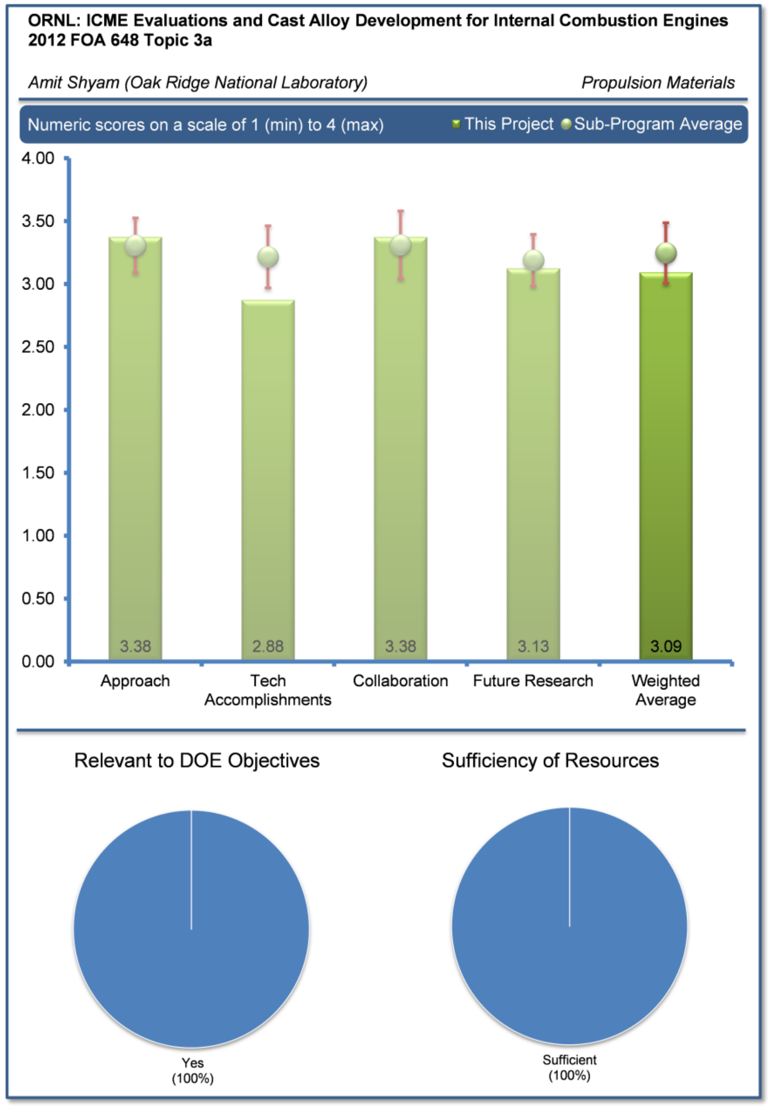
Reviewer 2:
The reviewer said that the project funding appeared to be sufficient.

Reviewer 3:
The reviewer noted that the resources appeared to be sufficient at this point.

Reviewer 4:
The reviewer commented that developing and validating a new material was a very costly and time-consuming process, but more resources did not automatically generate better results.

Reviewer 5:
The reviewer noted that since little alloy design is taking place without aluminum producer, too much funding was being spent without a pathway to a marketable alloy.

ORNL: ICME Evaluations and Cast Alloy Development for Internal Combustion Engines 2012 FOA 648 Topic 3a: Amit Shyam (Oak Ridge National Laboratory) - pm062



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the project had a thorough approach with ICME models and cost estimation but not as a final activity. This person acknowledged, however, that it was also early in the research.

Reviewer 2:

The reviewer stated that there the ICME approach to development of the new alloys was logical, and it was good to see that the plans include some sort of commercialization step, as well as the cost analysis, since both are important to eventual widespread use of the material. The gap analysis for ICME code would generally help users of this process more.

Reviewer 3:

The reviewer indicated that the approach was well defined; various commercial packages available are being evaluated. The reviewer added that one of the barriers identified was the non-availability of ICME-based alloy development and this project was one of three that address this issue.

Reviewer 4:

The reviewer remarked that the utilization of ICME to identify materials that meet or exceed baseline metrics might lead to ultra-high performing alloys. The reviewer added that coordination with Ford and GM, if possible, should be encouraged, as there may be an opportunity to leverage the work being performed under projects pm060 and pm061.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the project team was on track for the first major milestone, a selection of alloy family.

Reviewer 2:

The reviewer said that the project had been running for a year and the progress reported was adequate. The reviewer pointed out that only the characterization of the material is completed and ICME efforts are in progress. The reviewer stated that the problem is that the alloys being evaluated are all existing and do not have the required properties. The reviewer added that the predictions based on this effort might not be able to identify the high-strength alloys.

Reviewer 3:

The reviewer stated that it was difficult to judge, because the project had started later than the other two and no results were shown. Also, the reviewer noted that four baseline materials have been selected and delivered and are undergoing tests now. The reviewer said hopefully the researchers can explain in next year's review why the secondary dendrite arm spacing (SDAS) of approximately30 μm is such an important factor for the selection of these base materials.

Reviewer 4:

The reviewer indicated that the accomplishments were somewhat limited here, but the project has only been underway for a few months. The reviewer observed that the project team has already characterized the baseline materials, including microstructure characterization that will be used for ICME work.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that two major CRADA partners (Chrysler and Nemak) covered the OEM and supplier areas, and also included are software providers, some of which are participating in other, similar projects in the portfolio.

Reviewer 2:

The reviewer observed that the team was fully equipped and well balanced.

Reviewer 3:

The reviewer remarked that, in fact, there were three more-or-less competing projects, like SuperTruck, which means that there were consortia formed around every OEM and that it would be difficult for a research institute to collaborate with another institute involved in a competing project. All projects involve a research institute, an OEM with machining expertise, a foundry, a university, and other experts.

Reviewer 4:

The reviewer remarked that the project team was strong with national laboratory and industry partners. The reviewer said that adding an academic institution would strengthen the team even more.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the future work appeared to be logical and should accomplish the stated goals.

Reviewer 2:

The reviewer noted that hopefully the researchers can tell in the 2015 review how the link was made between the investigation of the baseline materials and the enhanced materials, or the new alloys.

Reviewer 3:

The reviewer commented that the project plan should provide a pathway to identify alloys with targeted performance. The reviewer added that any ultra-high-performing alloys that do not meet the cost parameters for this project should be identified and possibly assessed for other applications where cost is less of a concern.

Reviewer 4:

The reviewer reported that the team needed to look into newer alloy systems rather than existing alloys. The reviewer said that the new elements may be needed to be added to the existing alloys to improve high-temperature strength. The reviewer added that if the team was aware of this fact it is not evident from the presentation.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the lightweight material that could withstand higher temperatures can help to reduce the weight of the internal combustion engines and therefore reduce fuel consumption, by allowing more payload for HD vehicles or less empty weight for LD vehicles.

Reviewer 2:
The reviewer remarked that as the requirements for engine components are increasing, the time taken to develop new alloys is also increasing, and developing ICME-based models will accelerate this development and make powertrain components more efficient.

Reviewer 3:
The reviewer commented that this work is relevant to DOE’s efficiency goals, as these materials will enable lighter engines that can accommodate higher cylinder pressures and temperatures.

Reviewer 4:
The reviewer said that lighter materials will lead to a lighter and more efficient vehicle.

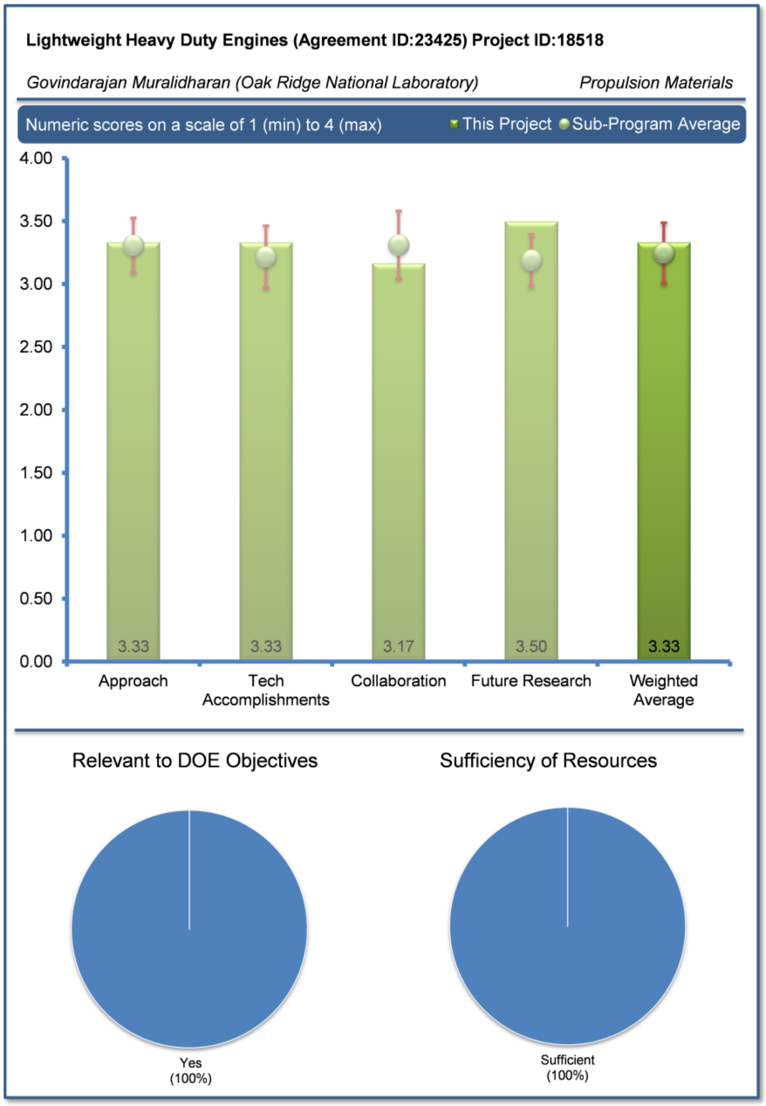
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that funding appeared to be sufficient.

Reviewer 2:
The reviewer reported that the funding appeared sufficient for this project. The reviewer added that the funding included a cost share of around $2 million beyond the DOE funding.

Reviewer 3:
The reviewer stated that developing and validating new material is very costly and time-consuming, but more resources do not automatically lead to better results.

Lightweight Heavy Duty Engines (Agreement ID:23425) Project ID:18518: Govindarajan Muralidharan (Oak Ridge National Laboratory) - pm063



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the low thermal conductivity aspect of this work was interesting as a way to improve efficiency by retaining heat in-cylinder. The reviewer added that the project team was focusing on pistons and exhaust manifolds as target components as a result.

Reviewer 2:

The reviewer commented that piston activities just started up. The reviewer stated that heat moves rapidly through a substance with high thermal diffusivity because the substance conducts heat quickly relative to its volumetric heat capacity or thermal bulk. The reviewer added that it was not completely clear why the selection was made for alloy 625 coatings applied to 4140 steels, probably the base piston material, at ORNL using laser-based technique. The reviewer also said that the exhaust manifold project had delivered first results that were very promising.

Reviewer 3:

The reviewer stated that a well-defined project plan was established and followed. The reviewer also observed a low-cost approach to solving the materials challenge.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer stated that the milestones appeared to be well on-track to meet goals, and progress has been good so far. The reviewer also said that it is good to see that an alloy previously developed by DOE researchers, CF8C-plus, was being used again for its optimal properties in exhaust applications. The reviewer added that piston coatings were an interesting idea to reduce heat conduction. The reviewer stated that it would be interesting to see how these coatings withstand conditions seen in combustion chambers. The reviewer presumed this had already been explored to some extent.

Reviewer 2:

The reviewer observed that the CRADA delay and lower funding levels had slowed progress; however, acceptable progress was still being achieved.

Reviewer 3:

The reviewer commented that, regarding the piston, it was not clear if the observed 25% decrease in thermal diffusivity up to 300ºC is a good step in the direction of meeting the goal. The reviewer added that, regarding the exhaust manifold, it was not clear how the materials were selected using finite element calculations. The CF8C-plus material performed well and has the best oxidation resistance. The reviewer reported that the D5S material showed a wide scatter; if there is a reason for the points at the left, and if these could be addressed, perhaps this material could be a cheaper candidate as well.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer stated that the project was between ORNL and Cummins and no other participants were identified or collaborations discussed explicitly, but it appeared that this should be sufficient.

Reviewer 2:

The reviewer pointed out that the project was a CRADA established between Cummins and ORNL.

Reviewer 3:

The reviewer said for the exhaust manifold there was a working relationship with a foundry, but for the piston, no company other than Cummins was mentioned. In the past, piston suppliers had done a lot of research on this topic, but perhaps not with the technology used in this project. The reviewer added that by involving a piston supplier perhaps some relevant information could be obtained.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the future work plan was appropriate and will be addressing the durability and manufacturing aspects of the coated/multi-material pistons, which will be important for the viability of the technology. The reviewer added that engine testing of the prototype CF8C-plus manifold was an appropriate next step.

Reviewer 2:

The reviewer indicated that this project leveraged the success of a previous project CF8C-plus where CF8C-plus was now being considered as a possible base alloy to improve specific properties needed for the piston application.

Reviewer 3:

The reviewer provided a more general, but applicable, observation that projects that are directly linked to a CRADA do not give many details about future research on which comments can be made.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer reported that this project was relevant to the DOE objectives of increased engine efficiency, as the materials developed would allow the increased operating temperatures and pressures likely required by future efficient engines.

Reviewer 2:

The reviewer said that lighter materials lead to a lighter, more efficient vehicle.

Reviewer 3:

The reviewer stated definitely for the piston. The reviewer added that for the exhaust manifold it was more a potential cost/price reduction, currently often for high-temperature application, the more expensive Ni-resist is used.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that resources appeared sufficient, and that the resources included a 50% cost share from Cummins, which showed a commitment from the OEM.

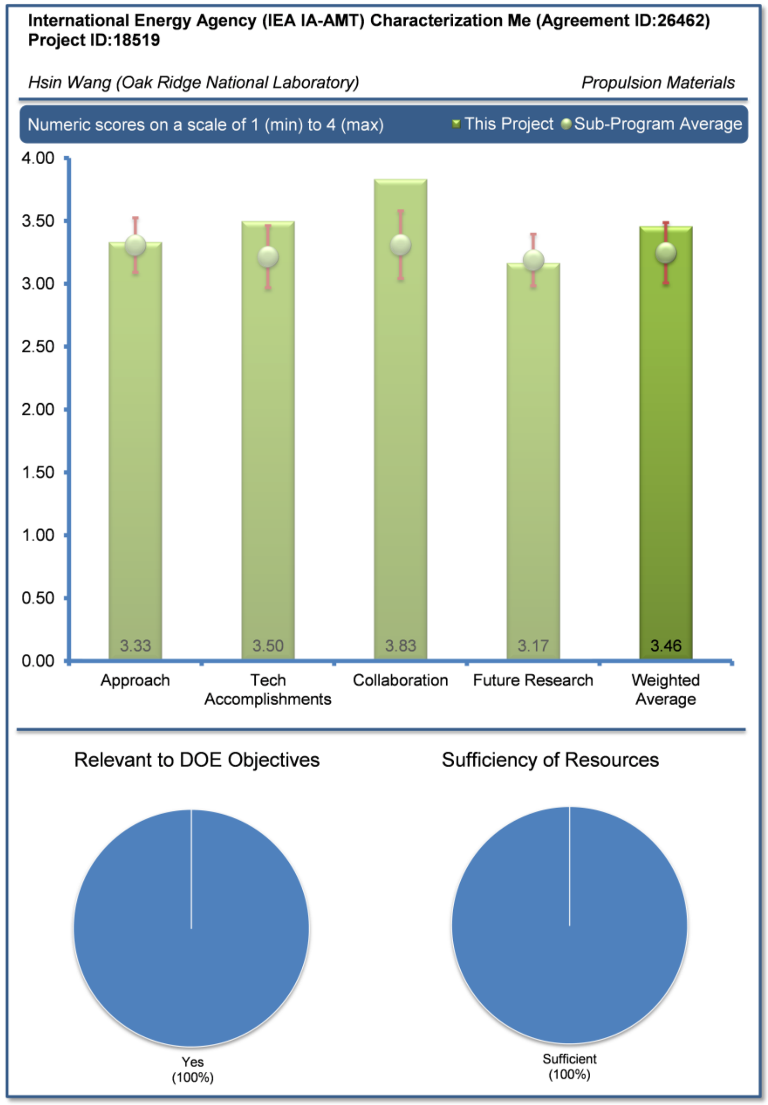
Reviewer 2:

The reviewer stated that funding appeared sufficient.

Reviewer 3:

The reviewer said that it was difficult to comment, because this was a CRADA with Cummins and no detailed planning for the whole project was shown.

International Energy Agency (IEA IA-AMT) Characterization Me (Agreement ID:26462) Project ID:18519: Hsin Wang (Oak Ridge National Laboratory) - pm064



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the approach to material property standardized testing via round robin testing was effective. Also, the reviewer said that international collaboration to improve consistency in testing was needed and this approach addresses that issue. The reviewer added that the go or no-go decision point allowed for a project exit, if needed.

Reviewer 2:

The reviewer commented that the approach to the round robin testing seems to have been successful and logical. The reviewer added that looking at the measurement implications at the materials and devices levels was a good idea.

Reviewer 3:

The reviewer observed that the introduction of new material standardization definitely helped, and also, in order to get consistent data, that can be used in simulation models.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer reported that the project team had completed round robin testing for multiple test labs. The reviewer added that there seems to be some improvement in the variability among labs, particularly on specific heat, a main source of error identified previously. Also, the reviewer stated that the team had considered factors affecting thermoelectric efficiency tests and proposed a reasonable solution for improving the accuracy of the tests.

Reviewer 2:

The reviewer commented that the round robin and survey was complete and that a report was under development.

Reviewer 3:

The reviewer stated that the project showed different results for the new material that can be used in future thermoelectric generator (TEG) systems for the different labs and the improvements from the last round-robin tests. Also, the results were the input for the Annex-VIII work. The reviewer added that it was not completely clear, especially for those laboratories that are using the same equipment, if the differences were due to noise, system accuracy, or other factors such as weight and load put on the sample or ambient conditions.

For the Seebeck coefficient, some laboratories used a different number of measuring points. The reviewer asked if it was possible to draw a conclusion for the desired number of points.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed that there was a wide-ranging and multi-national list of partners. The reviewer indicated that collaboration was necessary for round robin testing, and appeared to have been very good.

Reviewer 2:
The reviewer pointed out that very comprehensive partnerships were established.

Reviewer 3:
The reviewer commented that, world-wide, well-known laboratories were involved in this project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the development of international test standards through international collaboration would be an important future step for this work.

Reviewer 2:
The reviewer reported that it was not completely clear as to what should be the addition in Annex-XIX to Annex-VIII in which this future work has to go. The reviewer hoped that the researchers could make advisements to such international organizations as the International Organization for Standardization for a more detailed description about how the tests should be performed in order to reduce the differences in outcome, even if the same equipment was used.

Reviewer 3:
The reviewer indicated that additional materials should be considered for test standardization, specifically new interconnected materials.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that the waste-heat recovery systems could reduce fuel consumption, and added that new materials were needed for the TEG technology. The reviewer commented that this project was relevant for this reason.

Reviewer 2:
The reviewer commented that this work was broadly relevant to DOE goals for increased efficiency through advanced technologies; however, future relevance was unclear given DOE’s decision to discontinue thermoelectrics work.

Reviewer 3:
The reviewer said that lighter materials led to lighter, more efficient vehicles.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that funding appeared sufficient to complete this work.

Reviewer 2:
The reviewer said that funding appears sufficient.

Reviewer 3:

The reviewer remarked that more resources would not speed-up these kind of activities in which many external partners are involved.

Acronyms and Abbreviations

Acronym	Definition
3D	Three-dimensional
Ag	Silver
AHSS	Advanced high-strength steel
Al	Aluminum
AMR	Annual Merit Review
ANL	Argonne National Laboratory
APS	Advanced photon source
ASC	Ammonia slip catalyst
BTE	Brake thermal efficiency
C	Carbon
Ca	Calcium
CFC	Carbon fiber composites
CFD	Computational Fluid Dynamics
CI	Compression ignition
CRADA	Cooperative Research and Development Agreement
Cu	Copper
DOD	Department of Defense
DOE	Department of Energy
DPF	Diesel Particulate Filter
EGR	Exhaust Gas Recirculation
EV	Electric Vehicle
FSP	Friction Stir Processing
FSW	Friction Stir Welding
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
GM	General Motors Corporation
HC	Hydrocarbon
HD	Heavy-Duty
HDD	Heavy-Duty diesel
HOV	High-occupancy vehicle
HVAC	Heating, ventilation, and air conditioning
ICME	Integrated Computational Materials Engineering
IP	Intellectual Property
K	Potassium
LCCF	Low-cost carbon fiber
LD	Light-duty
Mg	Magnesium
MMV	Mapping, modeling and visualization
MMV	Multi-material vehicles
MPa	Megapascal
Na	Sodium

Acronym	Definition
NASA	National Aeronautics and Space Administration
N_2	Nitrogen
N_2O	Nitrous oxide
NDE	Non-destructive evaluation
Ni	Nickel
NO_x	Nitrogen oxides
NREL	National Renewable Energy Laboratory
NTRC	National Transportation Research Center
NVH	Noise, vibration, and hardness
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
Pt	platinum
PZT	Lead zirconate titanate
R&D	Research and Development
SAE	Society of Automotive Engineers
SCR	Selective catalytic reduction
SDAS	Secondary dendrite arm spacing
Si	Silicon
TEG	Thermoelectric Generator
UAB	University of Alabama at Birmingham
USCAR	U.S. Council for Automotive Research
VTO	Vehicle Technologies Office
WBG	Wide Bandgap

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8. Technology Integration

The Technology Integration subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles to help meet national energy and environmental goals and accelerate dissemination of advanced vehicle technologies through demonstrations and education. This subprogram's efforts logically follow successful research by industry and government and help to accelerate the commercialization and/or widespread adoption of technologies that are developed in other Vehicle Technologies Office (VTO) program areas. Deployment activities linked to research and development (R&D) also provide early market feedback to emerging R&D.

Subprogram functions include both regulatory and voluntary components. The regulatory elements include legislative, rulemaking, and compliance activities associated with alternative fuel requirements identified within the Energy Policy Acts of 1992 (EPAct 1992) and 2005 (EPAct 2005), as well as the Energy Independence and Security Act of 2007. EPAct transportation regulatory activities aim to reduce U.S. petroleum consumption by building a core market for alternative fuel vehicles (AFVs).

Voluntary efforts include demonstration of advanced technology vehicles to verify market readiness and public information, education, outreach and technical assistance efforts. VTO works with public/private partnerships between the U.S. Department of Energy (DOE) and local coalitions of key stakeholders across the country (such as through Clean Cities) to implement strategies and projects that displace petroleum. Clean Cities helps to advance the nation's economic, environmental, and energy security by supporting local actions to reduce petroleum consumption in transportation. A national network of nearly 100 Clean Cities coalitions brings together stakeholders in the public and private sectors to deploy alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies. These stakeholders come together to share information and resources, educate the public, help craft public policy, and collaborate on projects that reduce petroleum use. Clean Cities' primary goal is to cut petroleum use in the United States by 2.5 billion gallons per year by 2020. Since the program's inception in 1993, Clean Cities coalitions and stakeholders have saved more than 5 billion gallons of petroleum.

Education aids in overcoming institutional barriers to widespread use of advanced vehicle technologies and alternative fuels, and serves to train the next generation of participants in this technology sector. Activities such as the Advanced Vehicle Competitions (EcoCAR) and Graduate Automotive Technology Education (GATE) encourage the interest of university student engineers and engage their participation in advanced technology development and are discussed more below.

- *Student Competitions:* VTO has hosted student competitions (such as EcoCAR-the NeXt Challenge, EcoCAR 2, the Automotive X Prize, etc.) in advanced vehicle technologies for more than 25 years to educate the next generation of automotive engineers and accelerate the development of vehicle technologies. The latest competition, EcoCAR 2, required students to explore a variety of powertrain architectures and follow a real-world engineering regimen modeled after GM's Global Vehicle Development Process using a Chevrolet Malibu as the integration platform for their advanced vehicle design.
- *Graduate Education:* VTO's graduate education program (GATE) supports efforts at top universities to train a future workforce of automotive engineering professionals in developing and commercializing advanced automotive technologies. These universities' multidisciplinary curriculums and unique laboratory facilities will prepare students to overcome technology barriers preventing the development and production of cost-effective, high-efficiency vehicles for the U.S. market.
- *Workforce Development and Professional Education:* Through its workforce development programs, VTO partners with non-profit organizations that offer training on a variety of alternative vehicle technologies. This training builds a strong workforce that can develop, build, repair, and respond to these vehicles. In addition to formal instruction, DOE and its partners host several events and conferences each year to gather automotive experts and foster information sharing and innovations such as the Directions in Engine-Efficiency and Emissions Research Conference (DEER) and the Vehicle Technologies Office Annual Merit Review and Peer Evaluation meetings. Also, the Green Racing partnership between DOE, EPA, and SAE provides outreach to the public on alternative fuels and advanced vehicles being used in automobile racing. Other resources that may be useful to student researchers include VTO's Annual Reports describing the results of our research, vehicle modeling software, transportation system analysis software tools, or the Fact of the Week featuring the latest information about energy and automotive markets.

In addition, the annual DOE/U.S. Environmental Protection Agency (EPA) Fuel Economy Guide publication and related data dissemination efforts (required by law) are produced, along with the website www.fueleconomy.gov.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Connie Bezanson, Dennis Smith (U.S. Department of Energy) – ti000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer exclaimed that there was absolutely adequate coverage.

Reviewer 2:
The reviewer said that the overall program area, including all of the activities worked on such as Clean Cities, legislative and rulemaking, advanced vehicle competition and educational programs, were described very well. The strategy for deployment, which is to implement national policies and initiatives facilitating change on a local and national basis, was presented.

Question 2: Is there an appropriate balance between near-, mid- and long-term research and development?

Reviewer 1:
The reviewer responded yes, and stated that the program has the right balance. The reviewer observed that the local vehicle technologies demos/deployments address near-term technology, the vehicle competitions experiment with mid-term technologies, and the education programs prepare the industry for the long-term.

Reviewer 2:
The reviewer pointed out that since this program area is related to deployment, it does not contain a research and development component.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer commented that issues and challenges were identified, including the lack of public awareness and consumer acceptance of new vehicle technologies, and that consumers need to change their related driving and purchasing habits.

Reviewer 2:
The reviewer said important issues were not directly identified. The reviewer explained that the issues and challenges are mostly assumed and understood by those in the industry. It would be worthwhile to articulate the specific challenges that new vehicle technologies face and how each program element addresses the challenges. The reviewer acknowledged that the persistent challenge is that introducing new technologies to consumers and fleets is always difficult; this part is assumed. However, according to the reviewer, the specific challenges of various technologies change over time as the technology matures and the landscape of regulations, fuel availability, consumer preference, and politics changes. The program will have to be agile to be effective. Seeing a multi-year strategic plan would be very helpful.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer remarked that these challenges are being addressed through the Clean Cities deployment efforts in this program.

Reviewer 2:
The reviewer said yes, and explained that the briefing is mostly focused on the planned programs to address the issues.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer observed that progress continues to be excellent in this program area. The reviewer noted over 6 billion gallons in petroleum reduction since 1993. In addition, Clean Cities continues to make great progress by adding more coalitions and expanding

the National Clean Fleets Partners program. The reviewer commented that training the next generation of engineers continues to make progress and has been a very important part of the program for over 26 years. EcoCAR2 and 3, and the next advanced vehicle technology competition series, give students excellent real word experience.

Reviewer 2:

The reviewer said yes, but only for petroleum reduction.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer pointed out that through the success of this deployment activity, this program can point to actual gallons of petroleum that have been displaced, which of course is the ultimate goal of the VTO.

Reviewer 2:

The reviewer responded mostly. The reviewer indicated that the program works best for vehicle fleets. For individual passenger car consumers, this reviewer thought the program is largely invisible. To achieve acceptance of new passenger car fuel technologies by the general public, there needs to be a large outreach campaign to educate and dispel myths about the new technologies. The reviewer noted that the level of misinformation published by the press and available on the internet needs to be countered by a credible source, such as DOE. For instance, the reviewer pointed out there was a press release posted for a new “zero-emission” transit bus delivery when the bus was just a new “clean” diesel bus. There is also a misunderstanding about compressed natural gas (CNG) and propane as being zero-emission.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO’s needs?

Reviewer 1:

The reviewer responded yes, this project continues to be well managed and as evidenced by the progress made in all areas is a very effective program.

Reviewer 2:

The reviewer commented that the program is great overall. The reviewer recommended that additional focus could help bring the best solutions forward faster. It seems like the program’s focus is to bring all technologies forward, which helps create a greater number of mediocre solutions. The reviewer commented that mediocre solutions can hurt the adoption rate and make consumers wary of trying new technology in the future.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:

The reviewer commented that the Clean Cities project, which now has 100 coalitions and covers 80% of the U.S. population, has been an outstanding effort for over 20 years and will continue to provide an excellent way to get alternative fuel vehicles introduced to the public.

Reviewer 2:

The reviewer commented that the fleet deployments and the EcoCAR challenges are great strengths. The reviewer observed that the passenger vehicle information and outreach, and the education program, need a boost to get visibility with the general public.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer commented that providing opportunities for students to work on vehicles through the student competitions is a very unique way to both educate future engineers and to move them into the workforce with real world experience on advanced technology vehicles.

Reviewer 2:
The reviewer remarked that the EcoCAR challenge series is very innovative and seems like a win-win scenario for all involved.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer noted that partnering is one of the key elements of this program. The reviewer commented that working with all of the Clean Cities coordinators, as well as the colleges and universities through vehicle competitions, make this program a real success.

Reviewer 2:
The reviewer said yes, and elaborated that the program has many great partners.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer commented that as evidenced by the amount of petroleum displaced, and the number of students that have been prepared to enter into the workforce to continue their work on alternative fuel vehicles, this program is very effective at collaborating with its partners.

Reviewer 2:
The reviewer said that without having any specific working knowledge, it would appear that the collaboration is adequate.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer said that the portfolio of technologies that are evaluated in this program is very comprehensive.

Reviewer 2:
The reviewer commented that the full range of technologies was not identified, but this reviewer assumed that all have access for entry when and where appropriate.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer was unaware of topics that are not adequately addressed.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer commented no.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer remarked no, the current approach seems to be a very effective way to approach the barriers.

Reviewer 2:

The reviewer recommended promoting other metrics for the program overall and for the individual vehicle technology deployments. The reviewer suggested focusing on life-cycle cost estimates and emission reductions.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer commented that if DOE provided more funding in this area, the program may be able to reduce petroleum consumption more rapidly than currently planned.

Reviewer 2:

The reviewer suggested adding or reformulating the outreach component for passenger cars. The reviewer suggested that the program establish methods for the general public to get the truth out about the state of new technology and what is being done to alleviate consumer concerns about range anxiety, safety, and fuel availability. The reviewer also suggested providing a fuel station forecast by locality so that people could see what was planned for their area, a means for consumers to express interest in certain types of fuel, and stimulating more interest in alternative fuels to create more technology pull. As a consumer, this reviewer may have a technical interest in natural gas, but would quickly lose interest if it could not be readily determined whether it will be available in the reviewer's operating area. The reviewer opined that electricity will likely be the primary future passenger car fuel, but expressed some doubt.

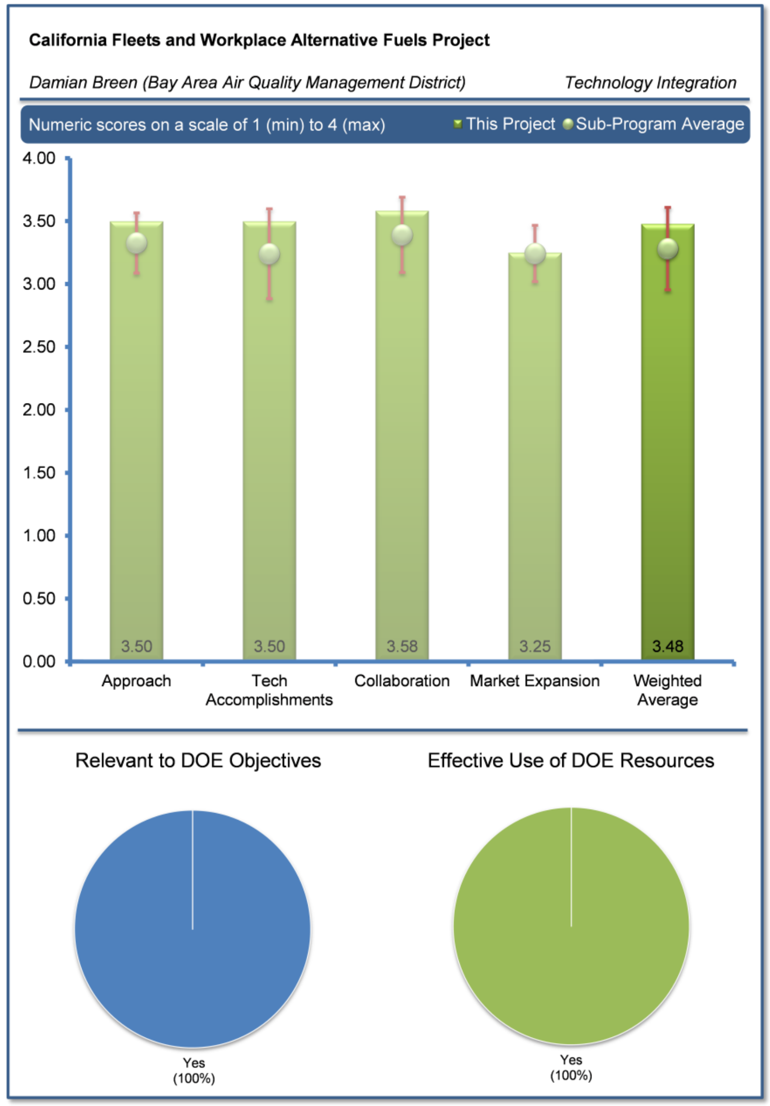
Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
California Fleets and Workplace Alternative Fuels Project	Damian Breen (Bay Area Air Quality Management District)	8-9	3.50	3.50	3.58	3.25	3.48
Fast Track to Ohio AFV Adoption	Sam Spofforth (Clean Fuels Ohio)	8-14	3.58	3.58	3.50	3.33	3.54
Advancing Alternative Fuel Markets Adoption and Growth	Ron Flowers (Greater Washington Region Clean Cities Coalition)	8-19	2.88	2.75	3.25	3.13	2.89
Unlocking Private Sector Financing for Alternative Fuel Vehicles and Fueling Infrastructure	Kate Marks (National Association of State Energy Officials)	8-23	3.25	3.25	3.25	2.92	3.21
Pennsylvania Partnership for Promoting Natural Gas Vehicles	Robert Graff (Delaware Valley Regional Planning Commission)	8-28	3.30	3.10	3.40	3.00	3.18
I-40 Collaboration of Clean Cities	Adriane Jaynes (Tulsa Area Clean Cities)	8-33	3.30	3.30	3.50	3.40	3.34
Accelerating Alternatives for Minnesota Drivers	Lisa Thurstin (American Lung Association of the Upper Midwest)	8-37	3.40	3.40	3.40	3.40	3.40
Advancing Alternative Fuel Markets Adoption and Growth	Kelly Gilbert (Metropolitan Energy Center, Inc.)	8-41	3.25	2.75	3.38	3.13	3.00
Michigan Fuel Forward	Sean Reed (Clean Energy Coalition)	8-44	3.50	3.50	3.50	3.50	3.50
Lake Michigan Corridor Alternative Fuel Implementation Initiative	Ted Barnes (Institute of Gas Technology)	8-48	3.25	3.25	3.38	3.13	3.25
Removing Barriers, Implementing Policies and Advancing Alternative Fuels Markets in New England	Jennifer Puser (Greater Portland Council of Governments)	8-52	3.38	3.25	3.63	3.13	3.31
Alternative Fuel Market Development Program - Forwarding Wisconsin's Fuel Choice	Maria Redmond (Wisconsin Department of Administration)	8-55	3.13	2.88	3.25	3.25	3.03
Refuel Colorado	Cabell Hodge (Colorado Energy Office)	8-59	3.25	3.38	3.25	3.50	3.34
Advancing New Mexico's Alternative Fuels	Louise Martinez (New Mexico Department of Energy, Minerals & Natural Resources)	8-62	3.25	3.38	3.38	3.38	3.34
Central Texas Fuel Independence Project	Andrew Johnston (City of Austin)	8-65	3.75	3.58	3.92	3.75	3.69
A Recipe for Fueling Diversity in the Energy Capital of the World	Allison Carr (Houston-Galveston Area Council)	8-69	2.90	2.20	2.30	2.80	2.46
Southeast Regional Alternative Fuels Market Initiatives Program	Steve Clermont (Center for Transportation and the Environment, Inc.)	8-73	3.20	3.20	3.60	3.10	3.24
Advancing Alternative Fuel Markets in Florida	Colleen Kettles (University of Central Florida)	8-77	3.10	3.30	3.50	3.10	3.25

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Alternative Fuels Implementation Team (AFIT) for North Carolina	Anne Tazewell (North Carolina State University)	8-80	3.80	3.80	3.60	3.50	3.74
Moving North Texas Forward by Addressing Alternative Fuel Barriers	Mindy Mize (North Central Texas Council of Governments)	8-84	3.60	3.50	3.30	3.20	3.46
Overall Average			**3.33**	**3.24**	**3.39**	**3.25**	**3.28**

California Fleets and Workplace Alternative Fuels Project: Damian Breen (Bay Area Air Quality Management District) - ti035



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the approach of developing safety and training initiatives, and holding best practices workshops for fleets and local governments, in addition to the statewide forums and workshops, should allow the project to meet its objectives. The market development and outreach initiative tasks would also be useful to the project’s success.

Reviewer 2:

The reviewer commented that the project’s approach was well organized and addressed the following: safety and training; identification and reduction of barriers to electric vehicles (EVs), natural gas (NG) and hydrogen (H_2) vehicle adoption; policy initiatives; and promoting awareness and market development.

The reviewer noted the scope of work focuses primarily on EVs, plug-in electric (PEV), NG, and H_2 vehicles. The reviewer also noted that the primary focus is on workplace fleets, with less focus on the general public. The reviewer observed there is a significant emphasis on identifying needs for training and developing training to fulfill the needs. The development of best practices and cost of ownership tools is a strength of the project. The reviewer noted that the project also targets Chief Executive Officers (CEOs) of companies through workshops. Overall, the reviewer remarked the project had a strong approach.

Reviewer 3:

The reviewer stated that compiling a best practices tool kit for H_2, compressed natural gas (CNG), and EV safety is important to the fleets, and recommended that the information be searchable so that users can find the information relevant to their areas of interest easily.

Reviewer 4:

The reviewer observed that training is a vital element in the successful introduction of alternative fuels. Conducting an assessment of training in California, as a prelude to developing new courses and materials, is appropriate and prudent.

By focusing on and getting buy-in from CEOs, the reviewer observed that the project was going after the right audience. The reviewer also noted there seemed to be significant attention to developing best practices. The reviewer would like to know more about the extent to which the project uses previous work documenting best practices and toolkits, to be assured that the project is not duplicating material already developed. The reviewer noted that the presenter stated that the project is coordinating with DOE's H_2 program and using materials developed by other DOE efforts.

Reviewer 5:

The reviewer liked how this project targets CEOs and first responders and seems to be reaching a large audience. The reviewer was not sure why the project only targets EVs, H_2, and NG, and posed that question to the presenter. The presenter responded that there is funding for H_2 in California that the project team tapped into, and that when the project team asked California Clean Cities coalitions about other fuels they should target, NG was mentioned. Additionally, the presenter noted that the Bay area has more propane stations than CNG already.

The reviewer also applauded the best practices documents generated, and the plans to expand the best practices guides to other fuels, despite not receiving funding for this. The reviewer noted that all the presentations appeared to target firefighters and first responders. The reviewer noted that DOE may want to pursue this issue nationally, because grant funds were already being used to develop programs regionally. There would be overall savings if DOE worked with fuel advocacy groups, such as the Propane Education and Research Council (PERC), to develop one best practices document that could be distributed nationally. The reviewer offered that PERC and the NG industry both have the knowledge and the funding to implement this.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer stated that the safety and fire marshal best practices are applicable to the entire state because the project team is partnering with 13 Clean Cities coalitions throughout California. The reviewer explained that this information is useful to ensure the ease of transition to these alternative fuels, and particularly H_2, which is not as prevalent as CNG and EV in most markets.

Reviewer 2:

The reviewer remarked that accomplishments to date have been very good. The reviewer thought it was excellent that at the CEO-level workshop, 40 Fortune 500 executives committed to obtaining chargers and PEVs by September 2014. The reviewer noted that the published safety and training report that provided recommendations for fleets, fleet training organizations, and Clean Cities coalitions would be very useful for California and may be used across the county.

Reviewer 3:

The reviewer indicated that a highlight of the project's accomplishments was the commitment of corporate leaders to EV chargers and over 1,500 PEVs. It also seemed to the reviewer that the Drive the Dream workshop, attended by California's Governor and industry executives, was a factor in gaining private sector commitment to investment.

The reviewer highlighted that another tangible, positive project result is the publication, "Needs Assessment for Alternative Fuel Vehicle Training in California." The reviewer would like to know more about the value added and benefits of best practices, as well as the PEV and H_2 websites.

Reviewer 4:

The reviewer concluded that the project made substantial progress toward achieving its goals and objectives. The reviewer noted a training assessment report identified first responder training as a challenge, due to emergency response agency time and funding constraints. The reviewer also noted that the report also summarized recommendations to fleets, training organizations, and Clean Cities coalitions, and that several workshops were held to address barriers and increase awareness (including a CEO workshop which attracted 40 Fortune 500 executives).

The reviewer remarked that everyplace.com was launched to promote the adoption of EV fleets and is a well-organized website. The reviewer pointed out that the PEV cost of ownership calculator being developed was not yet finished. The reviewer also pointed out that significant work has been done to develop best practice guidelines for PEVs and H_2, CNG, liquefied natural gas (LNG) vehicles.

Reviewer 5:

The reviewer emphasized that the project was very sharply focused on deliverables and on providing more bang for the buck. The reviewer observed that the project was leveraging outside funds to provide deliverables that were not in the original scope of work.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer noted that the presentation on the project included an excellent diagram which displayed the responsibilities and coordination among the various project participants.

The reviewer commented that the project partners were widely and deservedly recognized for their expertise and contributions to the advancement of alternative fuels. It was also a big plus to include all California Clean Cities coalitions and Advanced Transportation Technology and Energy Initiative Centers.

Reviewer 2:

The reviewer mentioned that major collaborators include CALSTART, the South Coast Air Quality Management District (SCAQMD), the California Energy Commission (CEC), three Clean Cities coalitions, and several community colleges to deliver training.

Reviewer 3:

The reviewer observed that the Bay Area project team was collaborating with all the California Clean Cities coalitions as well as a host of other partners to ensure that all issues of safety and adoption are addressed.

Reviewer 4:

The reviewer commented that the project was working with outside funding sources to deliver more products (training and case studies) for other fuels that were not originally targeted. Additionally, the project involved major California players like the California Air Resources Board (CARB) and the CEC. The reviewer also noted that this project involved all 13 California Clean Cities Coordinators, and that the cost calculator could be used for other projects outside the scope of this project.

Reviewer 5:

The reviewer stated that this project coordinates and collaborates with groups and organizations throughout California that are necessary to make the project a success. These groups include 13 Clean Cities coalitions, CALSTART, SCAQMD, and the CEC.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer affirmed that this project has the potential to help expand the alternative fuel market. The reviewer gave the example that one-on-one assistance for fleets from the Clean Cities coalition would be ongoing through the end of the project, and in the future, designated trainers would use best practices guidelines to train technicians and first responders in their regions.

Reviewer 2:

The reviewer acknowledged that a plan was developed for using the results of work done on Best Practices Guidelines for H_2, CNG/LNG and PEVs. Also, Clean Cities coalitions and Advanced Transportation Technology and Energy programs would use the materials from the project to conduct fleet workshops and alternative fuel vehicle (AFV) training.

The reviewer indicated that the Best Practices documents should be reviewed by DOE and considered for dissemination to Clean Cities coalitions and others committed to alternative fuels throughout the country.

Reviewer 3:

The reviewer emphasized that the project made significant strides to increase awareness that alternative fuel and propulsion technologies are commercial and ready for deployment. The reviewer noted that the project identified weaknesses in existing training, and worked to fill those gaps. The reviewer indicated that the best practices documents would help decrease anxiety associated with adopting new technologies.

Reviewer 4:

The reviewer noted that safety is important to successfully transition to an alternative fuel market. Also, the West Coast may have issues that do not pertain to the Mid-West. If so, the report should specify those aspects.

Reviewer 5:

The reviewer said California is a unique market that really pushes EVs and provides incentives to do so. While the reviewer thought this project would help deploy EVs in California, the reviewer did not think it would spread to other states.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that among the states, California is at the leading edge in terms of initiatives to promote the use of alternative clean fuels. The reviewer commented that this project draws on and takes advantage of the expertise, experience, and commitment of major alternative fuels proponents within California. Also, products resulting from the project should have value for other organizations throughout the country that are engaged in commercialization of alternative fuels, and that are considering investing in AFVs and associated infrastructure.

Reviewer 2:

The reviewer observed that the project would reach a lot of fleets, and the development of a best practices toolkit would reach others long after the funding is gone.

Reviewer 3:

The reviewer commented that the project is relevant to the DOE goal of petroleum displacement. The reviewer said that by eliminating barriers to deployment of AFVs and infrastructure in California, this project would allow the use of AFVs and thus reduce petroleum use.

Reviewer 4:

The reviewer acknowledged that the project addresses all of the DOE program goals.

Reviewer 5:

The reviewer noted that the safety aspect is very important. However, since most of the projects are addressing first responders, fire marshals, codes, and safety, it would be useful to understand these in terms of region of the country in the final Clean Cities National Report roll up.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer observed that this project accounts for more DOE funds than any other of the seven projects reviewed. In the reviewer’s opinion, the funds for forums, workshops and training were being used wisely and properly. The same goes for work on preparing the training assessment report. The reviewer noted that when questioned about which organizations accounted for the bulk of the effort, the presenter had the information readily available.

The reviewer stated that DOE should undertake a critical review of the project's work on best practices guidelines and website development. The reviewer suggested that it is possible that the resulting products set a new standard and should be widely disseminated.

The reviewer said it may be more efficient for such products to be developed "centrally" with periodic updates, rather than produced as part of any single regional project portfolio. The reviewer's impression was that such products are being procured under multiple DOE-funded projects and if this is accurate, then alternative approaches should be considered.

Reviewer 2:

The reviewer commented that the use and distribution of resources appear to be directed toward meeting the DOE objectives, and are well allocated among the project objectives.

Reviewer 3:

The reviewer asserted that the project was a good use of DOE funds because it is necessary to address the barriers of consumer reluctance to purchasing new technologies, and the project addresses the lack of technical expertise with new fuels and vehicle technologies. The reviewer said similar efforts could be funded in the future, but DOE should wait to see the results from this effort.

Reviewer 4:

The reviewer reiterated that since many of the projects focus on the safety and first responder aspects of preparation for an alternative fuel market, it would be helpful to have a larger report that breaks down these individual reports by regions (for example, West Coast, East Coast, Mid-West, etc.)

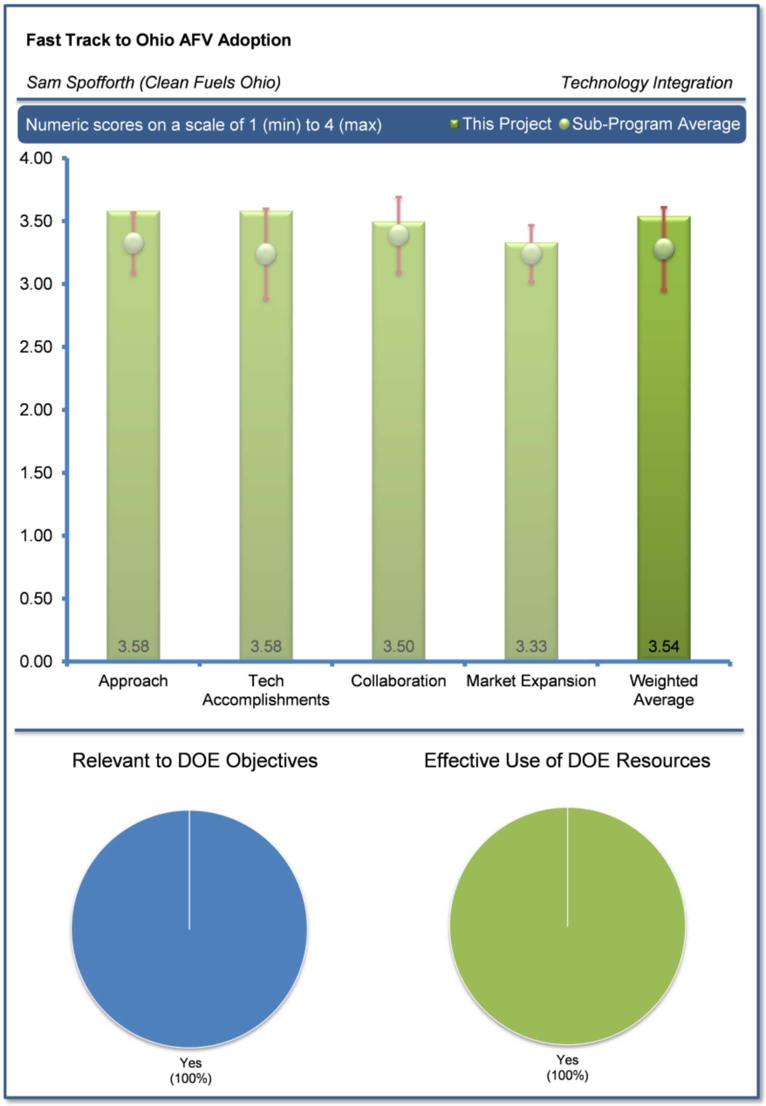
Reviewer 5:

The reviewer commented that this project involves all 13 California Clean Cities coalitions and the entire state of California. Also, the project has incorporated funding from other organizations and appears to be self-sustaining after funds go away.

Reviewer 6:

The reviewer noted that the project received more funds than the other projects reviewed.

Fast Track to Ohio AFV Adoption: Sam Spofforth (Clean Fuels Ohio) - ti036



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the project's approach to developing activities related to policy, barrier reduction, safety and training, and market development and outreach initiatives, is very good and will help the project meet its objectives.

Reviewer 2:

The reviewer commented that Clean Fuels Ohio has taken an interesting approach with its Green Fleet Model because it allows the adopters to apply critical thinking. The Model is a framework adopters could use to consider how to achieve fleet goals, and to see which options are economically feasible. The reviewer said this model could be used by other Clean Cities coalitions.

Reviewer 3:

The reviewer stated that unlike California and New York, Ohio does not have policy initiatives that are well developed and aimed at increasing AFV deployment. Therefore, the project included a significant effort to reach out to policymakers in the state government. Specific project objectives are to develop model language for inclusion in Transportation Improvement Plans, and study and develop options for financial incentives, including tax incentives for AFVs and encouraging AFV options in procurement specifications. The reviewer observed that these were all good approaches.

The reviewer commented that to address barriers, the project develops outreach through Ohio Green Fleets and brings policymakers, public utilities and fleets together. Specifically, the project seeks to develop five green action plans with cities and major organizations within the state. The reviewer noted that the project is also addressing training needs for gaseous fuels and EVs, and market development is being addressed through workshops, media and advertising, social media and online websites and resource center. The reviewer found that the project approach is well organized and adequately addresses the DOE program objectives and the project goals.

Reviewer 4:

The reviewer pointed out that the project supports multiple alternative fuels; CNG, propane, and PEVs. The reviewer affirmed that the project included a great mix of events that target specific fuels. The reviewer said the coalition realized that agencies cannot dictate what alternative fuel a fleet should use, and agencies should provide information on all of the fuels and let the fleet decide what fuel is best for them based on their fleet profile.

Reviewer 5:

The reviewer noted that the project has many activities that address multiple alternative fuels (i.e., NG, propane, electricity, and biodiesel). The presentation slide titled "Milestones" is a summary of activities rather than a list of milestones. The three presentation slides on "Approach" (Slides 5 - 7) provide a more extensive list of project activities, segregated by the four initiatives (i.e., policy, barrier reduction, safety and training, and market development/outreach), which are common to the Technology Integration (TI) projects.

While this reviewer acknowledged a sense that a lot was going on in the project, the result seemed information overloaded. The reviewer remarked that the presentation lacked a concise, focused approach that articulates the major project elements, tasks, and milestones. The reviewer indicated that the oral presentation did provide some confidence that there is a plan which defines and guides the numerous project activities.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer commented that progress and accomplishments have been excellent and demonstrate that the project is moving towards a successful completion. Several workshops have been hosted for local governments and public utilities, and the project completed three of five planned green fleet action plans and identified fleets near alternative fuel stations.

In addition, the reviewer noted that training on gaseous fuels and EVs has taken place or is planned in the near future. Social media content focusing on EVs and Ohio Green Fleet successes was developed and the team hosted a workplace charging workshop which included participation from Google, Disney, and General Motors. The reviewer said that these accomplishments help address the barriers of availability of charging stations, consumer reluctance to purchase new technology vehicles, and lack of experience with new vehicle technology.

Reviewer 2:

The reviewer said that Ohio has identified barriers to adoption, and the project team demonstrated through their progress that they have successfully addressed them by providing the right information and tools to the adopters. There are remaining barriers, but their approach is targeted through correct education, which includes safety. The reviewer was most impressed by the social media utilization to advance alternative fuel and electric vehicle adoption.

Reviewer 3:

The reviewer stated that many excellent products are resulting from the project, including model policy documents, workshops, fleet action plans, alternative fuel station maps, AFV training activities, and a variety of information and education materials. The reviewer commented that there seems to be significant attention to training activities and would like to know more about the extent to which the project utilizes work accomplished through other projects (for example, development of training curricula). The reviewer pointed out that the oral presentation noted coordination with other projects, and would like assurance that the project is not duplicating other available materials.

The reviewer commented that evidently NG fueling infrastructure is growing nicely in Ohio, and it is likely that Clean Fuels Ohio and this project are contributing. The Drive Electric Ohio initiative and the Workplace Charging Workshop should help with increased investment in EVs and infrastructure. The reviewer brought to light that there was no indication in the presentation that there were quantitative results such as number of AFVs and alternative fuel infrastructure investment which could be linked to the project.

Reviewer 4:

The reviewer noted that significant progress had been made toward achieving the project objectives. The project developed the cleanfuelsohio.org web page and a model Green Fleet policy for municipalities that gives guidance on how to structure policies and action plans. The project also completed three green fleet action plans with the City of Cincinnati, City of Green and Tipp City. The project team developed substantial promotional material with 15 press releases to date and hosted many workshops to educate policymakers, public utilities, municipalities and fleets. The reviewer thought the approach to identify and target fleets that are in close proximity to refueling infrastructure was an excellent idea. The reviewer noted that the project hosted several alternative fuel station training workshops as well as EV safety training, and had a broad outreach campaign. Overall, the reviewer asserted that good progress had been made in the project.

The reviewer identified several remaining challenges and barriers, including lack of technical and educational experience with new fuels and vehicle technologies among fleets; lack of industry coordination; inadequate availability of training; and lack of state government focus on alternative fuels.

Reviewer 5:

The reviewer commented that the project had made significant strides and was over 75% complete. The reviewer remarked that the project team had really increased the number of CNG stations and has helped notify fleets close to these new stations through direct outreach and events. The reviewer noted great outreach to fire marshals, operators, and technicians, and noted that this step is often overlooked and can be a huge barrier to infrastructure development. The presenter felt that the project's biggest accomplishment was using education to leverage new additions to AFV infrastructure.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer said that the project partners are recognized for their expertise and contributions to the advancement of alternative fuels. Collaboration with organizations such as the Earth Day Coalition, CALSTART, state and local governments, and the National Fire Protection Association (NFPA), is a big plus. The reviewer commented that Clean Fuels Ohio is doing outstanding work in establishing cooperation with many other organizations, and enlisting their assistance in pursuing DOE goals.

Reviewer 2:

The reviewer said that there was good collaboration with government and municipal fleets and organizations. Also, the reviewer exclaimed that the number of quality events is a great accomplishment.

Reviewer 3:

The reviewer noted that the project team partnered with the local cities successfully, in addition to a host of private corporate partners and the NFPA. The project team also did a great job in using social media, and the reviewer believed this has really helped to reach folks that traditional outreach efforts might not.

Reviewer 4:

The reviewer commented that this project has very good coordination. There are many organizations involved in the project including city governments, trainers, and state and local agencies. In addition, sub-recipients involved in the project provide the opportunity for more coordination, including outside the state of Ohio.

Reviewer 5:

The reviewer remarked that there was good coverage among project collaborators, including training organizations, state and local government, the Mid-Ohio Regional Planning Commission, and communications and technical subject matter experts.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer said that through increased fleet educational outlets and consumer education, the project developed partnerships and training programs throughout the state and established programs to educate state and local officials about AFVs. The reviewer said that this project has the potential to aid with alternative fuel market expansion.

Reviewer 2:

The reviewer noted that Ohio has a number of educational workshops planned and the project team is working on further sharing success stories. The reviewer commented that the project team is on the right track.

Reviewer 3:

The reviewer said that by educating fire marshals, the project team has eliminated some of the barriers that exist to the installation of any gaseous fuel stations. The reviewer would like to compare the various training programs the different projects have put together to see how the industry as a whole could use them as building blocks for future projects. The reviewer noted great use of social media to educate the general public.

Reviewer 4:

The reviewer said that the project was making good strides toward increasing awareness, encouraging policymaking to leverage alternative fuels and vehicle technologies, and addressing training needs. However, a lot of work remains to be done beyond the scope of the current project in the state of Ohio to further address these barriers.

The reviewer acknowledged that the completion of this project would result in improved identification of needs and potential pathways to overcome the remaining barriers to AFV and EV acceptance. The reviewer said the project has done a good job of leveraging other related efforts in the state of Ohio, as well as nationally.

Reviewer 5:

The reviewer stated that there are five packed presentation slides on “Alternative Fuel Market Expansion Potential” and half of the content is on efforts not funded by the project. In the reviewer’s opinion, there is an issue of information overload with insufficient focused communication of key points. For example, it would be helpful to identify what specific products resulting from the project should have priority consideration for replication nationwide. The reviewer commented that lots of future activities are listed which will contribute to achieving project objectives and DOE goals. The reviewer’s preference would be to select a few high priority ones for the presentation, and articulate their contributions to AFV market expansion.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said the project directly addresses the DOE program objectives.

Reviewer 2:

The reviewer noted that there is great potential to expand AFV and fuel adoption in Ohio. A great deal of progress has been made, but there is room for much more. The reviewer also noted that the framework established in Ohio could easily be transferred to other states (particularly those in the Midwest).

Reviewer 3:

The reviewer commented that this project is very relevant to the DOE objective of petroleum displacement. By meeting the objectives of the project, such as educating and informing fleets and government regulators about AFVs, and educating consumers about PEVs, this effort will help with the introduction of advanced technology vehicles and thus reduce petroleum use.

Reviewer 4:

The reviewer commented that products resulting from this project should have significant value in increasing the use of alternative transportation fuels in Ohio. The project should also benefit other organizations throughout the country that are engaged in commercialization of alternative fuels, and that are considering investing in AFVs and associated infrastructure.

Reviewer 5:

The reviewer said that the project team was focusing on the bigger picture by developing tools that would help them long after the funding is gone. For example, the project team has developed a Green Fleet Model that assists fleets when they are deciding on whether or not to use AFVs. Additionally, the project has secured $10.7 million for Ohio fleets.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer emphasized that this project leveraged about $500,000 of DOE funds with $109,000 of partner contributions.

Reviewer 2:

The reviewer commented that the funds are being used wisely because the model and framework developed to help the adopters is easily transferable to other states. The Green Fleet Model helps adopters plan and evaluate the right approach and the social media aspect helps further the outreach in addition to the traditional outreach approach (workshops, flyers, etc.).

Reviewer 3:

The reviewer said that this is a good use of DOE resources. Future similar projects could be funded, but it may be good to wait for the outcome of this project and develop new projects to enhance the results.

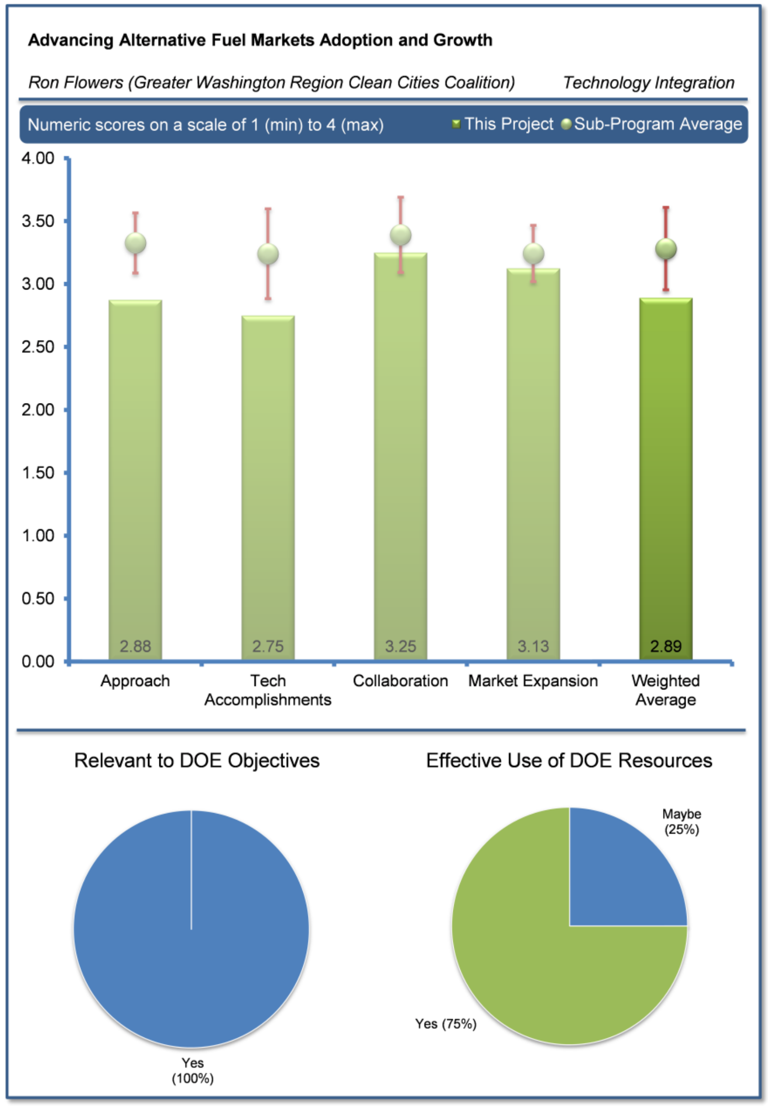
Reviewer 4:

The reviewer commented that this project is providing a variety of products that are very important to alternative fuel progress in Ohio. Such work should continue to be a high priority for the VTO. The reviewer is concerned that there is not a “critical mass” of project funds being devoted to fuels or activities considered high priority for petroleum displacement in Ohio. Mr. Spofforth stated that it is important to be “fuel neutral” and cover all the bases. The reviewer remarked that whether there are sufficient funds available to do that in Ohio, taking into account this and other related alternative fuel projects is an important consideration. When this round of TI projects is completed, DOE should conduct an analysis to determine which projects have achieved better results for the resources expended – those addressing multiple fuels or those that focus the bulk of the funds on advancing one or two fuels.

Reviewer 5:

The reviewer noted good use of the resources that were available through the grant, but the work revealed that further investment was needed in the state of Ohio in order for AFVs to gain significant deployment.

Advancing Alternative Fuel Markets Adoption and Growth: Ron Flowers (Greater Washington Region Clean Cities Coalition) - ti037



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted collaborative local efforts to further education and update infrastructure on all alternative fuels. The Washington metropolitan area is in a unique position because of the federal government presence. The fleets are required to purchase AFVs, but not all are using the fuels due to a lack of coordination or accessible infrastructure. This project identifies and attempts to address those barriers directly.

Reviewer 2:

The reviewer commented that this project appeared to be mainly focused on the early stages of developing working groups, identifying barriers and ways to overcome them and developing pathways to encourage the adoption and development of alternative fuels. The reviewer noted that this is the first grant that the group has received, so the project is in an earlier stage than other programs that have been active for a longer period of time.

The reviewer noted that the approach has been to establish working groups for each alternative fuel that is of interest to the Washington D.C. metropolitan area. The working groups are then tasked with identifying barriers for each specific fuel and organizing workshops to increase awareness and interest in the alternative fuels. The reviewer thought the approach was adequate to establish early stage awareness and interest in alternative fuels and to establish working groups that will address each alternative fuel option. The reviewer indicated that this is a good starting point for a first time award recipient.

Reviewer 3:

The reviewer commented that the only information provided concerning the approach was that working group teams were formed for each alternative fuel being discussed. It would be useful to know the team members and what type of agenda is used for working group meetings.

Reviewer 4:

The reviewer commented that this project has many activities that address multiple alternative fuels (i.e., NG, propane, electricity, H_2, biodiesel, and ethanol). With the resources available, making desired progress on all these fronts could be unrealistic. However, the project approach has aspects that reduce concerns about dealing with multiple fuel-related barriers simultaneously. The basic approach is to establish teams, each one of which is focused on a specific fuel. The reviewer acknowledged that conscious decisions have been made about the fuels (CNG and propane, which have priority) and those of secondary importance for project purposes.

The reviewer noted that the project's target and objectives (presentation Slides 5 – 7) were very general and qualitative. Specific, quantitative objectives and milestones for each of the various work groups would improve the project plan and increase the likelihood of substantive project results.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer commented that the Greater Washington Region Clean Cities Coalition has been effective in bringing the region's fleet professionals together to increase education and was successful in getting the local airports to install alternative fuel stations. The reviewer recommended that the project continue the collaboration to ensure that those stations are better promoted and use more outreach via social media.

Reviewer 2:

The reviewer commented that there are a number of accomplishments associated with the project, including working group meetings, CNG and propane technical training, educational workshops, webinars and presentations to students. Project partners are also contributing to a variety of policy and regulatory initiatives. The reviewer commented that the presentation cites alternative fuel station openings, and access to existing stations by additional fleets. The reviewer did not know if there is a specific, direct linkage between the project and these actions. In the reviewer's opinion, there is a question about whether new stations would still have opened in the absence of this DOE-funded project. Similarly, the reviewer asked if the project can take credit for repeal of the Virginia hybrid electric vehicle (HEV) tax. The reviewer commented that the accomplishments include some training activities. Mr. Flowers stated that the project has drawn on training materials that were produced by other projects, which the reviewer noted is positive.

Reviewer 3:

The reviewer said it was not clear if the accomplishments such as the opening of several alternative fuel fueling stations, including E85, CNG, propane, and biodiesel, is really attributable to this project. The reviewer commented that one of the main accomplishments was that four working group meetings were held. The reviewer added that it would be useful if the agenda and a summary report of the meetings were provided at least to DOE to see what was discussed.

Reviewer 4:

The reviewer commented that the program had organized and hosted four working group meetings, bringing over 125 professionals from industry and government together. The coalition had hosted seven of the eight planned events. The reviewer also commented that the coalition hosted a webinar presenting a case study of propane use for school buses, and organized workshops held at the Washington D.C. Auto Show. The reviewer noted that the group disseminated information related to taxes on HEVs in the state of Virginia, which was later repealed, and is organizing alternative fuel technician and first responder training.

The reviewer remarked that the presentation listed several accomplishments in terms of new fueling stations, providing public information related to incentives and tax credits on equipment and labor costs for vehicle conversions. However, the role that the coalition played in those accomplishments was not apparent. The investigators might consider providing more specific details about accomplishments in the next project review.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer commented that this project brings together three Clean Cities coalitions (i.e., Greater Washington Region, Virginia, and Maryland). A strong partnership and collaboration among these organizations bodes well for advancement of alternative fuels in the region. The reviewer said the project partners are well recognized for their commitment to and initiatives for overcoming barriers to investment in alternative fuels. The reviewer emphasized that the project has an excellent understanding of the barriers and challenges.

The reviewer commented that the Clean Cities coalitions' well-established relationships with local utilities, government agencies, and alternative fuels proponents (PERC, NGVAmerica, Clean Energy) will be a key to project success and results. During the oral presentation, the reviewer thought that Mr. Flowers made a valid point that it is more productive to have fewer, really committed partners, than to have many that are not completely committed.

Reviewer 2:
The reviewer observed a good deal of coordination on this project because there are over 20 groups in Washington, Virginia, and Maryland that participate in this effort.

Reviewer 3:
The reviewer noted that the project has a wide range of local partners from Virginia, Maryland, Washington DC, and the federal community.

Reviewer 4:
The reviewer acknowledged good representation among project collaborators and partners. The respective roles of the collaborators were not particularly clear in the presentation and reviewer materials. It would be helpful to include some more specific information on the roles of collaborators in the next review.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer commented that the potential for the area is good. There are a number of federal and state vehicles in the area that are required to purchase and use AFVs and alternative fuels, which can act as an anchor to bring in private adopters. The challenge is to make the alternative fuels more accessible and increase public knowledge to ease transition.

Reviewer 2:
The reviewer noted that the success of the CNG tariff started by Washington Gas would guide discussions on policy and infrastructure barriers that may be faced by other utilities on tariff matters, and this could have a positive effect on alternative fuel market expansion. The reviewer also noted that the tax credit for vehicles and infrastructure in Washington D.C. could provide for alternative fuel market expansion.

Reviewer 3:
The reviewer observed three presentation slides on "Alternative Fuel Market Expansion Potential". The first one lists some important, potentially high-payoff initiatives to be undertaken in the months ahead. The reviewer said it would be helpful to know which fuels these initiatives will focus on, and which working groups will be responsible for them. The reviewer said one future initiative would be to review and develop best practice models for conversion of diesel and gasoline engines. The reviewer would like to know more about the extent to which the project leaders plan to use work done previously on documentation of best practices and toolkits, to be assured that the effort is not duplicating material already developed.

Reviewer 4:
The reviewer thought this project was a good first start for a coalition that has not had previous DOE funding. The focus of this particular project is to establish working groups with expertise, as well as to develop and encourage greater penetration of alternative fuels into the regional fleets and market.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer noted that this project supports the DOE goal of petroleum displacement. Specifically, the project meets the objective to develop policies, initiatives, and programs to positively impact growth and expansion of alternative fuel usage and the development of barrier reduction initiatives. This would eliminate impediments to the adoption of alternative fuels.

Reviewer 2:

The reviewer commented that products resulting from this project should have a significant value in increasing the use of alternative transportation fuels in Washington, DC, Virginia, and Maryland. The reviewer noted that the project should also benefit other organizations throughout the country that are engaged in commercialization of alternative fuels, and considering investing in AFVs and associated infrastructure.

Reviewer 3:

The reviewer commented that this region already has early AFV adopters that provide a base to build on to increase AFV/EV purchases by private companies and the public. The refueling locations and ease of access are important to the success of this project.

Reviewer 4:

The reviewer commented that the project does focus on the DOE program goals and objectives.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer commented that the use of resources is appropriate to meet the project objectives.

Reviewer 2:

The reviewer stated that the success of alternative fuel adoption in the nation's capital is viewed by other states and the world. Having a successful AFV/alternative fuels infrastructure system is important in moving the nation toward these technologies.

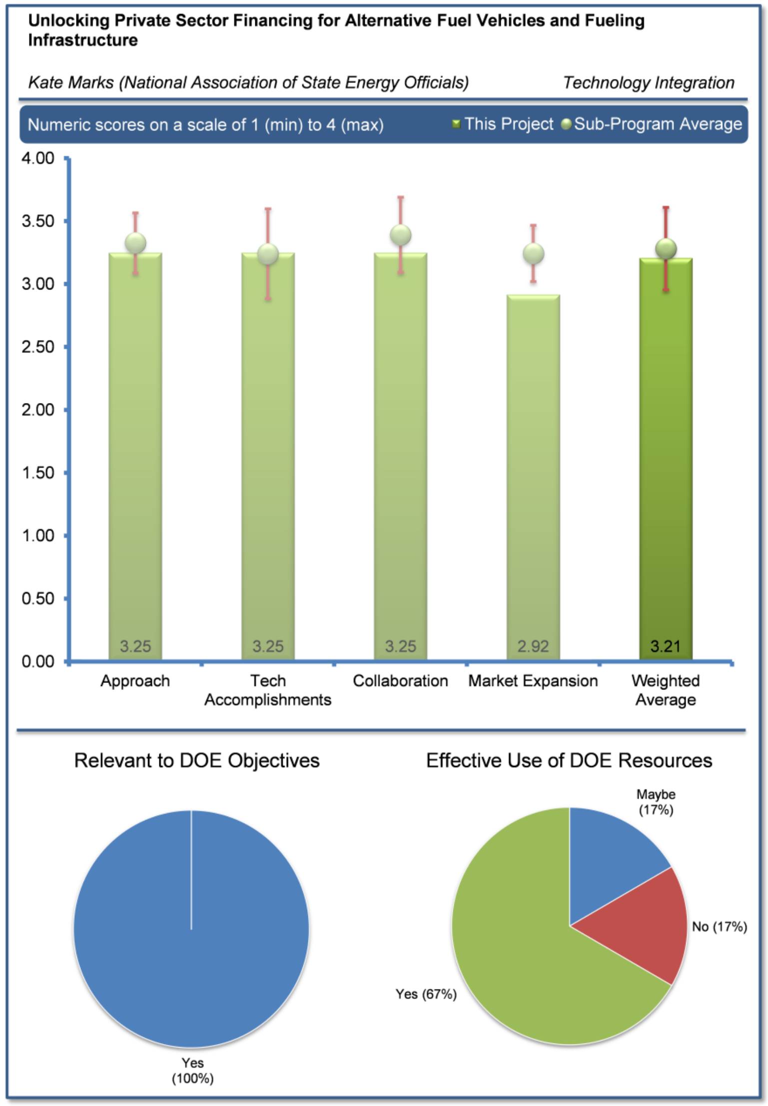
Reviewer 3:

The reviewer commented that it was not clear if funds have been used wisely in this project. The reviewer said it is not clear if all of the accomplishments listed could be attributed to the work done by this project.

Reviewer 4:

This project is providing a variety of products that are important to alternative fuel progress in Washington, D.C., Virginia, and Maryland. The reviewer commented that such work should continue to be a high priority for the VTO. The reviewer was concerned, however, that there was not a “critical mass” of project funds being devoted to fuels and activities which are considered the highest priority for petroleum displacement in the region. The project is attempting to be fuel neutral and cover all the bases. The reviewer said whether there are sufficient funds available to do that, taking into account this and other related alternative fuel projects is an important consideration. The reviewer suggested when this round of TI projects is completed that DOE should conduct an analysis to determine which projects have achieved better results for the resources expended (i.e., those addressing multiple fuels, or those that focus the bulk of the funds on advancing one or two fuels).

Unlocking Private Sector Financing for Alternative Fuel Vehicles and Fueling Infrastructure: Kate Marks (National Association of State Energy Officials) - ti038



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

In addition to identifying the key tasks of policy, barrier reduction, safety and training, outreach, and market development initiatives, the reviewer noted that the project also identified specific barrier mitigation strategies. These include easing consumer reluctance, increasing experience with alternative fuels, leveraging public funds with ratepayer and private activity, and leveraging and expanding the Clean Cities network. The reviewer asserted these strategies, and the associated approach and related milestones and status are an excellent description of the overall approach.

Reviewer 2:

The reviewer commented that the approach of harmonizing policies and objectives of states with the Clean Cities programs is an important factor in successfully moving the nation toward AFVs and alternative fuel use. The reviewer said that the approach to work through the states to address consumer reluctance and other barriers is important. States can be highly effective in moving the private and public fleets toward newer technologies.

Reviewer 3:

The reviewer noted that this project focuses on identifying unique and innovative funding options for AFVs and infrastructure. The reviewer stated that the financing focus is a unique aspect compared to the other funded projects. The reviewer also stated that the approach aims to ease consumer reluctance by doing the following: developing and disseminating information about barriers, risks, and financing options for infrastructure development; improving coordination between Clean Cities, State Energy Offices (SEOs) and fleets; and developing an innovative way to finance infrastructure development.

The reviewer commented that the plan included establishing a regional transportation committee to promote peer-to-peer learning and information sharing on best practices, challenges, opportunities, and priorities. The reviewer noted that workshops developed in this project would emphasize financing options, strategies, and mechanisms, whereas other projects are focused more on safety and technician training. The reviewer said that this focus makes this project unique.

Reviewer 4:

The reviewer said that the financing model has been a critical and missing piece of the AFV puzzle for quite a while. The reviewer said having this model available to all Clean Cities coordinators would be helpful. However, there was not much mention of this.

Reviewer 5:

The reviewer commented that the project objectives, shown in presentation slide three, are important. However, they are stated generally and the reviewer would have preferred something more specific. The reviewer said it was nice to see a list of milestones with the month scheduled for completion of each. (Some of the projects reviewed do not include completion dates associated with milestones in their presentations).

The reviewer commented that presentation Slides 5 - 9 provide a thorough treatment of the project approach. The reviewer said it seems that significant thought has been devoted to development of an approach. However, the reviewer thought the combination of tasks, milestones, barrier mitigation strategies, and approach elements is somewhat difficult to grasp with limited exposure to the project. The reviewer found the "Related Milestones and Status" section in Slides 6 - 9 to be helpful, but the connection between "Barrier Mitigation Strategies" and the tasks listed on Slide 5 was not obvious. The reviewer commented that the approach seemed to emphasize plans, reports, development of tools and establishing committees, and had some concern about that.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer said that the project's accomplishments and progress had been excellent. The scan of the Integrated Resource Plan is the only report completed, but most other activities have started, including work by the Transportation and Finance Advisory Committees, a Technical Reference Manual draft and an energy security planning data template, and training for Clean Cities stakeholders.

Reviewer 2:

The reviewer commented that the Technical Reference Manual is interesting because it is looking at the policy angle feasibility perspective. This is a tool that can encourage those states that are reluctant to lead in this area to take a more proactive approach. The reviewer said the approach to data collection through the plug-and-play template is very good because it can be used by other Clean Cities coalitions.

Reviewer 3:

The reviewer commented that a number of project accomplishments are cited, including the following: creation of a National Association of State Energy Officials (NASEO) Transportation Committee; review of utility Integrated Resource Plans; a Technical Reference Manual with information related to electric vehicle investments; an energy security planning template for Clean Cities coordinators, SEOs, and other users; establishment of a Financing Advisory Committee; case studies, with the associated development of innovative business models; and training for Clean Cities stakeholders.

Despite concerns about too many initiatives, and insufficient focus on a few priorities, the reviewer's conclusion was that the project is delivering some results and organizational links, which can add value. The reviewer noted that there was no indication in the presentation that there are quantitative results (for example, more AFVs and alternative fuel infrastructure investment) that can be linked to the project.

Reviewer 4:

The reviewer noted excellent cooperation.

Reviewer 5:

The reviewer said that the project had made good progress toward completing its planned tasks. The project completed and published a survey of 31 utilities nationwide to determine how utility planners and regulators were accounting for the impact of electric vehicles on the grid. The reviewer noted that the project also created a Technical Reference Manual that characterizes energy savings, environmental benefits, and financial costs; developed a plug-and-play data template for Clean Cities and transportation agencies to use for data collection; established a Financing Advisory Committee and conducted and published several case studies; and is planning several regional training workshops. The reviewer commented that this is a strong list of accomplishments so far and that the project is making good progress.

Reviewer 6:

The reviewer commented that there was nothing presented on innovative financing except the formation of a committee [DOE Program Clarification: Private investment tools were discussed on Slide 4 and Slide 6 of the project presentation].

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer commented that there is an excellent team of partners brought together on this project. In addition, the reviewer stated that the number and type of participants in the Financing Advisory Committee was impressive.

Reviewer 2:

The reviewer commented that NASEO, the project leader, primary partners, and project advisors, are well recognized for their expertise and contributions to the advancement of alternative fuels. The reviewer found that Slide 18 of the presentation provided an excellent diagram on the responsibilities and coordination among the various project participants.

The reviewer commented that throughout the presentation there is evidence of collaboration with Clean Cities coalitions and SEOs, as well as efforts to establish more communication and partnership among those organizations. Slide 10, for example, indicates participation from Clean Cities coalitions in five states and the District of Columbia, and Slide 15 cites a partnership with the Harvard Business School.

Reviewer 3:

The reviewer commented on the exemplary Transit Effectiveness Project outreach.

Reviewer 4:

The reviewer noted that project collaborators have good coverage of expertise. Advisory board members represent major vehicle producers and environmental and energy organizations.

Reviewer 5:

The reviewer noted good collaborations, but would like to see more SEOs such as Colorado's become active participants.

Reviewer 6:

The reviewer said it was a very nice group of partners, but was surprised there were no matching funds especially with the New York State Energy Research and Development Authority (NYSERDA) being involved, and that there are no Clean Cities coalitions involved.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer commented that targeting private sector investors is a good approach that may help the states that are less active become more proactive in response to this added interest.

Reviewer 2:

The reviewer said that if private sector companies implement the innovative financing mechanisms identified in this project, then there is a high potential for this work to aid in the alternative fuel market expansion. In addition, the reviewer stated that state and utility decision-makers would be able to more accurately assess the costs and benefits of investments in transportation efficiency measures, and this would also allow for alternative fuel market expansion.

Reviewer 3:

The reviewer commented that the project is delivering results, such as case studies and innovative business models, which can add value. The reviewer said the project is also building important organizational links, which could influence private sector investments. Whether the desired positive results are achieved would depend on accomplishments during the last half of the project and follow-on after the project by DOE and others. The reviewer said DOE should critically review materials and actions resulting from the project, and work with NASEO to assure that they are used by organizations that make decisions affecting alternative fuels.

Reviewer 4:

The reviewer commented that the project has good potential to raise awareness of the benefits of AFV and EV technologies and identify mechanisms for financing the necessary infrastructure, by increasing cooperation between SEOs, and by developing guidance documents and templates for developing infrastructure plans and financing plans.

Reviewer 5:

The reviewer remarked that the goals of this project mimic the goals of the Clean Cities program in general.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the results of this project have the potential to provide significant value in increasing the use of alternative transportation fuels throughout the country. With proper use and continued development, they should benefit organizations that are engaged in commercialization of alternative fuels, those that are considering investing in AFV and associated infrastructure, and those that should be, but are not yet, interested.

Reviewer 2:

The reviewer commented that having the States as active partners is important to the continued success of the Clean Cities Program. Also, NASEO is a natural partner to help move AFV/alternative fuels adoption across the country.

Reviewer 3:

The reviewer noted that the project objectives support the DOE goal of petroleum reduction, including stimulating private sector investment in AFVs and associated infrastructure projects, and developing innovative vehicle and infrastructure financing models to make AFVs more accessible to potential users.

Reviewer 4:

The reviewer remarked that the project was well aligned with DOE program objectives.

Reviewer 5:

The reviewer noted that SEOs were paramount to the success of the project.

Reviewer 6:

The reviewer commented that the project had similar goals, but the reviewer did not see any hard numbers of fleets or vehicles that would be using AFVs because of this program.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer commented that partnering with NASEO is important in increasing the role of the states in furthering petroleum reduction efforts though alternative fuels use.

Reviewer 2:

The reviewer noted that for the amount of resources put into this project, DOE would be getting a lot of very good information, and DOE funds were definitely being used wisely.

Reviewer 3:

The reviewer noted that in the presentation package, states have a critical role in establishing an environment that is conducive to investment in alternative fuels. The reviewer noted that some states have had success in serving as catalysts for deployment and commercialization of energy technologies, and states are the primary audience for NASEO and the products of this project. The reviewer said it seems appropriate for DOE to support activities that assist states in achieving emissions reduction from vehicles and fuel diversification.

The reviewer commented that DOE should undertake a critical review of the project’s work to assure that its results are disseminated widely to relevant State agencies, fleet managers, regulators, and legislators. The reviewer stated that an assessment should be done to confirm that SEOs find the reports and other products to be usable and useful. Consistent with the project objectives, the reviewer thought that if the states and Clean Cities coalitions take advantage of this work to influence greater private sector investment, then DOE can justify funding periodic updates. Given the widespread use of project results by states, the reviewer also thought that DOE should consider funding development of case studies and success stories that can be shared with both public and private decision-makers.

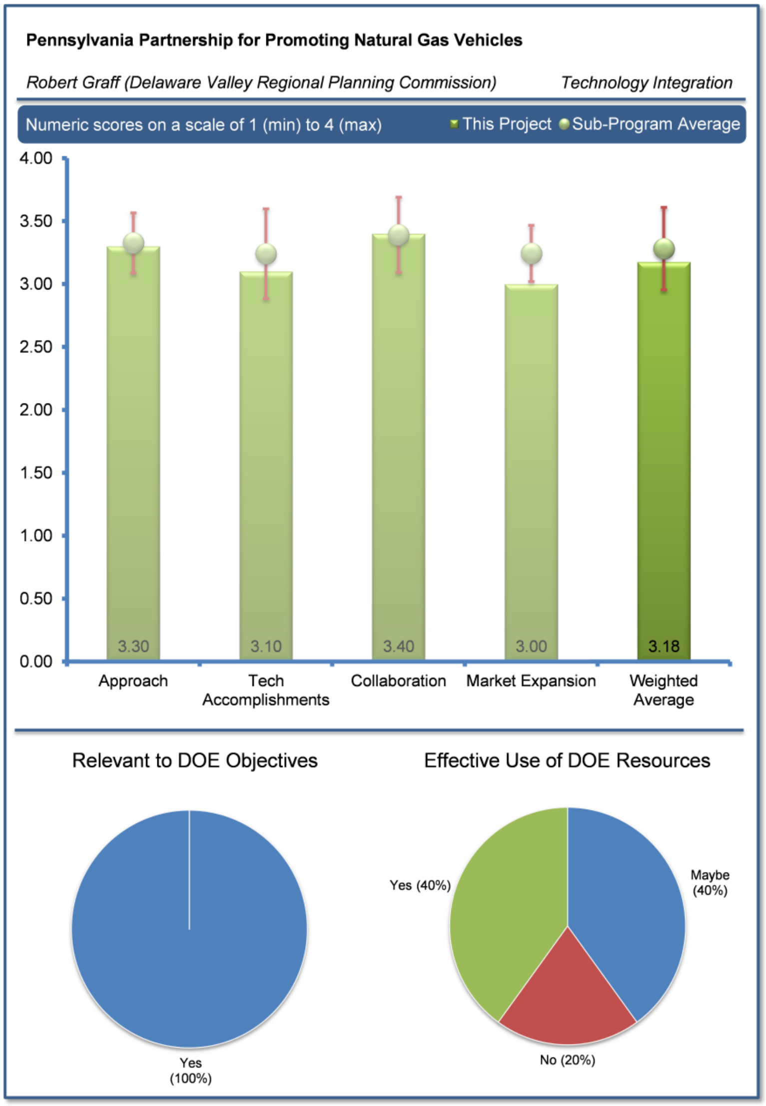
Reviewer 4:

The reviewer commented that this project takes a unique approach of addressing the financing aspect of AFV investment and infrastructure. The reviewer said financing is often a substantial barrier that has not been a focus of other programs aimed at increasing AFV adoption, and projects that address the financing aspect should be funded in the future.

Reviewer 5:

The reviewer stated that the funds would have been better off going to a Clean Cities coalition. The reviewer thought NASEO should already be doing these tasks as part of their normal duties.

Pennsylvania Partnership for Promoting Natural Gas Vehicles: Robert Graff (Delaware Valley Regional Planning Commission) - ti039



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that the Pennsylvania Partnership to Promote Natural Gas Vehicles (P3NGV) is taking a niche approach by targeting refuse haulers and school buses, and the lesson learned is the important factor in this approach. While the refuse haulers are transitioning successfully, the reviewer noted that there are economic and refueling issues with the school buses. The reviewer also remarked that this approach could help identify opportunities for other cities interested in niche market approaches.

Reviewer 2:

The reviewer noted that this project is primarily focused on increasing NGV adoption in municipal refuse vehicles and school buses. The reviewer also noted the scope of work includes providing information to potential NGV fleet operators, addressing code enforcement and permitting issues to enable NGV operation and infrastructure, and providing technician/mechanic and first responder training. The reviewer said no regulatory mandates exist to encourage alternative fuels and technologies in this area, and the alternative fuels initiative must make sense from a business case/economics perspective.

The reviewer commented that the approach would target procurement guidelines and code enforcement officials to make the process of permitting alternative fuel stations and infrastructure more efficient by educating fleets and code enforcement offices. Training for maintenance personnel and first responders is also being developed and delivered, and workshops have been held for school district officials, municipal officials, and small private refuse haulers. The reviewer thought the approach seemed well-designed to accomplish the goals and objectives.

The reviewer noted that it is very difficult to make a business case for NG school buses due to low vehicle turnover, bus leasing instead of purchasing and contracting bus services to outside vendors, and asked whether it was really advantageous to target CNG as a fuel for school buses. The reviewer said maybe the resources going to this target fleet could be more effectively applied to fleets where it is easier to make a business case for CNG. The reviewer also said that the project would develop easy and accurate tools to assess maintenance facility conversion costs, which could be significant for CNG.

Reviewer 3:

The reviewer remarked that the project covers the four major areas well (policy, barriers, education, and market outreach). The reviewer said education of public officials, whether it is fire marshals or code officials, is critical to the long-term success of any AFV project.

The reviewer said that there are some overlapping training classes being developed that may be better organized at a national level with national partners.

The reviewer also added that DOE should include national fuel partners in their national meetings or perhaps during the project review phase so that they can step up when there is an obvious need for a national curriculum.

Reviewer 4:

The reviewer commented that given the resources available for this project, focusing the effort on a single alternative fuel, CNG, is prudent. The reviewer said that concentration of the work on limited vehicle classes and fleets (refuse haulers and school buses) should increase the probability of success in achieving project objectives and contributing to DOE's alternative fuel deployment goals.

The reviewer stated that workshops and training are major elements in the project approach, and that both are important to the successful introduction of alternative fuels. The reviewer thought it was nice to see a list of milestones with the month scheduled for completion of some. For others, however, the reviewer noted the "milestone" is actually an activity that extends over a period of months (and more than a year for one entry).

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer commented that accomplishments included formalizing a partners group, creating a stakeholder and expert advisory group, deploying five workshops for municipal officials, presenting to the Delaware Valley Association of School Business Officials, and contracting with the National Alternative Fuels Training Consortium (NAFTC) to provide mechanic and first responder training. The reviewer said good progress had been made toward completing the proposed tasks.

Reviewer 2:

The reviewer commented that the lessons learned, particularly with the school buses, are useful because they may point to an opportunity to encourage school buses to go toward another alternative fuel with lower cost, such as propane. The reviewer noted that refuse haulers, on the other hand, are successfully switching to NG. The reviewer commented that the first responder training and maintenance training workshops are very useful, and recommended that the materials and training be made available on the web for those that need refresher courses.

Reviewer 3:

The reviewer commented that there are a number of accomplishments associated with the project, including the following: a well-defined management structure; establishment of a stakeholder and expert advisory group; workshops for municipal officials with the focus on using NG for refuse vehicles; preparation for workshops devoted to using NG in school buses; and selection of a contractor to provide training for first responders. Project partners are also analyzing municipal and school district procurement processes.

A solicitation was issued seeking a contractor to conduct training and the NAFTC was selected. The reviewer commented that this is an organization that developed training curricula and materials through a prior DOE funded project, and that utilizing materials produced by other projects is appropriate and cost-effective. The reviewer noted that there was no indication in the presentation that there are quantitative results, such as increased AFV use and alternative fuel infrastructure investment, which can be linked to the project.

Reviewer 4:

The reviewer is concerned that the "failure" to promote CNG buses would set back the Pennsylvania AFV program. Focusing on one fuel, in this case CNG, would close the door for other more viable options. While CNG is capturing the refuse hauler market, propane is capturing the school bus market and operators are saving money by using propane. The reviewer asked what provisions were in this program to hold propane or biodiesel school bus workshops. The reviewer said perhaps this is an opportunity for a TIGER Team deployment.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer commented that P3NGV has put together good collaborations, including the Pittsburgh Clean Cities, which is advising. The reviewer noted working locally was as important as working regionally.

Reviewer 2:
The reviewer acknowledged that the collaborators seemed appropriate to accomplish the objective of the project. Collaborators include the following: Delaware Valley Regional Planning Commission and lead partner, Greater Philadelphia Clean Cities; Pittsburgh Regional Clean Cities; Pennsylvania Department of Environmental Protection; PECO Energy Company; and Philadelphia Gas Works.

Reviewer 3:
The reviewer observed good coordination with the local Clean Cities and NG and electric utilities.

Reviewer 4:
The reviewer said broad outreach.

Reviewer 5:
The reviewer commented that with the leadership of the Delaware Valley Regional Planning Commission, there are relatively few partners associated with this project. However, collaboration among two Clean Cities coalitions, two public utilities, and the Pennsylvania Department of Environmental Protection bodes well for advancement of NGVs in Pennsylvania. The reviewer said Slide 11 of the project presentation clearly describes the role of each project partner. In his oral presentation, Mr. Graff noted that project partners have also reached out to other organizations for assistance. He mentioned a NYSERDA-developed model for decision-makers and the National Renewable Energy Laboratory.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer commented that because of the barriers identified with the school buses converting to NG buses, the expansion is limited.

Reviewer 2:
The reviewer said a number of activities are listed for accomplishment during the remainder of the project and all activities included on Slide 12 of the presentation should contribute to achieving project objectives and DOE goals. Also, DOE could inquire about which activities the project partners believe would have the greatest impact on those whose decisions would affect growth in the use of NGVs. Slide 13 and Mr. Graff’s oral presentation indicate that there is a good understanding of the barriers to market acceptance of NG trucks and buses and what is needed to overcome those barriers.

Reviewer 3:
The reviewer commented that the project has the potential to increase CNG use in refuse fleets. Some issues such as inability of fleets that use refuse trucks for snow removal to use slow fill fueling stations need to be addressed. New York City Sanitation uses refuse trucks for snow removal and has CNG trucks in their fleets. Some lessons may be learned from their experience. The reviewer remarked that the project is exploring the potential to share fueling facilities. There are hurdles to overcome with shared facilities due to locations of school bus depots and refuse fleets, and traffic that would increase in residential areas. The reviewer pointed out that the potential to expand CNG use in school bus fleets may present a greater challenge because it is hard to make a business case. This case may need to rely more heavily on the health effects of particulate emissions from diesel fuel buses on children.

Reviewer 4:

The reviewer pointed out that it was mentioned that school bus fleets are not experiencing any savings and it has been determined that CNG without incentives will not fly. It appears that the expansion of CNG school buses would not move forward without incentive funding in Pennsylvania, so according to the reviewer, this will not be something we would want to replicate nationally.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer found that the lessons learned are the most important aspect of this approach. Economics is a major factor in converting the niche market vehicles and it would be good to see what solutions P3NGV recommends based on their experience on this project.

Reviewer 2:

The reviewer concluded that results of this project have significant potential for increasing the use of alternative transportation fuels, specifically NG, in Pennsylvania. The reviewer observed that follow-up analyses and case studies may also benefit other organizations throughout the country that are engaged in commercialization of alternative fuels, and are considering investing in AFVs and associated infrastructure.

Reviewer 3:

The reviewer noted that this project seeks to increase CNG use in certain fleets in the Philadelphia metropolitan area, and found that the project is aligned with the DOE program goals.

Reviewer 4:

The reviewer observed that CNG and EV do displace petroleum, but in this case the reviewer did not think this project would displace much.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer opined that the funds for workshops, training, information dissemination, procurement analysis and other project activities are being used wisely and properly. As the reviewer noted previously, this project is providing products important to alternative fuel progress in Pennsylvania. The reviewer suggested that work on deployment initiatives such as this should continue to be a high priority for the VTO. When this round of TI projects is completed, DOE should conduct an analysis to determine which projects have achieved better results for the resources expended – those addressing multiple fuels or those that focus the bulk of the funds on advancing one or two fuels.

Reviewer 2:

The reviewer concluded that if it is determined that it is very difficult to make a business case for CNG in school bus fleets, funds directed at that objective may be redirected to fleets for which a better economic case can be made, or toward focusing on the health related benefits of converting diesel bus fleets to CNG. Market outreach and mechanic/first responder training may not be adequate to convince school districts to invest in CNG as a fuel [DOE Program Clarification: The reviewer's comment was recognized as a general observation because training is not included as part of this project].

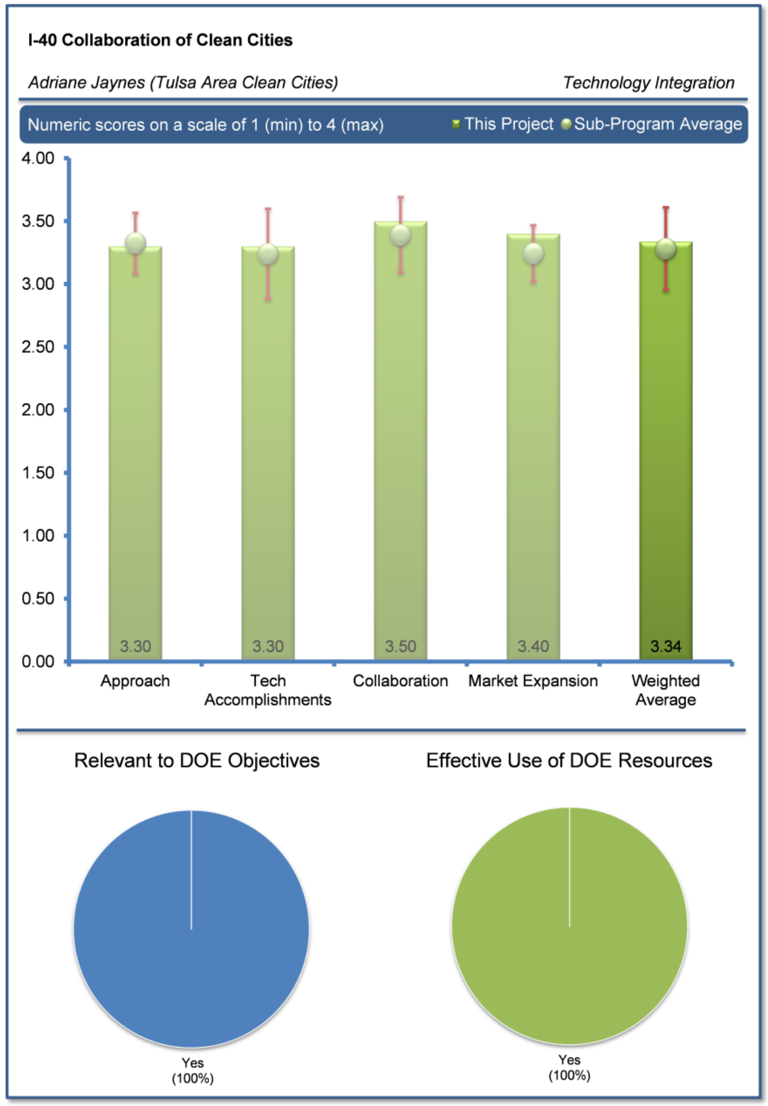
Reviewer 3:

The reviewer commented that the niche market approach with only one fuel in mind is too limiting. The reviewer suggested that it might have been better to look at municipal buses and delivery trucks operated by private companies, with a variety of fuel options.

Reviewer 4:

The reviewer did not think DOE should fund a NG school bus project, but rather a generic Alternative Fuel school bus project where all of the viable options are explored. The reviewer commented that this project pretty much proves that [DOE Program Clarification: This project was selected from a fuel neutral solicitation process. The project team selected the alternative fuel and/or technology options on which the project would focus.].

I-40 Collaboration of Clean Cities: Adriane Jaynes (Tulsa Area Clean Cities) - ti040



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the zoning code updates, highway signage, and step by step guide for alternative fuel developers were particularly interesting. These are all useful approaches that can be transferred to other cities.

Reviewer 2:

The reviewer observed a very good approach to education of fire marshals, code officials and fleets. Once again, this project is developing its own training materials; that should be done on a national level and then tweaked locally. The reviewer concluded that this project has a great mix of partners, especially the Oklahoma State University Fire Service Training folks.

Reviewer 3:

The reviewer noted that the project approach is clearly and succinctly communicated in Slide 8 of the presentation. Tasks are defined by the four elements that are common to the TI projects being reviewed (policy, barrier reduction, safety and training, and market development/outreach). The reviewer observed that topics or key activities associated with each task are included on the “Approach” slide. Slides 4 through 7 convey expanded information on activities linked with each of the four program elements.

The reviewer commented that this project has a variety of activities that address multiple alternative fuels – NG, propane and electricity. The reviewer pointed out that there could be a concern about trying to cover too many bases. However, according to the reviewer, this project is different than others that were reviewed, given its focus on more utilization of existing NG and propane infrastructure, and steps to ensure that vehicles using gaseous alternative fuels, and the fueling infrastructure, are safe. The reviewer gathered that evidently Oklahoma has a relatively robust NG and propane vehicle fueling infrastructure; conversion and original equipment manufacturer (OEM) vehicles are needed. The reviewer pointed out that presentation slides titled “Milestones” are actually statements of project activities rather than a list of milestones that link deliverables and completion dates. The reviewer indicated that Ms. Jaynes’ oral presentation provided additional confidence that there is a plan that defines and guides the diverse project activities. The reviewer offered that the statement of objectives (Slide 3) adds no value or content to the presentation.

Reviewer 4:

The reviewer detailed that this project addresses policy barriers, safety and training availability and market development/outreach to increase alternative fuel and electric vehicle market penetration along I-40 in Oklahoma and Arkansas. Policy initiatives include investigating policy changes in other municipalities and developing a best practices report on the findings, and hosting meetings of code enforcement officials, fire marshals and alternative fuel station designers to streamline the permitting processes.

The reviewer pointed out that the project addresses a unique requirement in Oklahoma for licensure of mechanics that repair CNG vehicles, and policies and resale restrictions that prevent owners of electric vehicle charging stations from charging a fee for the charging service. The reviewer detailed that marketing and awareness efforts include a campaign to identify alternative fuel stations on road signage along major highway routes. Many people are not aware of the existence and location of alternative fuel stations. The reviewer concluded that these are solid approaches to improve adoption of alternative fuels and technologies.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer noted that progress includes developing the Ozone Advance Program and getting it included in the State Implementation Plan. The reviewer pointed out that the project researched highway signage to identify alternative fuel stations. The project developed a course syllabus for AFV mechanic training in Arkansas that mimics the program in Oklahoma, developed a safety training curriculum and delivered 10 training sessions in Oklahoma. The reviewer noted that a contract for 10 additional training sessions in Oklahoma and 10 in Arkansas has been awarded, that footage for a public outreach video has been shot, and that the project has helped get AFV recommendations into the zoning code update process in Tulsa. The reviewer concluded that significant progress has been made toward accomplishing the scope of work.

Reviewer 2:

The reviewer acknowledged that the policy initiatives are helpful because other cities can also benefit from the lessons learned and the process. Another important factor the reviewer pointed out was that the education videos were useful to both public and private entities. Linking this work with the ozone alert is also very important in terms of educating the public on the benefits of alternative fuels.

Reviewer 3:

The reviewer found that the most significant aspects of this program appeared to be code official training and the station installation guides. The reviewer noted that the CNG guide had been completed using the grant funds and the liquefied petroleum gas (LPG) station guide appeared to be a bonus.

Reviewer 4:

The reviewer pointed out that there are a number of accomplishments associated with the project, including the following: preparation of zoning recommendations for alternative fuel infrastructure; research on policies for licensing and oversight of mechanics working on AFV and alternative fuel infrastructure; a case study on signage that will provide greater visibility for alternative fuel stations; a video on conversion of vehicles for CNG use; training for mechanics, inspectors and fire marshals; and outreach workshops. The reviewer found that the partners in this project are making sound decisions to take advantage of available products and materials resulting from other projects and initiatives. For example, partners have researched legislation, regulations and codes of municipalities within their region, as well as other states; decided to use a CNG guide published by the American Natural Gas Alliance rather than writing a new one; and worked with the National Alternative Fuels Training Consortium to adjust its curriculum to suit project objectives for training of emergency response systems and law enforcement personnel. The reviewer commented that as a result of the project, materials that have been developed for use in Oklahoma will be made available for training in Arkansas. That is all positive. The reviewer remarked that several activities have been completed for a lower budget than planned, allowing more work, including training classes, to be added. The reviewer noted that there was no indication in the presentation that there are quantitative results – for example, increased AFV use – that can be linked to the project.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer applauded a wonderful mix of organizations that have been pulled into this program, and although there was no match in the original grant, it appears this program has been able to get others to contribute funding.

Reviewer 2:
The reviewer remarked on the excellent partnerships, because the project team also includes academia and air quality organizations.

Reviewer 3:
The reviewer pointed out that the project has a broad coverage of collaborators including two Clean Cities coalitions, state agencies and energy offices, several universities and other industry constituents.

Reviewer 4:
The reviewer observed that this project brings together the Tulsa Area and Arkansas Clean Cities coalitions. A strong partnership and collaboration between these organizations bodes well for advancement of alternative fuels in the region. The reviewer found that the project is further strengthened by the participation of state agencies in Oklahoma and Arkansas, as well as area colleges. Slide 15 indicated that there is also collaboration with a number of other organizations. The Clean Cities coalitions' relationships with local utilities, government agencies, fleet managers and alternative fuels proponents will be a key to project success and results. The reviewer pointed out that the project presentation does not describe the respective roles and responsibilities of each project partner.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer found that the training is very good because it is heavily focused on safety. Training for mechanics, code inspectors and fire marshals is needed and can be easily transferred to other cities across the country.

Reviewer 2:
The reviewer pointed out that Slides 16 and 17 provide, for each of the four major tasks, a summary of project activities to be completed. A statement suggesting how selected project results could be used is also included for each task. The reviewer noted, for example, that the Policy task will provide case studies that states and municipalities can use to update zoning codes, utility regulations and licensing of AFV mechanics.

The reviewer concluded that the project is delivering results that can add value. The reviewer suggested that DOE should review the materials produced, such as case studies, developer guides and videos. The reviewer expressed that these materials should be considered for replication, and disseminated as appropriate to Clean Cities coalitions and others committed to alternative fuels. The reviewer suggested that DOE could inquire about which materials the project partners believe will have the greatest impact on those whose decisions will affect growth in the use of NGVs.

Reviewer 3:
The reviewer commented that the mechanic licensure process in Oklahoma has potential for replication in other localities and states. The reviewer found that the program should increase awareness of the availability of alternative fuels in the region through a highway signage campaign and public outreach efforts, and that some progress was being made on utility resale restrictions.

Reviewer 4:
The reviewer pointed out that the lack of AFV signage has been a barrier to AFV commercialization for a long time. The reviewer emphasized that if this project gets signage in place perhaps it will spread to other states and provide key consumer awareness.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer concluded that the project is aligned with DOE program goals.

Reviewer 2:
The reviewer pointed out that this project focuses heavily on zoning and safety with an important educational component in successfully transitioning to newer technology. The process and the outcome can be shared with other cities.

Reviewer 3:
The reviewer found that project results have excellent potential for increasing the use of alternative transportation fuels, particularly NG and propane, in Oklahoma and Arkansas. The reviewer noted that follow-up analyses and case studies may also benefit other organizations throughout the country that are engaged in commercialization of alternative fuels, and are considering investing in AFVs and associated infrastructure.

Reviewer 4:
The reviewer remarked that every deliverable supports this goal.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer remarked that the accomplishments from this project are transferrable and are needed to successfully transition to an alternative fuel market and petroleum reduction.

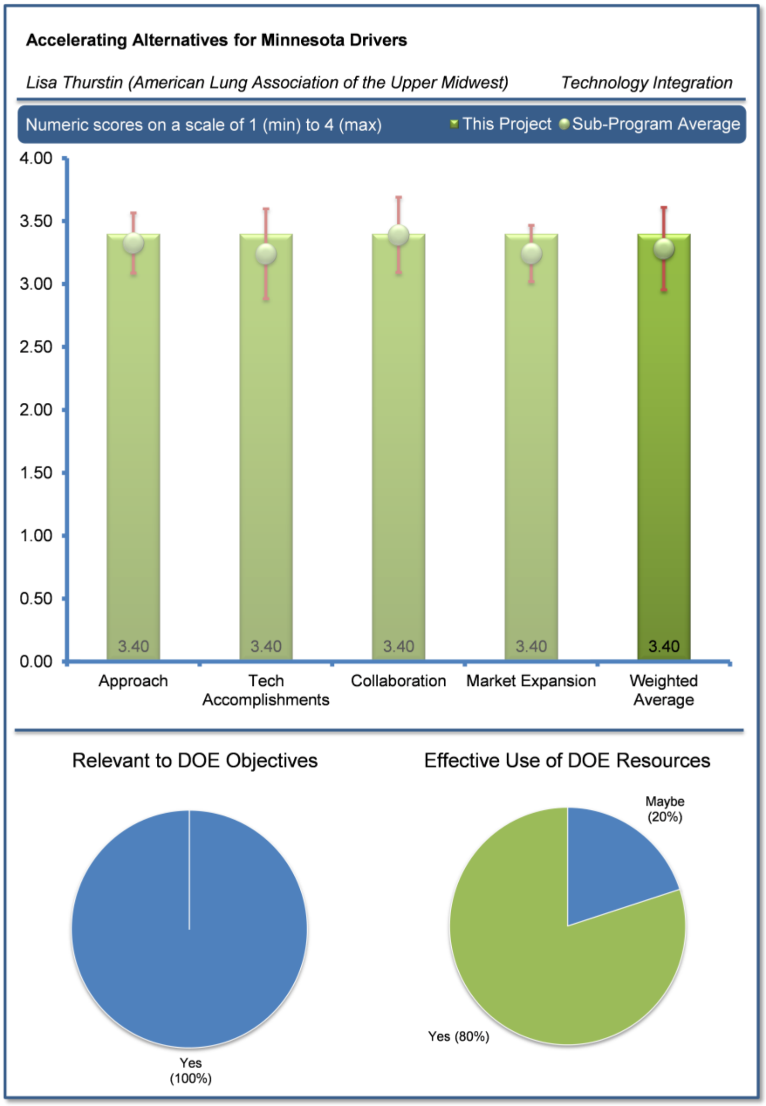
Reviewer 2:
The reviewer said that this project has higher funding than most others reviewed. While the reviewer applied a bit higher standard, this reviewer's opinion is that the funds are being used well and prudent decisions are being made.

As noted previously, the project is providing products important for alternative fuel progress in Oklahoma and Arkansas. The reviewer remarked that work on deployment initiatives such as this should continue to be a high priority for the VTO. The reviewer said that when this round of TI projects is completed, DOE should undertake a critical review of materials such as case studies, guides, training curricula and information videos. It is possible that these products set a new standard and should be widely disseminated. The reviewer remarked that it is also possible that it would be more efficient for such products to be developed "centrally", with periodic updates, rather than produced as part of any single regional project portfolio. The reviewer suggested that DOE should also conduct an analysis to determine which projects have achieved better results for the resources expended – those addressing multiple fuels or those that focus the bulk of the funds on advancing one or two fuels.

Reviewer 3:
The reviewer indicated that use and allocation of resources seems appropriate.

Reviewer 4:
The reviewer is sure that Oklahoma has a unique code of regulations for AFV station development, so spending funds to educate code officials and Fire Marshals is well spent. The reviewer commented that more funds could go to this task if there was already a national DOE funded program in place, as this reviewer mentioned ad nauseam on other project reviews.

Accelerating Alternatives for Minnesota Drivers: Lisa Thurstin (American Lung Association of the Upper Midwest) - ti041



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that this project addresses safety trainings not only on alternative fuels but also multi-unit buildings for EV charging. The reviewer pointed out that this is a barrier that is shared across the country. The availability of EV chargers in multi-unit housing will have a large positive impact on the EV market.

Reviewer 2:

The reviewer liked the fact that the project involved the multi-unit housing group. The reviewer exclaimed that this seemed to be some outside of the box thinking. Additionally, this project has already delivered quite a few deliverables with the smallest budget of the projects reviewed.

Reviewer 3:

The reviewer commented that this project has a diverse, wide-ranging set of objectives, which are included on Slide 3 of the presentation. Primary targets of opportunity for the project are PEVs and NGVs. The reviewer found that some objectives are good (i.e., specific); others are too general.

On Slide 4, most of the “milestones” are activity descriptions rather than deliverables with completion dates. One milestone is nearly a year beyond the scheduled project end date.

The reviewer observed that the project approach is described in Slide 5. Project tasks are defined by the four elements that are common to the TI projects being reviewed (policy, barrier reduction, safety and training, and market development/outreach). Topics or activities associated with each task are included on the “Approach” slide. The reviewer cautioned that given the relatively small amount of funding for the project, there could be a concern about trying to cover too many bases.

The reviewer suggested that spelling out the most important, specific, quantitative objectives and milestones – for each project task – would improve the project plan and increase the likelihood of substantive results.

Reviewer 4:

The reviewer commented that the project’s intent is to reduce obstacles to alternative fuel, NGV and PEV adoption in Minnesota. The reviewer detailed that the approach includes providing safety and technical training opportunities for first responders and fleet personnel, delivering outreach at the state fair and through other educational events to increase awareness and address policy barriers, and mechanisms to encourage NGV and PEV adoption. The reviewer observed that a particular objective is to increase access to charging infrastructure at multi-unit housing complexes by developing a database of information about providing charging infrastructure.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer indicated that there is a need for concrete tools and good examples of multi-unit housing EV chargers. This project is looking at 19 sites and has made the information available online. The reviewer observed that the sites include worksheets, a cost analysis tool, and billing option guidelines, as well as 12 case studies. This area is new to most cities and having this information can really boost the EV market. The reviewer noted that the project team is also actively addressing CNG issues in Minnesota and working with dealerships to further educate them on alternative fuels.

Reviewer 2:

The reviewer observed that multiple outreach and educational events have been delivered. A website to deliver information about PEV charging station access has been developed. The reviewer noted that a Drive Electric Minnesota partnership comprised of government, utilities and private businesses has been launched with 49 public and private partners. The emphasis of the group is on promoting the establishment of additional charging infrastructure, investigating financial incentives, and promoting education and technical support and public policy. The Minnesota Natural Gas Vehicle Coalition was also created and was formed to accelerate the deployment of NGVs in public and private fleets and to expand infrastructure. The reviewer pointed out that a total of 47 training and outreach exhibits had been held. According to the reviewer, progress seems reasonable.

Reviewer 3:

The reviewer pointed out that there were noteworthy accomplishments associated with the project. A highlight seemed to be development of decision tools for potential PEV owners and multi-unit housing owners who are considering investments in charging stations. Another accomplishment cited is the formation of the Minnesota Natural Gas Vehicle Coalition (Slide 10).

The reviewer noted that the Drive Electric Minnesota initiative has attracted nearly 50 public and private partners who meet quarterly. In the presentation, the initiative is linked to installation of more than 120 EV charging stations. The reviewer observed that during the oral presentation, Mr. Kukkonen indicated that the project has increased the number of EV-related case studies nationwide from 3 to 12. This initiative is supported in part by funds from this project.

The reviewer commented that the connection between specific accomplishments – for example, case studies, workshops and first responder training – and the project are difficult to ascertain from the presentation. The reviewer pointed out that bullets on Slide 7 are not stated as accomplishments, but are more like a “To-Do” list. One, for example, says “Further the deployment of electric and NG vehicles”. Despite concerns about too many initiatives for the funds available, and insufficient focus on a few priorities, the reviewer’s conclusion is that the project is delivering some results and organizational links that can add value.

Reviewer 4:

The reviewer exclaimed that progress seems to have exceeded the project goals by a large amount. The reviewer would like to see more inclusion of all alternative fuels though.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer observed more than 40 active partners, and pointed out that this level of partnership helps increase awareness.

Reviewer 2:

The reviewer observed a great partner list that has generated additional in-kind support and contributed to this project, exceeding its goals and objectives. The reviewer concluded that the multi-unit housing charging initiative will make a great case study for others.

Reviewer 3:

The reviewer noted that this project is led by the Twin Cities Clean Cities coalition. Slide 2 identifies seven partners, including Xcel Energy, the Minnesota Pollution Control Agency, the City of Duluth and the University of Minnesota. A strong partnership and collaboration among these organizations bodes well for advancement of alternative fuels in the region. The reviewer observed that Slide 11 indicates that there is also collaboration with additional local governments, fleet owners and other organizations. The relationships with local utilities, government agencies, fleet managers and alternative fuels proponents will be a key to project success and future endeavors.

The reviewer pointed out that the project presentation does not describe the respective roles and responsibilities of each project partner, nor does it provide information about their commitment to alternative fuels and to the project.

Reviewer 4:

The reviewer noted that the collaborations included multiple county and city government agencies, fleets and light duty vehicle manufacturers, utilities and other constituents. Collaborators represent appropriate constituents with the potential to contribute to the project goals.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer noted that the work being done on the multi-unit housing EV charging could be transferred across the country, which would have a major impact on the EV market.

Reviewer 2:

The reviewer concluded that by tackling the multi-unit housing charging issue this project can pave the way for other coalitions to adopt similar projects.

Reviewer 3:

The reviewer concluded that there is potential to improve alternative fuel and electric vehicle acceptance through the work being done in this project. The reviewer pointed out that there is some leveraging of other related efforts in the state.

Reviewer 4:

The reviewer noted that most of the information in Slide 12, “Future Work”, was about related efforts not funded by this project. The three bullets about the project are, again, very general, with no information on specific events, plans or milestones.

The project, in conjunction with other alternative fuel initiatives in Minnesota, should deliver some results that can add value. The reviewer suggested that DOE review materials produced, such as case studies, websites and training programs. These materials should be considered for replication, and disseminated as appropriate to Clean Cities coalitions and others committed to alternative fuels. The reviewer suggested that DOE could inquire about which materials the project partners believe will have the greatest impact on those whose decisions will affect growth in the use of EVs and NGVs.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer complimented the project for setting itself apart by addressing a newer area for EV recharging, as well as addressing fleet needs and the CNG market.

Reviewer 2:

The reviewer concluded that results of this project have some potential for increasing the use of alternative transportation fuels, particularly electricity and NG, in Minnesota. Follow-up analyses and case studies may also benefit other organizations throughout the country that are engaged in commercialization of alternative fuels, and are considering investing in AFVs and associated infrastructure.

Reviewer 3:

The reviewer commented that the project supports DOE program goals.

Reviewer 4:

The reviewer found that all of the deliverables will help displace petroleum.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer said that the use and allocation of resources seemed appropriate.

Reviewer 2:

The reviewer exclaimed that this was a very efficient use of funds.

Reviewer 3:

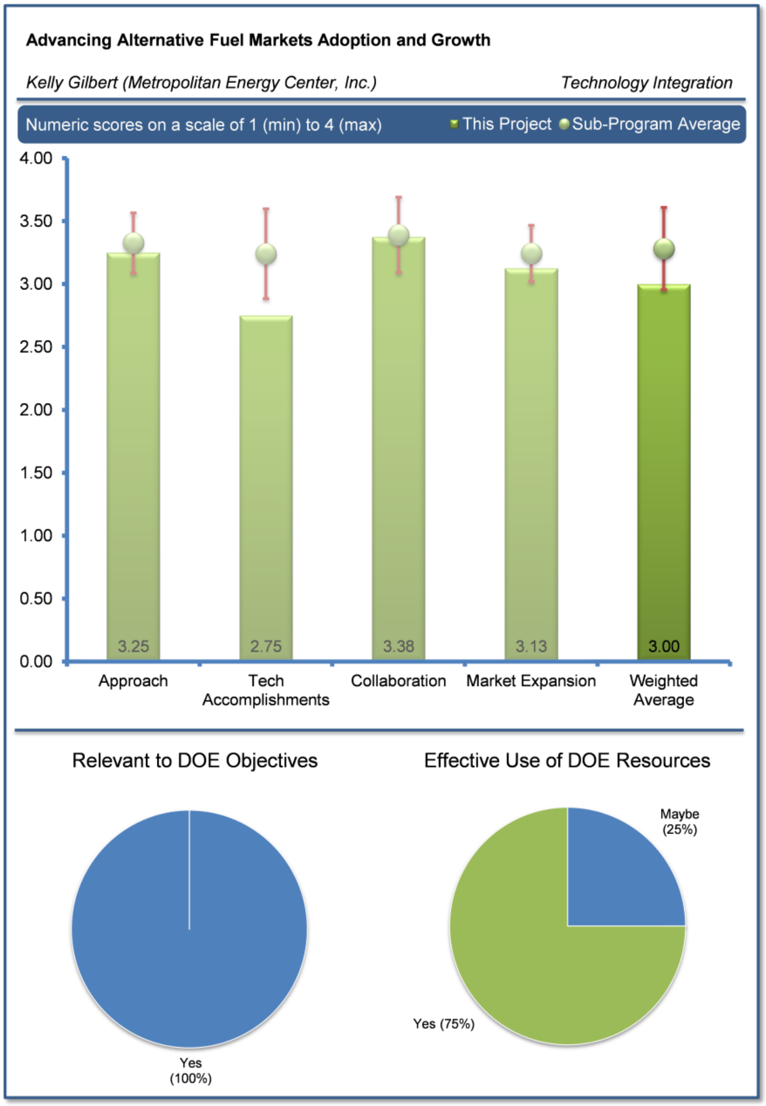
The reviewer commented that the educational material that will result from this project can be transferred to other Clean Cities coalitions.

Reviewer 4:

The reviewer pointed out that this project has less funding than all others reviewed. Despite limitations in information provided by the presentation materials, the reviewer believed the funds were providing sufficient value and were enabling accomplishment of initiatives that will contribute to advancing the cause of alternative fuels. This reviewer expressed a bit of concern that there is not a “critical mass” of project funds being devoted to fuels and activities considered to be the highest priority for petroleum displacement in Minnesota. Whether there are sufficient funds available, taking into account this and other related alternative fuel projects, is an important consideration.

The reviewer commented that work on deployment initiatives such as this should continue to be a high priority for the VTO. When this round of TI projects is completed, the reviewer suggested that DOE should undertake a critical review of materials such as case studies, workshop reports, training curricula and websites. The reviewer said that it is possible that some products set a new standard and should be widely disseminated. It is also possible that it would be more efficient for selected products to be developed “centrally”, with periodic updates, rather than produced as part of any single regional project portfolio. The reviewer suggested that DOE should also conduct an analysis to determine which projects have achieved better results for the resources expended – those addressing multiple fuels or those that focus the bulk of the funds on advancing one or two fuels.

Advancing Alternative Fuel Markets Adoption and Growth: Kelly Gilbert (Metropolitan Energy Center, Inc.) - ti042



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that this project clearly laid out its approach. It was inclusive of multiple fuels. The reviewer liked that the project managers found a creative way to work with the state air quality agency using an EPA tool to promote AFV benefits. This project also used a variety of trainings to address barriers, such as technician training. The reviewer liked the consumer outreach component. The reviewer pointed out that oftentimes Clean Cities coordinators only focus on fleets, understandably so, but it was refreshing to see this project exploring consumer education. The reviewer concluded nice project.

Reviewer 2:

The reviewer said that the air quality marketing tool looks to be helpful to municipal planners to sell the air quality benefits of AFVs to policy makers. The reviewer pointed out that the approach seems to be fairly heavily biased toward gaseous fuels. While these fuels are a staple for current fleets, the rapid influx of OEM-produced EVs and HEVs should be anticipated and perhaps more efforts to stimulate the necessary infrastructure would be desirable. Such infrastructure would benefit both the fleet operators as well as the general public. The reviewer suggested that training for first responders needs to incorporate the latest NFPA guidance on fighting lithium-ion battery thermal events. Also, while possibly out of scope for this project, the project team should consider outreach to the salvage and holding yard operators to inform them of the potential re-ignition tendencies of such batteries.

Reviewer 3:

The reviewer commented that the air quality and green fleet tools will be very useful for this project as well as others across the country that are looking to estimate/measure the air quality benefits of alternative fuel projects, especially for accessing Congestion Mitigation and Air Quality (CMAQ) funding. The reviewer encouraged the project partners to share the tool with the Association of Metropolitan Planning Organizations (AMPO) so that other metropolitan planning organizations (MPOs) across the country could utilize the tool.

Reviewer 4:

The reviewer said that the air quality modeling tool is an interesting and distinctive part of the project/approach. However, plans for deploying and distributing the tool are not well developed, and the tool is targeted for deployment within only one of the three states involved in the project.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:
The reviewer said that progress seemed to be good. Once the tools are up and running, accomplishments from the project can be quantified.

Reviewer 2:
The reviewer said that this project seemed to be headed in the right direction. The reviewer expressed concern that only a small fraction of the overall project funds had been spent, and it was more than halfway through. DOE will need to ensure the work gets done. The reviewer was not sure why there was a big lag in spending because it appears much work has been done.

Regarding policy, the reviewer commented that so far the project has designed the air quality tool and its methodology and a procurement policy model, though this reviewer is still not sure what this is. These might be good resources to share with other coalitions depending on their outcomes and impacts. Regarding barrier reduction, the reviewer commented that as a result of DOE funding, this coalition was able to develop a Green Fleets Technical Assistance and Certification program. This reviewer was curious to see how this was working. Again, it might be a good model for other coalitions. DOE needs to ensure it is providing objective and verified technical information and that the coalition is balanced in its approach. Regarding safety and training, the reviewer commented that both first responder training and diesel technician training was offered, which was nice. Regarding the marketplace, the reviewer said that the project resulted in an interstate corridor planning meeting. The reviewer noted that this had been delayed and the reviewer was unsure why. The reviewer liked that the coalition did a survey to identify reasons for consumer reluctance to purchase new technologies. It seems that only a few of the questions were presented. The reviewer would be interested in the overall report. The reviewer hoped the project included a discussion about fuels too, as 14 million flex-fuel vehicles (FFVs) are on the road but getting folks to buy the fuel is the challenge. The reviewer was not surprised that a lack of infrastructure is the number one barrier. The reviewer hoped that DOE plans to assist with that in the coming years. The reviewer would have liked to learn more about the Green Fleet program.

Reviewer 3:
The reviewer expressed disappointment that staffing issues have delayed/precluded completion of some of the outreach tasks in the specified timeframe. However, it was helpful to note that the project team still intended to complete the tasks as part of their Clean Cities activities.

Reviewer 4:
The reviewer pointed out that progress on portions of the project appeared to be notably delayed. Milestones were barely skimmed, and not thoroughly reviewed, during the presentation. The presenter did not thoroughly discuss reasons for task delays, and was not decisive about how the project schedule would be put back on track. The reviewer said that there was satisfactory to good progress for some project tasks.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer said that the project draws on the expertise and network of three active Clean Cities coalitions.

Reviewer 2:
The reviewer liked the multiple coalitions working together and the diversity of the collaborators. It seemed manageable and targeted.

Reviewer 3:
The reviewer observed good collaboration and coordination with local MPOs and the state air quality agency.

Reviewer 4:

The reviewer commented that the depth and breadth of collaboration among the partners seemed appropriate for this type of project. However, the reviewer noted that the collaborating partners did not bring any of their own funds to the table.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer remarked that there seems to be great potential for expansion. The interstate fuel demand study will provide a very good foundation to build out the refueling infrastructure.

Reviewer 2:

The reviewer commented that the Green Fleet Technical Assistance and Certification could have long lasting impacts, as could the air quality tool. The training should also help reduce barriers. In general, the reviewer found that this project has a lot of merit and that it will be successful when it is fully complete.

Reviewer 3:

The reviewer commented that the project team had conducted activities that will facilitate the expansion of AFVs. However, as this reviewer noted in previous comments, additional work on EV infrastructure might lay the groundwork for both fleet and general consumer adoption of the wide range of EVs coming onto the market by the OEMs.

Reviewer 4:

The reviewer commented that the project's potential to advance alternative fuels is dependent on the completion of delayed deliverables, about which there seems to be uncertainty at the time of review (e.g., GreenFleets certification program, Interstate Corridor planning activity, etc.).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the main project objective, to identify and remedy obstacles to alternative fuel vehicle adoption in regional and statewide markets, is directly relevant to both DOE and Clean Cities program petroleum displacement objectives.

Reviewer 2:

The reviewer concluded that this project is relevant. As the reviewer mentioned previously, the scope of work is appropriately aimed at DOE goals.

Reviewer 3:

The reviewer remarked that project accomplishments should result in measurable petroleum displacement.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

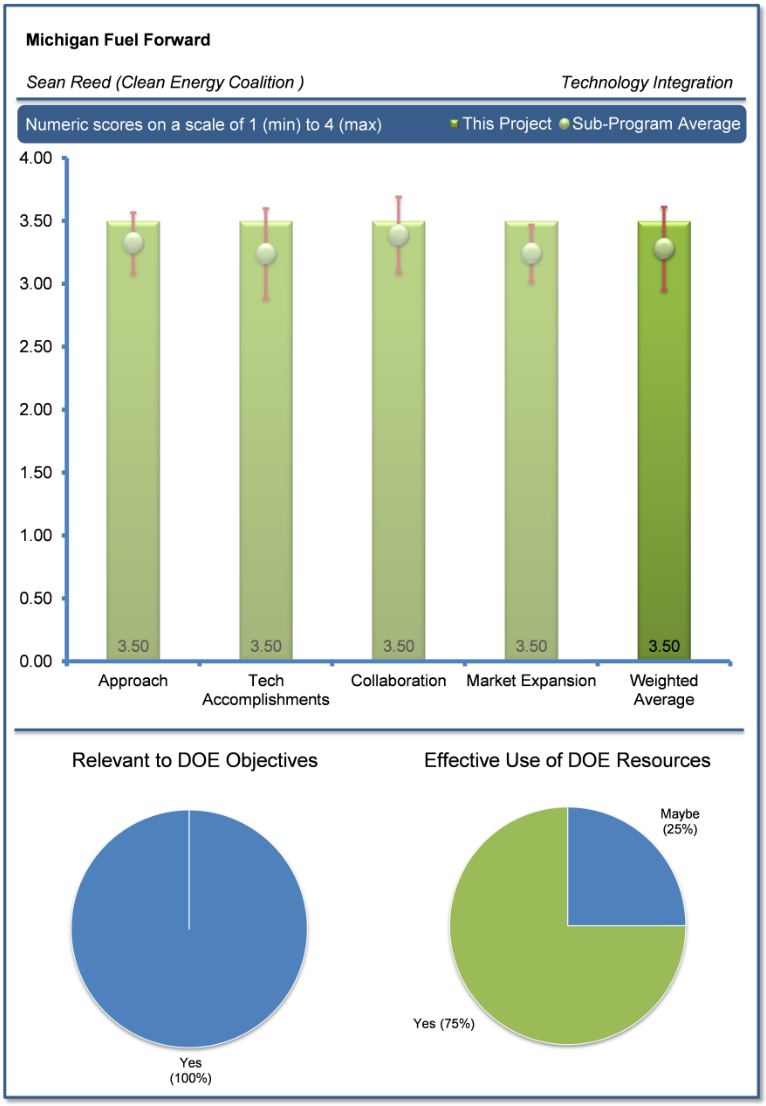
Reviewer 1:

The reviewer commented that the project activities represented a good use of DOE funding (as long as the tasks/activities are completed, naturally).

Reviewer 2:

The reviewer commented in general, yes. The reviewer emphasized that DOE needs to make sure the project tasks are completed on budget. Also, there is a lot of overlap on these projects. The reviewer hoped that DOE identifies outstanding tools developed under each of these projects and shares them so other coalitions are not duplicating efforts, but rather learning from one another.

Michigan Fuel Forward: Sean Reed (Clean Energy Coalition) - ti043



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that the project approach is very integrated and comprehensive and includes a breadth of well-designed activities.

Reviewer 2:

The reviewer observed a very organized and well thought out approach to the project. Focus on integrating alternative fuels into the long-range transportation plans is a very good strategy/approach.

Reviewer 3:

The reviewer remarked that this project included a well-balanced and developed set of activities that promoted a wide range of AFV technologies. While the training did seem to be biased toward EVs, during the question/answer session, the presenter indicated that that was in response to customer demand.

The reviewer noted a strong emphasis on working with fleets, and liked the idea of including a few "veteran fleets" into the mix to act as advisors/mentors to the new fleets.

Reviewer 4:

The reviewer remarked that this project's objective is to address barriers to AFVs. It outlines a number of good pathways to addressing AFV barriers. But when the reviewer looked at the slides and heard the presentation, it appeared that this project only supports EVs and HEVs, and some CNG training. When asked about it, the presenter said he let the market determine the training and activities. With more than 15 million FFVs on the road and more than 1.7 billion gallons of biodiesel being moved in this industry, there seemed to be sufficient market opportunities, but little public outreach and training on biofuels. The reviewer commented that it may be that the coordinator did not know how to promote or advocate for biofuels, propane and idle reduction. DOE could help coordinators know what tools or resources are available to help promote other alternative fuels in addition to EVs and HEVs. The reviewer said that it would be nice to see a better-rounded project, especially if the project was expected to promote a variety of fuels.

The reviewer remarked that this project established a policy task force, and the presenter mentioned that the state was lacking incentives for AFVs. While this was a good approach in general, it appeared that the task force only met once, according to the slides. The reviewer encouraged the grantor to host more than one policy planning event. The reviewer liked hearing that the one way the project was going to share the results was by sending a white paper to the MPOs and other decision makers. The reviewer expressed hope that there was an additional one-on-one follow up too. Meetings were planned, but the reviewer just did not have a sense of how many.

The reviewer liked the concept of doing very in-depth fleet assessments, as long as the results were objective and the coalition understood the benefits of all the fuels/technologies.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer remarked that the project progress was very good, and that all completed work was well-substantiated by the presenter.

Reviewer 2:

The reviewer said that overall the project appeared to be well managed and making excellent progress in achieving its many subtasks.

Reviewer 3:

The reviewer remarked that the combination of quantitative and qualitative data will be useful in highlighting project accomplishments. The reviewer opined that the planned 2014 release of white papers, guides, and case studies indicated good progress on the project.

Reviewer 4:

According to the reviewer, the presenter indicated that the project resulted in safety training, mechanic training, first responders and vehicle sales staff training, largely related to EVs. The slides indicated CNG training would take place later in the year.

The project resulted in planning meetings and meetings with state officials. The reviewer recommended that DOE ensures these meetings take place.

The reviewer detailed that the project collected fleet data on 16 fleets (typical fuel use, miles driven by vehicle type, etc.). The project team discussed individual fleet goals with each fleet. The reviewer pointed out that with the help of the grant, the project would give each one a set of scenarios showing which AFVs would have the best payback for their fleets. The coalition claimed it would track the fleets' implementation and fuel procurement progress. The reviewer commented that these were fresh fleets, new to Clean Cities for the most part but had a few that were leaders that were experienced with AFVs. This reviewer expressed concern that propane, biofuels and idle reduction would be excluded from this coalition's evaluation based on perceived biases. The reviewer hoped that DOE does an in-depth review of how this coalition is making recommendations to their fleets. The potential for long-term success is very high.

The reviewer said to present best practices and lessons learned with what other states were doing, and reported having made recommendations to Michigan. The reviewer noted that training seemed to be heavy on HEVs, EV inspector and first responders. The reviewer recommended that DOE needed to make sure that other fuels were being included in this training effort.

The reviewer noted that the project put out a bi-monthly newsletter to promote accomplishments and highlight new events that were coming up. The reviewer hoped this was an effective outreach tool; it sounds like a good resource. The reviewer pointed out that this project is expected to develop case studies, and that DOE needs to ensure these are completed and shared.

The reviewer liked the idea of doing a dealer training webinar. The reviewer did not hear any discussion as to how to attract these folks to this webinar. The reviewer questioned if it will be posted online afterward. It would be valuable to share.

Under the policy task, the reviewer expected to learn more about the outcomes of that task force. DOE might help this coordinator learn about what other coalitions are doing to identify policies and to educate about these policy barriers. This reviewer liked that and recommended incentives without influencing public policies through MP education.

The reviewer remarked that under the infrastructure task, the only tasks observed were signage, outreach, and training. The reviewer asked if there were more tasks.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer noted good coordination with MPOs (attendance at MPO state meeting), and state agencies. The reviewer observed a very good variety of stakeholders.

Reviewer 2:
The reviewer said that the project had an impressive list of project collaborators. While the project team did not list contractor cost-share, there are a number of tasks that are being conducted without project funds.

Reviewer 3:
The reviewer commented that the project includes outstanding direct work with fleets (16 in total to date) on deployment/implementation, planning and analysis. The project also includes great work with MPOs, state officials on alternative fuels highway signage, and very close work with other important stakeholders/groups.

Reviewer 4:
The reviewer reported meeting with MPOs and getting their feedback on how AFVs and infrastructure would be incorporated into long range plans. The reviewer would like to know what specifically was recommended. This information would be valuable to share. The reviewer acknowledged that the project had a wide range of organizations and diverse expertise, but it was limited in terms of the technologies included. The partners did not seem to include all the fuel groups (again, propane and biofuels were missing).

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer said that it appeared that by hitting all of the correct bases in a fairly balanced manner, the project should result in real progress toward the market expansion of the many alternative fuels available.

Reviewer 2:
The reviewer noted that there were no AFV incentives in Michigan, so the project activities on policymaker engagement were important and very valuable.

Reviewer 3:
The reviewer concluded that the market for alternative fuel expansion–especially for EVs–seemed to be very promising. The reviewer commented that lessons learned and case studies as a result of this project would be extremely useful to other coalitions and stakeholders.

Reviewer 4:
The reviewer found that for the technologies that were promoted under this project, there is the potential to have positive impacts on technician and safety training, especially for HEVs and EVs. The fleet analysis, if done well, could lead to a long-term transition to AFVs. It might also be a good model for other coalitions. The reviewer was curious how the project team attracted fleets to do the analysis.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer remarked that the main project objective, to target and remedy obstacles to alternative fuel vehicle adoption and use in regional and/or statewide sectors and niche markets in Michigan, is directly relevant to both DOE and Clean Cities program petroleum displacement objectives.

Reviewer 2:
The reviewer said that the stated accomplishments and goals of this project will definitely help with petroleum reduction goals.

Reviewer 3:
The reviewer commented that the project approach and deliverables are relevant to AFV market development, although the reviewer would like to see it be more fuel diverse in its approach. See Approach and Accomplishment to understand why.

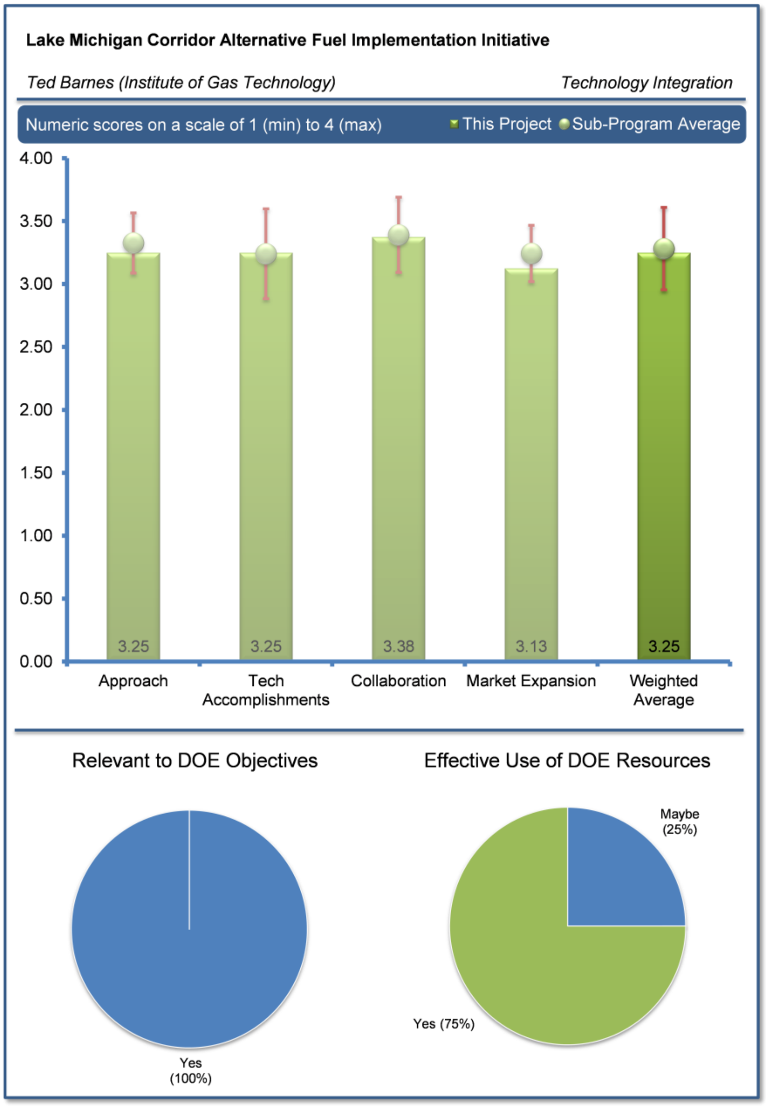
Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer found that the project activities represented a very good use of DOE funding.

Reviewer 2:
The reviewer noted in-kind cost share.

Reviewer 3:
The reviewer acknowledged that the approach was strong, but the reviewer was led to believe that it was going to promote all the fuel types. This project had significant biases toward one or two fuel types. If we expect to see a diverse project and it only promotes one or two, this reviewer considered the use of resources to be insufficient. The reviewer supported DOE funding fuel specific projects if that was how the project is pitched and identified from the proposal and review. The reviewer offered as an example how Minneapolis probably does not need to promote more FFV infrastructure but really needs more gaseous fuel support; that is okay. The reviewer guessed that Michigan could use help on all of them, so wanted to know why the project was only focused on one. The reviewer asked if DOE approved that approach. The reviewer further noted that although DOE had funded some great educational tools, the agency would still need to assist with infrastructure funding in the future. The industry and fleets would be motivated to do more with leveraged funding for infrastructure.

Lake Michigan Corridor Alternative Fuel Implementation Initiative: Ted Barnes (Institute of Gas Technology) - ti044



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project approach was well-rounded, and included some interesting subtasks such as CNG weights and measured training, maintenance facility (CNG safety) modification guidance, etc.

Reviewer 2:

The reviewer observed a good project approach. Stakeholder feedback on barriers would be very useful as the project progresses. The reviewer noted that a focus on the transit and taxi industries would potentially result in significant interest.

Reviewer 3:

The reviewer said that the project seemed well designed to address the gaseous alternative fuels, but appeared to be lacking with respect to the emerging EV/HEV markets.

Reviewer 4:

The reviewer liked the nice layout of the tasks to be accomplished. The tasks were clearly defined and easy to follow, and were not too broad or generic. This reviewer noted that broad and generic can be okay if the project team defines how they determine their deliverables. The reviewer noted that this project clearly laid out how it was going to develop new policy efforts (i.e., Green Fleet program, Smart Purchasing Policy, inspection criteria, and shared access to municipal stations). There is some good potential for models for other coalitions. The reviewer asked what DOE was doing to share successful projects with other coalitions.

The reviewer liked that this project did a survey to collect feedback to set project direction. It was used to confirm the coalition's/project's direction and the reviewer thought this was nice, but asked if the project had a well-rounded review. This reviewer recommended that DOE needs to observe whether or not these coalition projects are including a sufficient spread of industry/technology representation. The reviewer noted that one barrier identified was that there were a lot of private stations and limited public access stations. Further, municipalities were not experienced in the inspection of these technologies. The reviewer liked that these were targeted barriers under this project. But again, the reviewer suggested helping the coalitions understand what additional training resources were out there that did not need to be redesigned for each coalition (CNG, HEV, propane, biodiesel).

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer remarked that the project progress and accomplishments were very well documented and articulated by the presenter.

Reviewer 2:

The reviewer said that the educational and outreach components of this project seemed to be progressing very well, and that the webinar series seemed to be very successful.

Reviewer 3:

Regarding the Policy task, the reviewer liked that one goal of this project was to learn how to open municipal stations to the public. As a result of this project, one of the stations is now open and others were surveyed to determine their potential and interest in opening to public fleets. The reviewer noted that the project team developed a green fleet recognition program and obtained endorsements. This project also developed a safety checklist, which was vetted for vehicle inspections, which the reviewer commented was nice.

Regarding Barrier Reduction Initiatives, the reviewer said that this project resulted in weights and measures guidelines, and lessons learned to help identify problems, specific to CNG. The project team developed Vehicle Deployment Toolkits and offered webinars to educate about vehicles and station safety issues for CNG, EV, and propane. This is what the project said it was going to do and did it; it was clearly defined.

Regarding the Safety and Training Initiatives, the reviewer emphasized that this project resulted in hosting 18 Auto Tech Training Courses based on NAFTC's training. The project also held fueling station workshops for code officials (dealing with inspection awareness barrier). This reviewer expressed curiosity about what the comments were after that training. Also, the materials were developed for CNG and propane to simplify codes and provide guidance so that a code official could see it was similar to gasoline.

Regarding the Market Development task, the reviewer said that this project resulted in several education and market outreach events to attract niche market users. Those included taxi fleets, transit and heavy industry applications like cement mixers, and webinars to a variety of others. The reviewer asked what the outcome was of those workshops. According to the presenter, the five total webinars have had 3,000 views to date. The reviewer pointed out that the webinars, if updated regularly, would have longevity after the grant period.

The reviewer thought the Maintenance Garage Upgrade Guidelines were valuable to other coalitions. The reviewer would like to know what DOE was doing to vet and share these tools. The reviewer asked how it compares to other deliverables that DOE has received along the same topic.

Reviewer 4:

The reviewer said that the project accomplishments aimed at gaseous fuels were substantial; however, very little appeared to be accomplished to support the expansion of the EV and HEV markets. The reviewer said that the program needed more balance.

The reviewer said that the project needed to include recent NFPA lithium-ion battery fire suppression information in the first responder training. The reviewer suggested considering including outreach to salvage and holding yard operators on the re-ignition tendencies of that technology.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer found that the project's engagement of and collaboration with special niche heavy-duty fleets (e.g., cement mixers) is very interesting.

Reviewer 2:

The reviewer said that this project had a nice mix of training officials, industry members, fleets, planning commissions, and, of course, three coalitions. The reviewer would like to see more coalitions teaming up. The reviewer enthusiastically exclaimed that the project appeared to be getting results and was not encumbered by too many partners.

Reviewer 3:

The reviewer said that partnerships appeared to be adequate. The reviewer suggested that a bit more emphasis on EV partnerships would have strengthened the project. However, on the plus side, the reviewer noted the $55,000 recipient funding.

Reviewer 4:

The reviewer observed good coordination and collaboration with other coalitions, but they may need to expand to state agencies, MPO's and other stakeholders.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer noted that the project produced online webinars on CNG/propane conversion, infrastructure installation, and maintenance, and seemed to have had some enduring impact on the local and nationwide AFV community.

Reviewer 2:

The reviewer said that the fact that three coalitions were working together and there were tools that were getting a lot of use (webinars received 5,000 hits) said a lot about the products of this project. The reviewer liked that the project included some local community colleges so that the project had rising students interested in alternative energy. The reviewer would have liked to hear a little more about the outcomes of the trainings and their impact. The reviewer also liked that the first responder training was just filling gaps in information, not creating a whole new training. The reviewer pointed out that many of the safety trainings were already out there and just needed to be updated to stay current. The first responders need a reason to go back and look at updated materials periodically, not just once.

Reviewer 3:

The reviewer said that information obtained from surveys would be helpful to other alternative fuel projects across the country.

Reviewer 4:

The reviewer thought that it would help with expanding the gaseous fuel market, but was lacking on the EV side.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer remarked that project accomplishments to date seemed to support petroleum displacement goals.

Reviewer 2:

The reviewer remarked that the main project objective, to target and remedy identified obstacles to AFV adoption and use in key regional area - Lake Michigan corridor, is directly relevant to both the DOE and Clean Cities program petroleum displacement objectives.

Reviewer 3:

The reviewer noted that the five webinars (installations, vehicle survey, codes, etc.) seemed very relevant and received a lot of feedback and use. The reviewer expressed hope that the project team will share the information gaps on the first responder training with the right safety organizations. DOE could help to get this out to other organizations.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

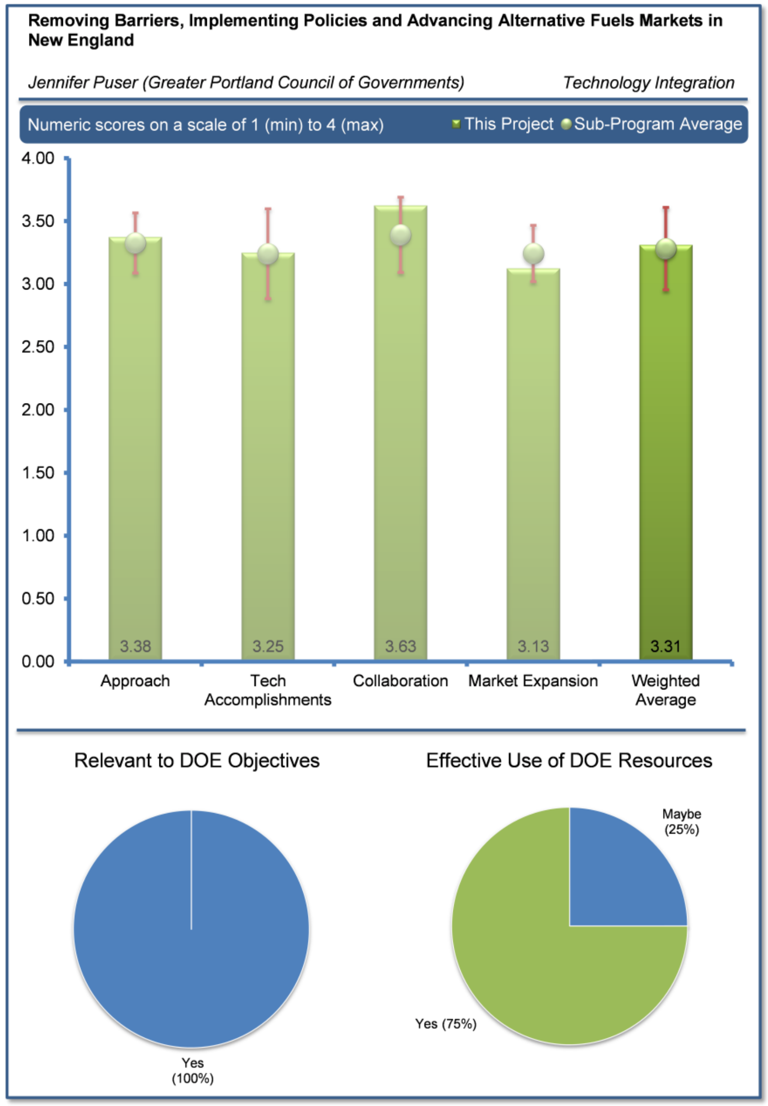
Reviewer 1:

The reviewer noted that the $55,000 recipient's funding was a positive.

Reviewer 2:

The reviewer said that it was hard to tell because reviewers were not reviewing budgets. In general, this project team was on track to complete its tasks on budget. However, the reviewer suggested that DOE needed to evaluate if educational projects were the only forum for future grants. Many of these coalitions are seeking support for infrastructure and vehicles. Education only gets us so far. The reviewer concluded that there needed to be better incentives/grants.

Removing Barriers, Implementing Policies and Advancing Alternative Fuels Markets in New England: Jennifer Puser (Greater Portland Council of Governments) - ti045



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed a good project approach. Once again, the focus on integrating alternative fuel projects into the MPOs' transportation planning process was a very good strategy and would be very useful in the long-run.

Reviewer 2:

The reviewer liked the overall approach of this project, which planned to work with MPOs to address policy initiatives, survey fleets to address barrier reduction initiatives, and planned safety training for first responders, CNG and EV inspectors and diesel technicians (for biodiesel). The tasks were clearly outlined in the approach section. The reviewer liked that this coalition was meeting the folks with the perceived barrier on their own turf. For example, the project team planned to integrate AFV technology materials into existing MPO documents – in their "language." The reviewer believed that many of the outcomes would have longevity after the project is done (i.e., the technician, safety and inspector trainings). Also this coalition developed a biodiesel working group with the producers to increase biodiesel development in the region. The reviewer thought that this is a good model for other coalitions to follow. This reviewer liked the Nissan LEAF Loaner Program. This is an innovative approach that could be modeled in other coalitions. The reviewer concluded, nice.

Reviewer 3:

The reviewer remarked that the project approach included numerous relevant and well-conceived activities. The "Clean Fleets Designation Program" activity is interesting; however, the extent to which this effort would be developed and deployed under the project was unclear through the presentation. The reviewer noted that the expansion of project scope to include EVs was good.

Reviewer 4:

The reviewer noted that the original project was very light on promotion of EV/HEV technology; however, a recent project modification had corrected this deficiency. The reviewer said that this was the only project with a strong biodiesel emphasis. The reviewer was unsure if this was a positive or a negative.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer found that substantial progress had been made in Year 1 of this project, and that the addition of the EV component to the project would help ensure success.

Reviewer 2:

The reviewer commented that the project had made good progress overall, with many milestones met to date. The only question this reviewer had was what the extent of progress would be with the Green Fleets activity.

Reviewer 3:

The reviewer pointed out that the original intention to develop a “certification” program for fleets was not accomplished, and the project changed the deliverable to a “designation” program. The reviewer noted that the project was just adding EVs; as a result, the project was playing “catch-up” in this area.

Reviewer 4:

The reviewer commented that the project developed the biodiesel working group and held three meetings. The intent was to identify the barriers in the region. The reviewer noted that it was mostly comprised of small producers, and would continue afterward. The reviewer noted that fuel quality was an issue, and that there was a problem with folks stealing feedstock. The reviewer observed that BQ9000 was expensive for small producers, and that this group would continue to work collectively. The reviewer noted that the project held five first responder trainings to date, held three CNG tank inspection and fleet workshops, and held one workshop for biodiesel. The reviewer liked the fuel diversity of this region, and pointed out that the project team was working to be fuel neutral. The reviewer noted that the project drafted fleet manager training, and went back and added MPO outreach and worked with EVs. The reviewer would have liked to see a few of the outcomes placed online to add even more longevity to the project.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer commented that the project included solid stakeholder collaborations; four other Clean Cities coalitions were actively involved with Maine and project tasks had been divided among coalitions for completion. The New England Biofuel Producer collaboration activity was an especially interesting part of the project.

Reviewer 2:

The reviewer complimented this project team on working with four coalitions plus collaborators wow! The reviewer asked if it was hard work to have so many coalitions and collaborators. The project team seemed to play nicely in the sandbox. The reviewer would caution coordinators not to add too many collaborators if it meant the project could not get the work done in a timely fashion. In this case, the project team seemed to be on track to get the work done on time and on budget.

Reviewer 3:

The reviewer observed that a wide variety and range of stakeholders were involved in the project.

Reviewer 4:

The reviewer noted a good range of collaborating partners; however, the reviewer did not observe a contractor/partner share of the funding.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer noted that CNG deployment in the project's host state of Maine continues to remain challenging. The project leverages other successful alternative fuel activities in Maine (EV Loan Program, biodiesel ferry service project, etc.).

Reviewer 2:
The reviewer commented that it appears that the effort, in coordination with the Transportation Climate Initiative, will help to expand the use of alternative fuels in the Northeast.

Reviewer 3:
The reviewer observed that the training would have longevity, and that the biodiesel working group would have longevity. The reviewer believed that lending out EVs to MPOs to expose them to the newer technologies like EVs would create market acceptance and awareness. The reviewer liked that this coalition included biodiesel use by ferries in this project. The reviewer encouraged DOE Clean Cities to think about markets beyond transportation that promote similar infrastructure development, such as the B20 in ferries or heating oil markets. The reviewer suggested that the Clean Fleet designation should be ongoing. The coalitions nominate fleets. Those that meet at least 30% use of alternative fuel in their fleets would receive recognition. The reviewer looked forward to seeing this come to fruition and what learning what reaction there is to the recognition.

Reviewer 4:
The reviewer was not sure if the focus on the biofuels would add or detract from the overall AFV market expansion potential. However, according to the reviewer, the addition of EVs would likely add to it, even when considering the range issues at extreme cold temperatures.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that the main project objective, to target and remedy obstacles to alternative fuel vehicle and fuel adoption and use in regional and/or statewide sectors and niche markets, was directly relevant to both the DOE and Clean Cities program petroleum displacement objectives.

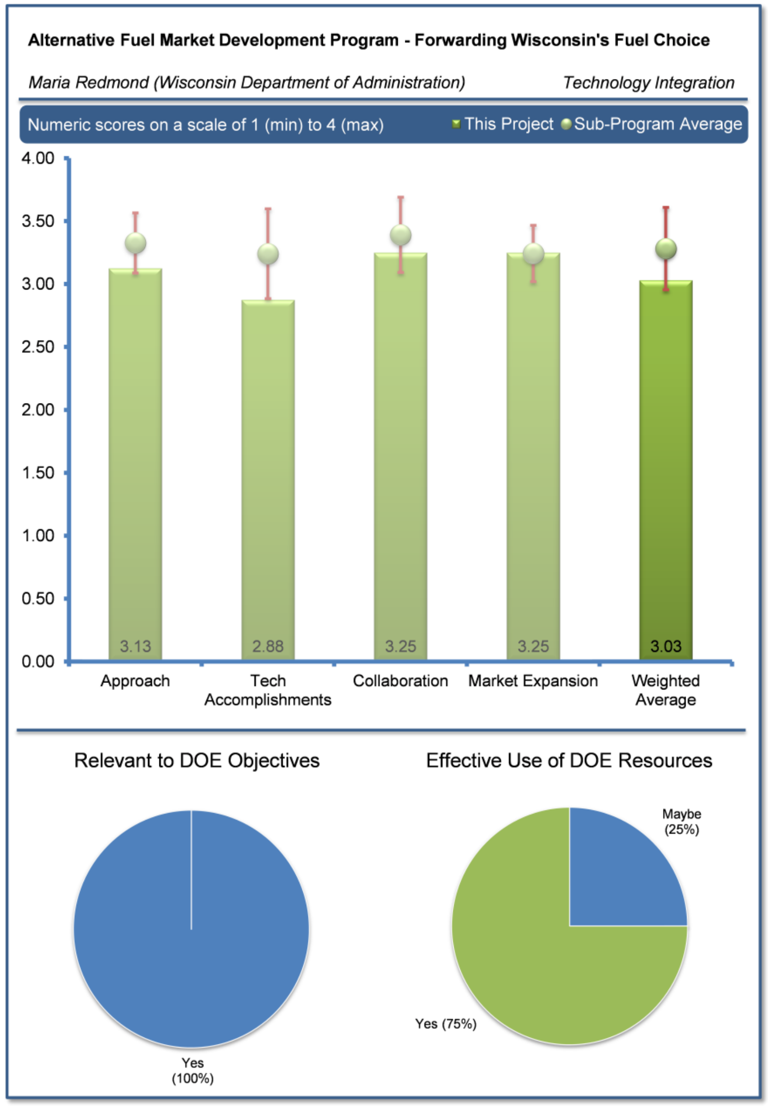
Reviewer 2:
The reviewer said that, as with other projects reviewed, this had merit and was designed to meet DOE goals.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer said that the project activities represented a good use of DOE funding.

Reviewer 2:
The reviewer liked this project and its outcomes overall, but stated that DOE needed to be aware that all the education in the world would not place infrastructure on the ground or purchase vehicles. The reviewer pointed out that each technology had different needs, but infrastructure is one of them (terminals for biodiesel, refueling stations for the others).

Alternative Fuel Market Development Program - Forwarding Wisconsin's Fuel Choice: Maria Redmond (Wisconsin Department of Administration) - ti046



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer commented that fleet data validation and standardization would provide consistency and credibility to the project. The development of the Smart Fleet Assessment Tool would enable stakeholders to gauge the potential for alternative fuel use in their fleets.

Reviewer 2:

The reviewer said that, in general, the project approach was in line with DOE goals. The deployment is similar to other projects (training, surveys, education, and state agency outreach). The reviewer liked the idea of completing 20 fleet assessments. Several other projects were doing something similar. The reviewer would like DOE to compare some of these fleets' survey tools and find out which ones were highly effective at transitioning fleets to AFVs.

Regarding the policy task, the reviewer said that this project also aimed resources at improving road signage. The reviewer expressed curiosity regarding whether this was a big problem compared to other barriers. The other task was to create an inventory of statewide laws and incentive programs. The reviewer thought that the Alternative Fuels Data Center (AFDC) already did this. The reviewer was unsure how the project was going to improve on this. In the future, this coalition might benefit from a policy working group to identify policy barriers.

The reviewer noted that based on the overview, this project was expected to address barriers for a variety of alternative fuels, but the outcomes were all focused largely on one or two fuels. The reviewer would like to know what DOE was doing to make sure the fleet evaluations were going to be unbiased toward each fuel type, not that there was not a specific fuel or two recommended. The reviewer would like to make sure that the project makes information available on the merits of each of the alternative fuels and that the coalition is not favoring a limited few.

Reviewer 3:

The reviewer was impressed that the project team had a waiting list for fleets and that this program would continue post contract. The program balance seemed reasonable but the reviewer suggested that the project could include some efforts to stimulate more EV charging infrastructure. The reviewer pointed out that the project team should ensure that training for first responders incorporates the latest NFPA guidance on fighting lithium-ion battery thermal events. Also, while possibly out of scope for this project, the project team should also consider outreach to salvage and holding yard operators to inform them of the potential re-ignition tendencies such batteries could exhibit.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer commented that a good amount of outreach, education and training had already occurred. Accomplishments and progress to date had been very positive.

Reviewer 2:

The reviewer found that in general, the project appeared to be on track to complete tasks and deliverables (i.e., signage throughout the state, fleet assessment program, safety training, etc.). The project is expected to over deliver on its 20 fleet assessments, and will end up doing about 27. The reviewer remarked that this was great, if the reviews were truly objective and not biased toward one or two fuels. DOE may have to be engaged with the coalition to understand how this assessment is discussed with the fleets, to ensure there are not prejudices for or against one or more alternative fuels. The reviewer remarked that it was hard to tell from the brief presentation. Keep in mind that benefits are not always financial; they could include a cheap octane or GHG reduction strategy.

The reviewer liked that this project surveyed fleet retailers. This should have been outlined in the project team's approach. It is very innovative and may address a lot of barriers during the survey. The reviewer suggested that the project share the survey with other coalitions. The reviewer commented that the project would provide a tool on incentives available for them. The reviewer thought this was okay, but asked if the AFDC was not already doing this.

The reviewer commented that safety training with the local college is done and will have longevity, and thought this was nice. The reviewer was not sure how helpful an inventory of policies would be. It would be nice to see policy recommendations that would further reduce barriers.

The reviewer liked the Smart Fleet Program, and reported that fleets applied for and received a stipend for participating. The reviewer pointed out a valuable lesson learned was that they did not need that stipend. The reviewer thought that the contract mechanism was a barrier and another good lesson. The fleets get personal feedback after doing the survey. The reviewer pointed out that there are more fleets interested in doing this than can be assisted under the grant. The fleets get a lot of feedback and coaching from the coalition. Again, this may be a good model for other coalitions. The reviewer noted that this project also resulted in five webinars, which were also on the coalition website and that this promoted longevity. The reviewer also noted that the project not only offered CNG safety training but did a train-the-trainer too. Cummins developed the curriculum and it was used by more than just this coalition.

Reviewer 3:

The reviewer said that the program's progress appeared to be on schedule. While some delays were encountered associated with the development of fleet stipends, it appeared that the project still had an impressive number of fleets in place and that the project intended to continue this activity post contract.

Reviewer 4:

The reviewer said that based on the presentation, it appeared that approximately 70% of the project budget was unspent but only approximately 30% of the project timeframe remained. The reviewer commented that the project seemed very behind, and it was not entirely clear how it would be completed without an extension. The reviewer observed that the presenter noted complications with data collection, and the fleet assessments were approximately 75% complete.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer said that the Wisconsin Smart Fleet Program was a well-designed strategy for engaging fleets; the program currently has a fleet waiting list. Overall, project stakeholders seemed enthusiastic and fairly involved in project activities.

Reviewer 2:

The reviewer observed a wide variety of collaboration and coordination with stakeholders, and good coordination with the State Department of Transportation on signage issues. The reviewer believed that development of a white paper would be very informative and useful.

Reviewer 3:

The reviewer liked the curriculum and training development with Cummins and the local college. The train-the-trainer would have longevity. The reviewer observed that the Wisconsin SEO and coalition worked well together and that their partners had effective roles, and thought this was nice. The reviewer wondered if the collaboration might have been more fuel neutral with broader stakeholder involvement. Most of the partners appeared to be related to CNG and EV technologies.

The reviewer asked if other fuel groups provided input into the project survey or responses. According to the presenter, the project just used DOE resources to provide guidance. The reviewer was not sure what this meant. DOE would need to check into this first hand. The reviewer noted that the outcomes were likely to link industry partners with fleets after the survey and assessment, and that each fleet would receive an assessment. Again, it was an interesting concept, but the reviewer asked if it was objective enough, and how much flexibility was built into the guidance.

Reviewer 4:

The reviewer noted some cost share (i.e., $10,000). Partners appeared to be fleets and Clean Cities coalition members only. The reviewer suggested that the project could use more partners that were specific to the various alternative fuel technologies.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer observed that the project had good activities to build alternative fuel market expansion potential (assuming slow/delayed project tasks are actually completed). The reviewer noted that the project would result in key recommendations across a wide range of areas to help future efforts.

Reviewer 2:

The reviewer commented that there appeared to be a very good market for expansion and replicability for similar efforts across the country. The Smart Fleet Assessment Tool would be useful to other organizations looking to expand the use of alternative fuels.

Reviewer 3:

The reviewer found that this project had the potential to have long-term impacts. It was focused largely on the fleet survey and tech training. The reviewer would have liked to see more about what the impacts of these surveys are telling the coalition, but it is probably too early to tell. The survey will result in direct interaction with fleets and is expected to have an impact on those fleets. The reviewer found that this was a good approach, and it was nice to see a pathway to transition the fleets to alternative fuel. The reviewer concluded that this is a good model for other coalitions to implement, if it is objective.

Reviewer 4:

The reviewer commented that the strong fleet work was a definite positive. However, more could be accomplished regarding stimulation of the EV charging infrastructure in anticipation of the expected increase in availability of OEM-produced EVs and HEVs.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer commented that the main project objective, to target and remedy obstacles to alternative fuel vehicle adoption and use by identifying, developing, updating, and modifying local/regional/state, was directly relevant to both DOE and Clean Cities program petroleum displacement objectives.

Reviewer 2:

The reviewer concluded that it appeared that this project would definitely support DOE's overall petroleum reduction goals.

Reviewer 3:

The reviewer commented that the task aligned with the program goals. The reviewer wondered if this was really the question DOE should be asking. All the projects were relevant or they would not have been funded. The reviewer asked if DOE was interested in what should be funded down the road. Infrastructure continues to be the biggest barrier.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

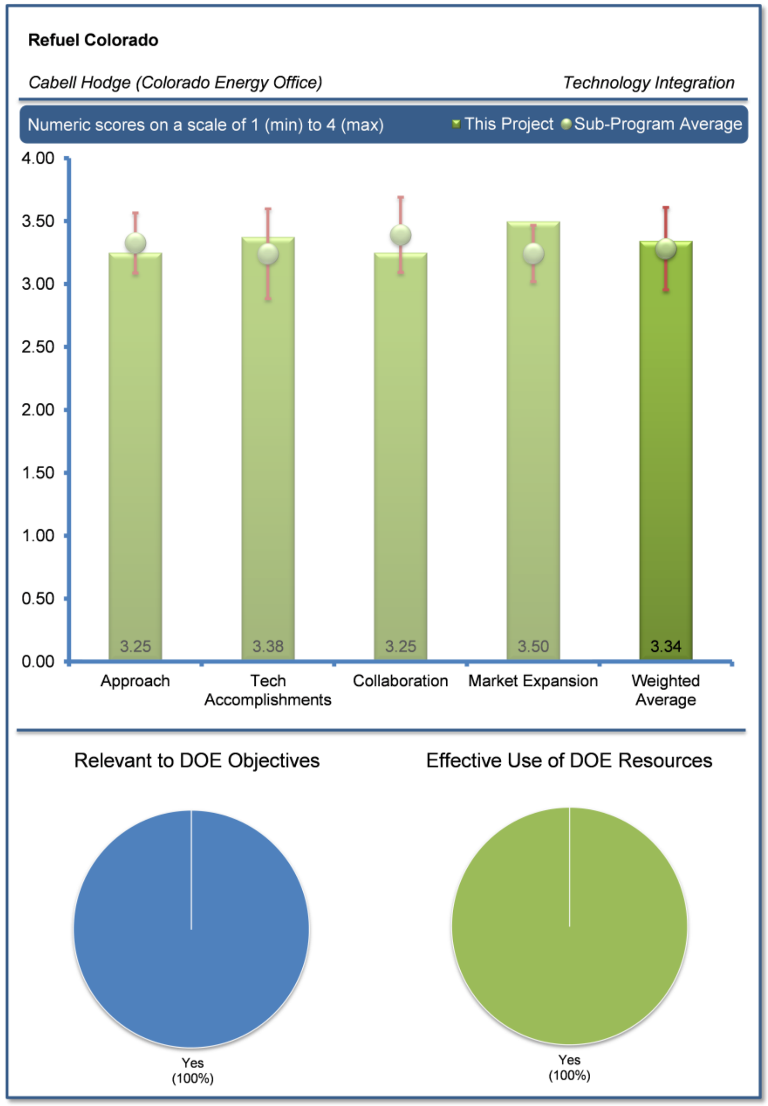
Reviewer 1:

The reviewer concluded that the project activities represented a good use of DOE funding, as long as the tasks/activities were completed.

Reviewer 2:

The reviewer remarked that the tasks seemed appropriate, but wondered if the implementation of these tasks, where relevant, was unbiased. If so, then yes.

Refuel Colorado: Cabell Hodge (Colorado Energy Office) - ti047



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the inclusion of a Hydrogen Coalition in this project was a good addition. Examining the utilization of idle reduction and aerodynamic technologies in the state fleet complimented the project and will help to meet the petroleum reduction goals.

Reviewer 2:

The reviewer found that the project activities supported a well-rounded approach, though leaning more towards a road-mapping approach. The reviewer pointed out that biofuels were practically excluded from the project's scope.

Reviewer 3:

The reviewer liked the inclusion of a wide variety of AFV technologies, including the emergence of H_2. The project website was very informative and well laid-out.

A lot of information was provided that was relevant to both consumers as well as fleet operators. According to the reviewer, the only deficiency was a lack of technician and first responder training. The reviewer thought the significant contractor cost-share was a definite plus, as well as non-project funded grants for EV charging stations.

Reviewer 4:

The reviewer commented in general, that this project's approach was strong. The reviewer liked the concept of fleet coaching, and noted that it was similar to other projects. This appeared to be an effective approach to integrate AFVs into their fleets.

The reviewer noted that the project appeared to have a fuel neutral approach. However, the project only included four fuel specific industry partners. The reviewer would have liked to have seen a better-rounded team. Biofuel partners were missing, and consequently the project did not include them. The reviewer suggested that DOE could have given the project feedback on this and on how to include biofuels in their region.

The reviewer liked that this project included idle mitigation. This was a great way to show payback and the effectiveness of idle reduction. The reviewer liked the development of stakeholder groups, and believed that this was an effective approach to sharing information. The reviewer liked that the coalition worked with Colorado state offices to create safety regulations for CNG. This would impact codes in the state. The reviewer identified that one task was to complete a state audit. The reviewer asked how DOE was ensuring this was fuel neutral or technology neutral, although this does not mean the outcomes are neutral. The reviewer liked the website tool for fleets, and hoped the project and DOE helped to make sure the materials are current.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer found that the project had excellent progress and task accomplishments.

Reviewer 2:

The reviewer observed that progress and project accomplishments seemed to be moving along. The reviewer noted that studying the potential for CNG use in the state provides an excellent foundation to define and build out the needed refueling infrastructure.

Reviewer 3:

The reviewer remarked that an impressive amount of work has been accomplished, with no significant delays noted.

Reviewer 4:

The reviewer said that the roadmap was intended to share information with stakeholders. The project “developed” the Refuel Colorado website, a fleet information resource. The reviewer loved the layout and the links, but there was very dated material on this website, especially for the biofuels. The reviewer gave as an example that the only performance characteristic listed for FFVs was a negative feature. According to the reviewer, there were a large number of additional positive characteristics such as high octane and engine performance.

The reviewer noted that this project seemed to limit alternative fuel success to economic benefits only. The reviewer encouraged DOE to work with this coalition to make sure the coalition was promoting other non-economic benefits, such as GHG reductions, domestic energy production, local jobs, etc. The reviewer again noted that idle reduction was a nice addition to the project. The reviewer expressed hope that this project motivates other fleets to incorporate this concept. The reviewer liked the concept of fleet coaching, but would like to see DOE review this process.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer liked the wide range of collaborating partners that spanned the range of AFV technologies, including H_2.

Reviewer 2:

The reviewer remarked that the fleet coaching activity, which has directly assisted 72 fleet managers, is excellent. The project has good overall stakeholder coordination, and leverages/incorporates expertise at a mix of organizations/groups with specialization in different fuels.

Reviewer 3:

The reviewer commented that the collaboration and coordination with various stakeholders appeared to be helping to move the project along. The reviewer suggested making sure that there was close coordination with the Colorado Department of Transportation on any signage issues.

Reviewer 4:

The reviewer expressed concern that this coalition only worked with limited fuel groups. Within those fuel groups chosen, the reviewer said the project team did a good job. The project reached 2,000 consumers through outreach efforts, which the reviewer remarked was nice. The reviewer liked that the project had 72 fleets impacted by this grant so long as the evaluation has the potential to be fuel neutral and not biased toward one or two fuels or technologies.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer found that the program would likely result in real-world AFV market expansions, especially considering the wide range of AFV technologies emphasized. The website also provided an impressive amount of information that was relevant both to fleets as well as general consumers.

Reviewer 2:
The reviewer said that the project activities such as the CNG marketing plan, fleet conversion assessments, and state fleet audit should have an enduring impact on alternative fuel market potential in Colorado.

Reviewer 3:
The reviewer said that this project has a great deal of potential through the fleet coaching effort and web resources.

Reviewer 4:
The reviewer remarked that the expansion potential of this project looked promising for the state.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer found that the main project objectives, to reduce barriers to fleet incorporation of alternative fuels and efficiency technologies, disperse information to consumers and fleets, and develop a roadmap for alternative fuels, were directly relevant to both DOE and Clean Cities program petroleum displacement objectives.

Reviewer 2:
The reviewer remarked that it appeared that this project was in line with and would help to achieve DOE's petroleum displacement goals.

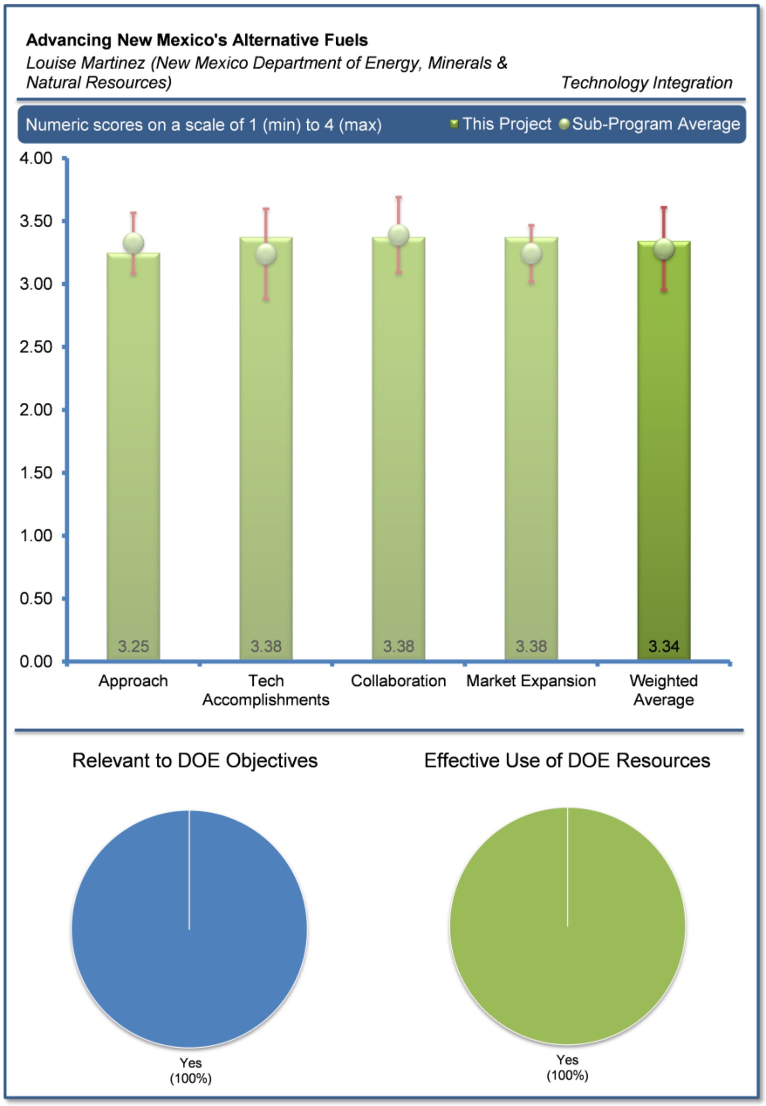
Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer said that the project activities represented a very good use of DOE funding.

Reviewer 2:
The reviewer pointed out that DOE funds were leveraged with a substantial contractor cost share ($107,000).

Reviewer 3:
The reviewer said that this appeared to be a good use of resources, but the products needed to be fully vetted by DOE.

Advancing New Mexico's Alternative Fuels: Louise Martinez (New Mexico Department of Energy, Minerals & Natural Resources) - ti048



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project takes a strong approach to addressing key task areas, although the scope of the project is almost exclusively on NG. The reviewer also pointed out that private fleets were not a focus at all.

Reviewer 2:

The reviewer noted that this project had a large number of partners. The project seemed focused on CNG and propane, which was understandable for the region. The reviewer noted that this project was geared towards workforce training to expand CNG and LPG use, and that the grant would pay for training. The project also assessed current and planned policies, addressed AFV road signs, and addressed issues with weights and measured folks.

Reviewer 3:

Originally, the reviewer was concerned about the emphasis on CNG/propane infrastructure as the expense of fleet coaching. However, in the Q&A period, it was revealed that the fleets had to travel considerable distances and that the infrastructure was a necessary first step. The reviewer also pointed out that because the fleets in the state seemed to be smaller than fleets based in the Midwest, a lot of funds could be consumed to coach these fleets with minimal real world results. As a result, the reviewer tended to agree with the program’s emphasis on the development of the CNG/propane infrastructure. The reviewer’s only real criticism was the lack of EV charging infrastructure and inclusion of NFPA research for first responders fighting Lithium-ion thermal events.

Reviewer 4:

The reviewer observed that given that New Mexico had no incentives for alternative fuels, this project would help encourage the use of alternative fuels and vehicles. The focus on the I-10 and I-40 corridors for the installation of refueling infrastructure is a good approach. However, the location/placement of infrastructure would be key to the success of this project, so careful examination should be given to where the optimal locations would be along the corridors, in order to maximize utilization.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer said that the project had a solid delivery of milestone tasks. There was an impressive amount of activity in New Mexico, including infrastructure development, for a state with no alternative fuel incentives and an overall lack of state wealth.

Reviewer 2:

The reviewer remarked that so far the project have been able to show tangible results in getting CNG and propane infrastructure designed and on track for completion by the end of the project period.

Reviewer 3:

The reviewer found that project accomplishments seemed to be good, especially in the training area. It appeared there was a lack of awareness of alternative fuel use in general in the state, so it seemed that a major focus area for further progress was in the outreach and education area.

Reviewer 4:

The reviewer found that overall this project was doing what was proposed, but was a little concerned that the project was not farther along with the funds that were expended. This reviewer suggested that this will need to be monitored by DOE. The reviewer then noted that this project held a large number of trainings, and did CNG Cummins training. The project did bi-fuel conversion tech classes and a Roush LPG overview and training. The principle investigator (PI) indicated that this was one of the successes of this project and that it was eliminating a barrier.

The reviewer observed that, to date, the project had resulted in 76 students being trained, with more planned, and that this was a good accomplishment. The reviewer noted that this project would identify legislation that taxes CNG and LNG on a gasoline gallon equivalent (GGE) and diesel gallon equivalent (DGE) basis, respectively, and educate decision-makers as to how it would work. This project helped with infrastructure planning, which was much needed. The project team helped partners meet each other (suppliers or technical assistance). The reviewer observed that in addition to tech training, the project also focused on first responder training and signage development.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer commented that the project had an exceedingly strong team of partners.

Reviewer 2:

The reviewer found that it appeared that the project was on track to get the work done. It seems the partners and collaborators are appropriate and not too many.

Reviewer 3:

The reviewer noted that the contractor/partner cost-share was an impressive $363,000. The reviewer believed that the partnerships seemed sufficient to achieve the increases in CNG and propane infrastructure emphasized in the program. The reviewer suggested that the project could use partners to bolster the development of EV charging infrastructure.

Reviewer 4:

The reviewer noted that there was good collaboration and coordination with both public and private stakeholders. The reviewer suggested making sure that the New Mexico State Department of Transportation is involved or stays involved in any signage issues.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer identified that the project is getting results in training (72+ students), and it has the potential to develop its CNG and propane markets. This project is likely to increase use of these fuels in the region. The reviewer remarked that the project identified many additional activities that the coalition will build on after the grant, including expanded CNG, establishing testing for weights and measures inspection, curricula development, etc. The project team is finding better and safer ways to do gaseous fuel inspections. The reviewer liked the fact that several stations were being designed or built because of the assistance of this project, and remarked nice.

Reviewer 2:

The reviewer remarked that the expansion of CNG and propane refueling infrastructure is a necessary first step. According to the reviewer, once adequate infrastructure is in place, fleet coaching could be fruitful. The reviewer thought that the next point of emphasis should be on the development of EV charging infrastructure. This would have benefits for both fleets (non-truck based) as well as general consumers who may be interested in the new EVs and HEVs coming onto the market.

Reviewer 3:

The reviewer remarked that there seemed to be a fairly good opportunity within the region and throughout the State of New Mexico for the expansion of the alternative fuels market. However, it is important that there are a sufficient number of vehicles in the fleets to utilize the refueling stations being constructed. As this reviewer mentioned above, outreach and education will be an important focus area for this project to succeed.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer found that given the objectives stated, it appeared that this project would support DOE's petroleum displacement goals.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer found that the main project objectives were directly relevant to both DOE and Clean Cities program petroleum displacement objectives. The project activities represented a good use of DOE funding. The reviewer commented that the strong project cost share from private stakeholders helped justify DOE's investment in the project.

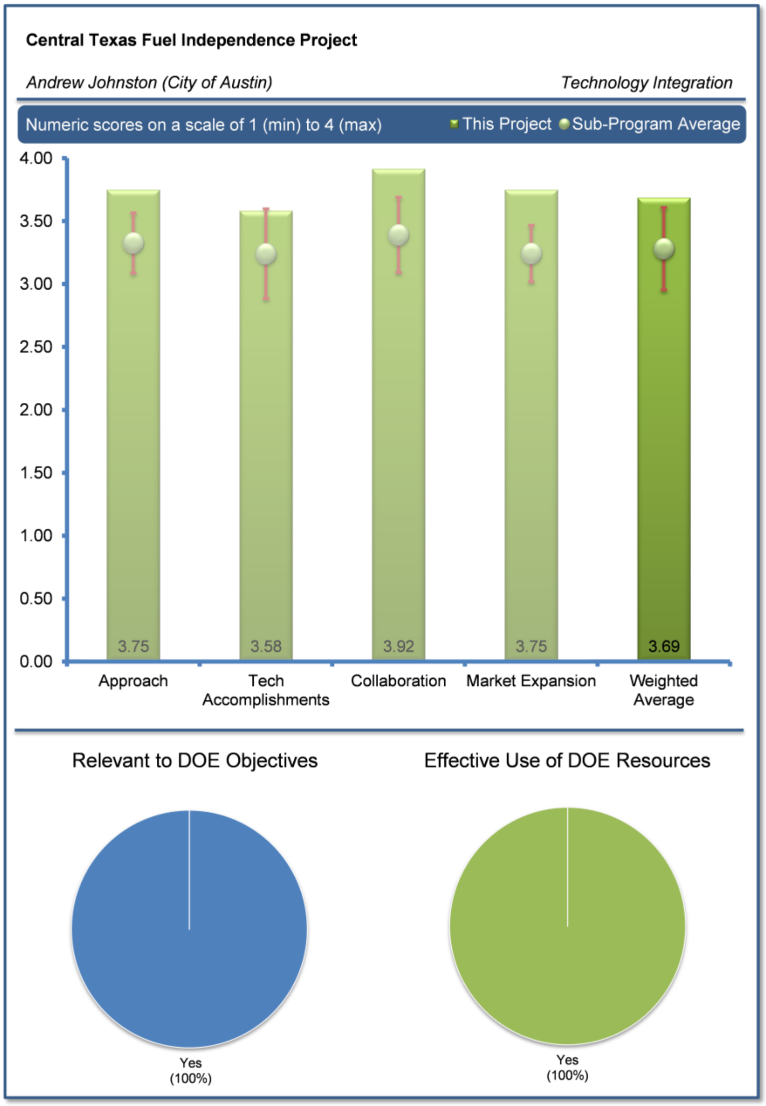
Reviewer 2:

The reviewer remarked that the $363,000 contractor/partners cost-share significantly leveraged the DOE project resources.

Reviewer 3:

The reviewer noted that this project was designed to promote CNG and LPG, and that the project appeared to be doing that.

Central Texas Fuel Independence Project: Andrew Johnston (City of Austin) - ti049



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that the Central Texas Fuel Independence Project (CTFIP) had developed innovative, performance-based initiatives and successfully engaged the participation of a diverse cross-section of stakeholders.

Reviewer 2:

The reviewer commented that the project is comprehensive and integrated with efforts initiated by partners.

Reviewer 3:

The reviewer commented that this project showed that the linkage of electric and CNG infrastructure was not exclusive. The project planners had also carefully linked today's expenditures to projects with the potential of succeeding in the future without this project's funds.

Reviewer 4:

The reviewer remarked that the project approach provided significant details, between the Approach slides and the individual Initiatives description pages, and included numerous specific numeric goals, such as the number of new electric vehicle supply equipment (EVSE) and CNG fueling sites developed, that could be easily tracked to measure progress and project success.

Reviewer 5:

The reviewer noted a rational and thorough approach, using working groups to first get stakeholders on the same page. The project focused on several key barriers to greater market penetration, particularly concerning infrastructure. The reviewer noted that the project included reliance upon a key organization (i.e., Austin Energy), to bring together the right parties as well as to help define the key issues, based upon its experience. At the same time, the reviewer observed that given the location in a state with significant alternative fuel activities, at least for NG, it was surprising that the scope of this project was somewhat limited geographically, at least compared to some of the other awarded projects, although that may have contributed to the collaboration’s success by providing a focused opportunity.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:
The reviewer concluded that the program appeared to have met or exceeded the overall project and DOE goals. The accomplishments and progress have been well documented.

Reviewer 2:
The reviewer found that significant progress had been made towards achieving project goals. All initiatives and activities appeared to be on track for completion by the project end date. The reviewer had identified no concerns.

Reviewer 3:
The reviewer noted that the project was halfway through the grant period. This person reported a training initiative, significant outreach that had already been conducted, materials that had been produced, and infrastructure that had been deployed. The reviewer concluded that the project was well positioned to complete actions by the end of the grant period.

Reviewer 4:
The reviewer found that the project appeared to definitely be succeeding in expanding refueling and recharging infrastructure. In particular, the project had involved local utilities, and gotten their support and commitment. The reviewer noted that the project had also gotten the necessary organizations on the same page concerning key implementation needs, such as rates, incentives, etc.

Reviewer 5:
The reviewer was impressed by the project's objectives of working on EV infrastructure in both existing multi-family housing and also in the plans for future developments. The reviewer will be interested to see if the project objective of placing EV infrastructure in rural locations is accomplished and how that infrastructure will be used.

Reviewer 6:
The reviewer commented that the project got off to a slow start but otherwise appears to be on track.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer remarked that the collaboration and coordination with project partners has been a complex undertaking, due to the large number of participants. Nonetheless, it appears that the project partners had been sufficiently engaged to produce excellent collaboration and to produce tangible results.

Reviewer 2:
The reviewer commented that the partners listed in the project were extensive.

Reviewer 3:
The reviewer commented that the project was coordinating with numerous organizations, including most of the regional implementation entities. Coordination includes governments, industry, and fleet users. The reviewer applauded that the project even included the local grid organization and the Electric Power Research Institute EPRI). The project seems to have gotten all organizations clearly committed and working together, even across fuel types. For this reviewer, it seemed like the central role of Austin Energy was the key element from which to start.

Reviewer 4:
The reviewer observed good coordination with university and public sector partners, and noted that coordination between NAFTC and a community college was apparent.

Reviewer 5:

The reviewer said that there was an extensive list of partners for this project, more than any other this reviewer had seen. This presented its own challenges because of the need to keep a large organization with many participants and many objectives going in the same direction.

Reviewer 6:

The reviewer commented that an excellent project team had been assembled to carry out this project, with numerous public and private entities involved. According to this reviewer, the only notable absence appeared to be the Austin-based Lone Star Clean Cities coalition, which was not identified as having any particular role.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer commented that the deployment of alternative fuel infrastructure and training programs would help to advance the market for alternative fuel vehicles.

Reviewer 2:

This reviewer was especially impressed with the work to provide web-based tools for fleets to evaluate vehicle performance and establish a business case for the expanded use of alternative fuels.

Reviewer 3:

The reviewer commented that 80 EV charging sites and the expansion of CNG infrastructure is, in planning, outstanding.

Reviewer 4:

The reviewer said that the project would clearly contribute to local/regional alternative fuel market expansion, with a predicted significant increase in EVSE installations, PEV sales, fleets converting to CNG, and CNG fueling sites development. The reviewer observed that numerous specific numeric goals could be easily tracked to measure progress and project success. Also noteworthy were the dedicated efforts of one individual working specifically on multi-unit and workplace EVSE development efforts.

Reviewer 5:

The reviewer expressed some small concerns that this project was not a bit broader in geographic scope or in taking on more than just two fuel types (electricity and NG). In general, the project's approach seemed to make sense to expand utilization of NG and electric technologies, and may include some approaches that could be replicated elsewhere. The reviewer noted that at the same time, some elements of the project were dependent upon a unique commitment of the partners in this geographic area.

Reviewer 6:

The reviewer observed excellent potential and noted that the project meets requirements under this funding opportunity. For this reviewer, one major barrier that still needs to be addressed is basic consumer education.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer found that this project strongly supported the DOE objectives of petroleum displacement by reducing barriers to facilitate the widespread adoption of electric and CNG vehicle technologies in the target areas of Texas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Reviewer 2:

The reviewer said that the tools and resources being developed would help fleets objectively weigh the benefits of alternative fuel use and accelerate their acceptance.

Reviewer 3:

The reviewer observed that the project was clearly focused on increasing market penetration of NG and PEVs, through expansion of infrastructure and training for maintenance and first responder personnel.

Reviewer 4:

The reviewer commented that the project expanded AFV infrastructure; obtained commitments and actions for partners to install AFV infrastructure; and provided back-end training to enable AFV use.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer found that many of the program elements are new, creative and capable of being replicated for use elsewhere.

Reviewer 2:

The reviewer remarked that in lieu of funding for hardware (i.e., vehicles and fueling sites), the use of DOE funding to lay the groundwork for such purchases is critically important. These projects that support implementation strategies and activities, such as barrier removal, should assist with market transformation in the local and regional target areas. The reviewer suggested that if a more significant level of funding were to become available in the future, these activities, combined with funding for hardware, would be the preferred strategy for targeted market expansion.

Reviewer 3:

The reviewer stated that, where possible, DOE funds should be deployed in ways that benefit regions across the country, so development of common training materials and information should be a priority. That being said, according to this reviewer, hands-on training at the local levels is still critical, as is working with local code officials to develop strategies for alternative fuel deployment, because different areas of the country follow different code requirements and different versions of the same code requirements.

Reviewer 4:

The reviewer observed that the funds have supported over 30 events and have utilities working together for development of infrastructure.

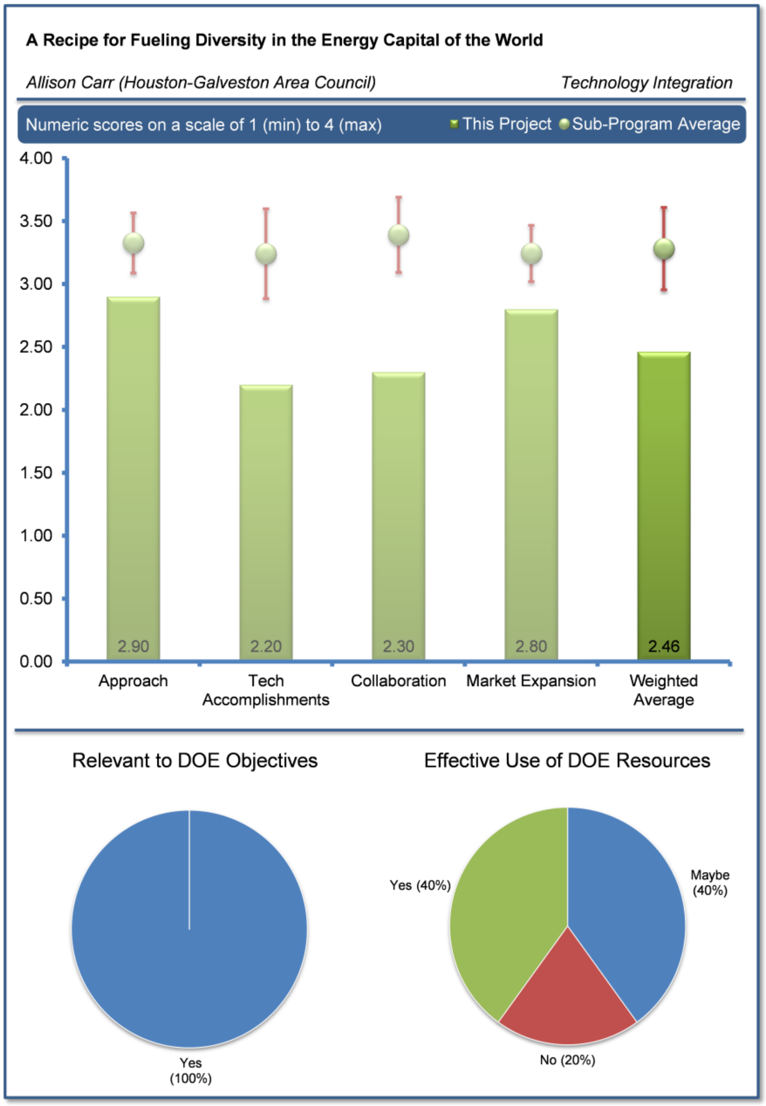
Reviewer 5:

The reviewer stated that the activities make sense for the desired outcomes. This type of project does make sense, but should be in addition to targeted efforts to assist in funding infrastructure, as was done in the past.

Reviewer 6:

The reviewer said yes, but would like to see more focus on consumer education.

A Recipe for Fueling Diversity in the Energy Capital of the World: Allison Carr (Houston-Galveston Area Council) - ti050



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer found that some elements, particularly the mapping tools, will be valuable in accelerating the deployment of alternative fuels to local fleets. Other program elements are less original and could have utilized existing programs and materials developed elsewhere and preserved resources for other tasks.

Reviewer 2:

The reviewer concluded that the major policy area seemed a little basic, and pointed out understanding the existing refueling infrastructure and communicating this to decision-makers. It seems as if that is something that would normally have already occurred, at least the understanding portion, if not the communication part. The reviewer thought that this was particularly surprising given that the project was in Texas, which largely has a relatively developed infrastructure, at least for gaseous fuels. This project is focused upon NG, and perhaps to some extent propane and electricity, the first two of which (NG and propane) would not appear to have great needs in Texas, though there was really not much mention by the PI concerning details beyond NG.

Reviewer 3:

The reviewer commented that the project approach and associated tasks/activities should contribute to the project objectives in the areas of policy, barrier reduction, safety and training and market development/outreach. The project appeared to only contain 1-2 activities associated with each barrier initiative, so it was unclear to this reviewer if the limited number of activities will have an effect on the overall goal of increased vehicle adoption.

Reviewer 4:

The reviewer remarked that the presenter did not have a convincing case that this program was contributing to the construction of CNG infrastructure that is experiencing “exponential growth” in the Houston-Galveston region. The reviewer observed that there was some anecdotal information that different jurisdictions in the region were using different interpretations of regulations and that the project team was addressing these differences. A better case could have been made by identifying the competing interpretations.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:
The reviewer observed that due to delays associated with community college partners and a revision in the scope of the geographic information system (GIS) mapping tool, the project's rate of progress is behind schedule with much of the activities being moved to the second year of the two year project.

Reviewer 2:
The reviewer noted that the project had a late start due to using community colleges, but that there has also been turnover that delayed the project.

Reviewer 3:
The reviewer noted that the PI indicated the level of spending was not indicative of status, but that the PI also stated that concerns with one key participant (a community college) had held back progress a bit. The project did not appear to have the training kickoff meeting with the community colleges until November. The reviewer commented that due to delays, it appeared that the appropriate curricula may be developed during this project, but much of the training would not appear to be done until after the project is completed. The reviewer detailed that to get done on time, the project needed to ensure that training gets underway shortly, and also that the mapping effort has to get focused (NG and electricity first) and get done, so it can be a key element of outreach. Given that the mapping tool is not scheduled for completion until November, it may not necessarily allow sufficient time for the appropriate outreach.

Reviewer 4:
The reviewer stated that the project is over a year behind on expenditures. This was because of the need to re-negotiate an agreement with a community college. The reviewer said that the project team did not present any evidence that the project team adjusted their project plans to bring some second year items into the first year. The reviewer had the feeling that the Clean Cities coordinator was not getting the necessary support of the Houston-Galveston Area Council or the project partners.

Reviewer 5:
The reviewer observed that progress descriptors included "back on board" and "will be developing", indicating late-developing progress. In fact, by the presenter's own admission, the project accomplishments and progress were significantly behind schedule, raising questions about the ability of the organization to meet its final deadlines.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The project has gotten off to a slow start, due to delays associated with community college partners. These issues appear to be resolved, but appeared to have negatively impacted the effectiveness of the collaboration as the project started. It was reported that these problems had been resolved. The reviewer observed that the remaining collaborations appeared to be generally effective.

Reviewer 2:
The reviewer summarized that the project was working with the local Area Council, NAFTC, the Gas Technologies Institute (GTI), and community colleges. The project had some issues with one of the key community colleges, which has delayed the overall project progress. The reviewer noted that NAFTC, GTI, and the community colleges will develop the curriculum. The reviewer said that it was unclear if the project had explicitly partnered with some of the organizations that would really be needed to ensure success – it sounded more like the project was planning to involve fleets, infrastructure providers, etc., but it has not appeared to have explicitly pulled them in yet.

Reviewer 3:

As stated above, the reviewer got the feeling that the Clean Cities coordinator was not getting the necessary support of the Houston-Galveston Area Council or the project partners.

Reviewer 4:

The reviewer was not left with the impression that collaboration and coordination have been progressing at the anticipated pace. The group is reliant on paid contractors to complete many of the work tasks.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer said that the project had the potential to contribute to a rapidly-expanding alternative fuel market in a major metropolitan area, where much of the progress appeared to be occurring external to the group's efforts. Whatever the group can do to contribute to the region's burgeoning interest in the alternative fuels market will undoubtedly be welcomed.

Reviewer 2:

The reviewer observed that indications are that the CNG market is expanding quickly. This seemed to be a process that pre-dates this effort because it takes a long period of time to develop CNG infrastructure from idea to funding, permitting, equipment purchase, installation, and commissioning.

Reviewer 3:

The reviewer commented that the project may help to expand opportunities for EVs, but it was unclear how much this project would increase utilization of NG and propane. The reviewer provided as an example how many incentives already existed in Texas, and that infrastructure in most areas had already been growing. This project seemed to be focused on ensuring that infrastructure was not stranded (underutilized). The reviewer noted that the project was also trying to assist in speeding permitting NG stations, which currently took approximately a year, so that could be a major benefit if successful.

Reviewer 4:

The reviewer agreed that the project may contribute to some market improvements, but the project's limited number of activities will in turn limit the overall market transformation potential of the project.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer found that this project supported the DOE objectives of petroleum displacement by reducing barriers associated with the adoption of alternative and advance vehicle technologies in the project target areas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Reviewer 2:

The reviewer remarked that the project was working to expand the utilization of alternative fuels through infrastructure, awareness, and tools.

Reviewer 3:

The reviewer commented that if the program goals and objectives could be met, it has the capability to accelerate petroleum displacement.

Reviewer 4:

The reviewer said that there was an ongoing effort that had the intent of moving the market forward.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer expressed concern that there seemed to be much duplication of efforts among similar organizations. Resources can be preserved by identifying elements that are common to many geographic areas, thereby conserving resources to develop program elements that are unique to the local jurisdiction.

Reviewer 2:

The reviewer remarked that some pieces of this project may develop useful products, such as the training and perhaps the mapping, if successful, but some parts of the project appeared pretty basic, as if they already should have been done. Plus, it seemed to this reviewer, that major efforts in Texas may not necessarily be needed to expand the use of NG and propane technologies.

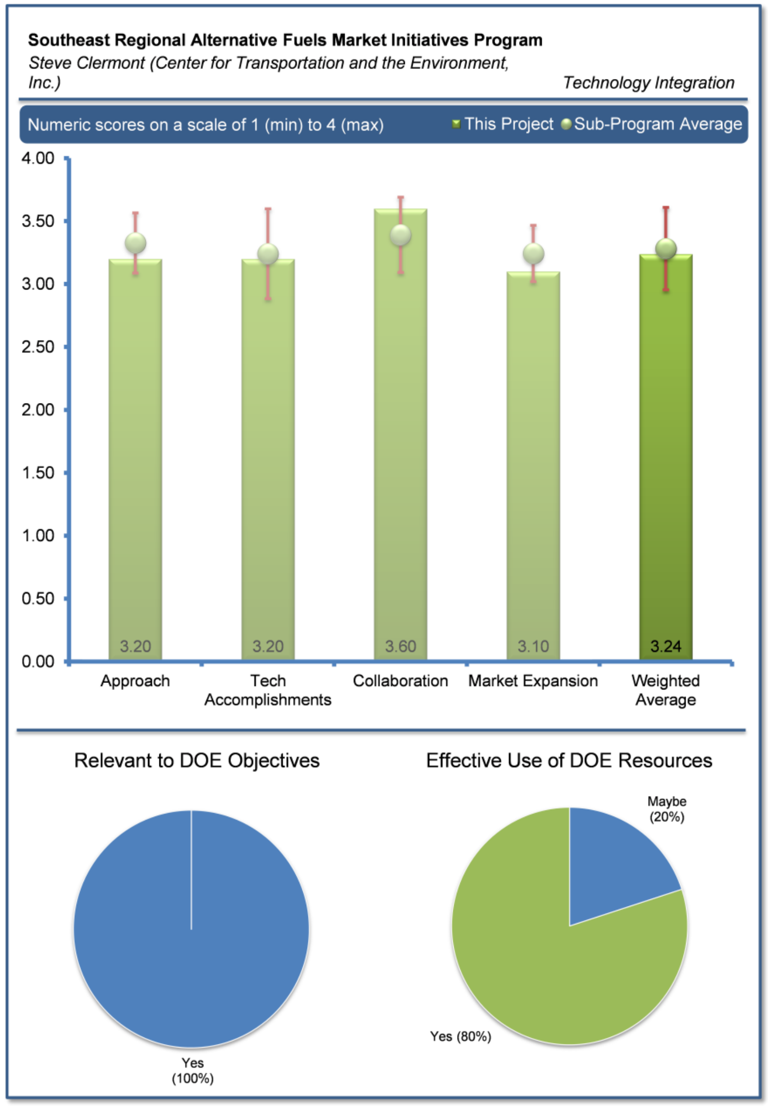
Reviewer 3:

In lieu of funding for hardware (i.e., vehicles and fueling sites), the use of DOE funding to lay the groundwork for such purchases is critically important. These projects that support implementation strategies and activities, such as barrier removal, should assist with market transformation in the local/regional target area. If a more significant level of funding were to become available in the future, these activities, combined with funding for hardware, would be the preferred strategy for targeted market expansion.

Reviewer 4:

The reviewer noted that this project was a year into a two-year program but had only expended about 1% of the available funds. This was reported as an issue because partners at one of the community colleges changed. The reviewer remarked that the team did not re-assess their program and accelerate second-year projects into the first year. As a result, the program now had eight months to complete a two-year project. The reviewer commented that it would be very challenging to meet the program objectives in the remaining time.

Southeast Regional Alternative Fuels Market Initiatives Program: Steve Clermont (Center for Transportation and the Environment, Inc.) - ti051



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the focus of seeking input initially and defining the problems and issues with market development earned this project high marks.

Reviewer 2:

The reviewer found that there seemed to be good coordination between organizations and stakeholders within its four-state focus.

Reviewer 3:

The reviewer said that this team was working hard on policy and regulatory issues that result in implementation barriers. Of particular interest was the barrier presented by fire marshals and their inconsistent interpretation of common language from jurisdiction to jurisdiction. The reviewer commented that a larger outreach to this group nationally should prove valuable in getting fire marshals to not treat CNG, propane, electricity or alternative fuels the same way as gasoline and diesel. In some respects these fuels are safer than petroleum-based fuels and yet have higher standards for permitting.

Reviewer 4:

The reviewer said that the project was focused on overcoming barriers through a four-state partnership. The project has a straightforward approach, focused on first identifying regional barriers/solutions, and then developing a regional outreach plan. The reviewer identified that the project also included a need for testimonials/success stories, and setting up opportunities for "Peer to Peer" discussions, such as fleet manager-to-fleet manager. The reviewer noted that the project was also offering "Train-the-Trainer" courses, which include materials for each student for 10 additional students. The project anticipated reaching as many as 2,000 technicians eventually. It is trying to also include a focus on developing return on investment for fleets, even without incentives. The reviewer noted that the development of a workbook is really aimed at putting all information in one place, which should be a highly useful product that can serve as a model.

Reviewer 5:

The reviewer observed a satisfactory approach to accomplishing the project objectives. Not much detail is actually provided on the two approach slides to describe all of the project activities (and the first slide could be a generic description of any of the 16 funded projects). The reviewer suggested that for a project spread across four states, more detail on activities and how these are spread across the project area would have been beneficial.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:
The reviewer commented that the project appeared to be on schedule. Several activities had been completed, including an assessment of regulations and policies, and barrier workshop identification/discussions.

Reviewer 2:
The reviewer thought that the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was valuable and jurisdiction specific. The reviewer found that the barriers analysis was comprehensive but quite generic—the barriers identified here were quite common to most of the country.

Reviewer 3:
The reviewer said that the project was making decent progress, but appeared a bit behind in some areas. It had completed analysis of regional, state and local policies, and identified areas of key barriers/areas for work. The reviewer noted that the project held eight workshops with government, fleet managers, infrastructure providers, and OEMs. In order to ensure forthcoming responses, the project also held interviews with key industry members who might not be as willing to provide input with competitors in the room. The reviewer noted that, overall, the project had reached 50 organizations, and had developed a detailed list of barriers requiring action, or to be addressed in workbooks.

Reviewer 4:
The reviewer remarked that this team expended a lot of effort identifying 30 barriers to deployment of AFVs and infrastructure. Many of these barriers existed across jurisdictions, and most were well understood on a national level. The reviewer recommended that the project should examine in detail those barriers that exist locally and develop plans to address those local issues.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:
The reviewer remarked on the excellent project team assembled to carry out this project, with numerous public and private entities involved. Communication among project partners appeared to be appropriate for the project of this scope.

Reviewer 2:
The reviewer found that there seemed to be good coordination and collaboration among project partners.

Reviewer 3:
The reviewer noted that six Clean Cities coalitions were involved. The project originally included Lawson State University to provide training, but it turned out that NAFTC would do the training themselves, so Lawson State was dropped. The project involved numerous local stakeholders, though not explicitly as partners on the project. The reviewer observed that the project included 50 organizations in efforts to identify barriers. The Approach was focused on utilizing the coordinators as the key bridge to stakeholders and ultimately outreach. The reviewer found that, overall, the list of organizations involved was impressive, and included many of the key organizations critical to implementation.

Reviewer 4:
The reviewer commented that the organizers of this project were to be congratulated for bringing together six Clean Cities coalitions. There is an extensive list of “stakeholders” that had participated. It was unclear to this reviewer the extent to which these stakeholders were contributing to the program objectives, beyond the fact that they were contacted and participated in the effort to identify barriers. The reviewer asked if any of them were planning to install infrastructure or procure vehicles.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer commented that what had been developed, especially in the barriers analysis, was a good template for nationwide use.

Reviewer 2:
The reviewer said that this was a good presentation. The project had the potential to bring more vehicles and infrastructure to the region.

Reviewer 3:
The reviewer noted that the project was looking to expand utilization of multiple alternative fuels across a four-state area by addressing key market/regulatory barriers.

Reviewer 4:
The reviewer found that the project should contribute to local/regional alternative fuel market expansion, through the completion of the remaining barrier reduction activities. However, according to this reviewer, the project appeared to be dependent on the use of the workbook for many of the barrier solutions and it was not clear how effective that strategy would be in achieving those results.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer agreed that this project supported the DOE objectives of petroleum displacement by reducing barriers associated with the adoption of alternative and advanced vehicle technologies in the project target areas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Reviewer 2:
The reviewer said that the project could have an impact on petroleum displacement and can provide stakeholders with useful information.

Reviewer 3:
The reviewer commented that the project is aimed at expanding utilization of multiple alternative fuels in a four-state area.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer commented that this is the kind of project a number of regions need. The key will be to take the results of this and similar projects to create a model approach for other regions to utilize. The reviewer noted that at the same time, this type of project will also likely identify a continuing need for funding for infrastructure, in particular, and possibly vehicles.

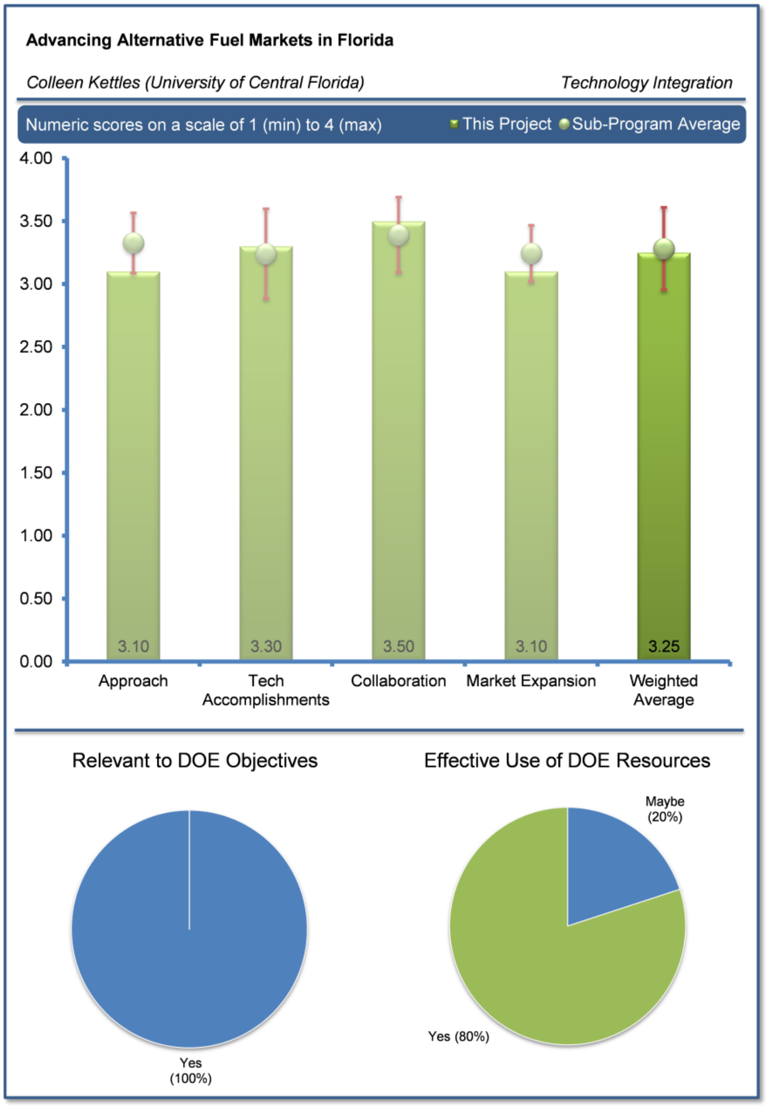
Reviewer 2:
The reviewer said that resources had been used wisely but much of what had been identified here, especially in the barriers analysis, was duplicative of similar efforts elsewhere. Nevertheless, this analysis may prove to be among the more comprehensive attempts to document this and should be made available to other regions.

Reviewer 3:
The reviewer commented that in lieu of funding for hardware (i.e., vehicles and fueling sites), the use of DOE funding to lay the groundwork for such purchases is critically important. These projects that support implementation strategies and activities, such as barrier removal, should assist with market transformation in the local/regional target area. The reviewer commented that if a more significant level of funding were to become available in the future, these activities, combined with funding for hardware, would be the preferred strategy for targeted market expansion.

Reviewer 4:

The reviewer remarked that the program was behind on expenditures and could have difficulty in bringing the project plans to completion by the end of the grant period.

Advancing Alternative Fuel Markets in Florida: Colleen Kettles (University of Central Florida) - ti052



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that it was advantageous to create stronger bonds with all of the Clean Cities coalitions and other collaborators throughout the state.

Reviewer 2:

The reviewer observed a generally effective approach to accomplishing the project objectives. Bringing various state stakeholders together under the Florida Clean Cities consortium should be an effective approach to accomplishing statewide activities. The reviewer found that Policy, Barrier Reduction, Safety/Training and Market Development/Outreach initiatives appeared to be appropriate for a statewide approach/focus.

Reviewer 3:

The reviewer commented that the project looked like it was timed to assist in re-invigorating the Central Florida coalition, and assisting several “fledgling” coalitions. The approach appeared relatively straightforward and thorough, and the reviewer highlighted the following activities: establish relationships; do the literature search; convene working groups; conduct surveys and outreach events; and hold training. The reviewer noted that the project also developed a fleet recognition program.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer said that the greatest accomplishment was to bring together all the collaborators. Many of the program objectives had already been accomplished.

Reviewer 2:

The reviewer found that the project appeared to have been making steady progress. It had conducted training sessions, finalized a best practices document, and conducted stakeholder focus groups. The project also obtained Department of Labor funding for first responder training, which may serve as a particularly useful model for other coalitions. The reviewer noted that the expos succeeded in bringing in new organizations, so outreach expanded significantly.

Reviewer 3:

The reviewer observed that the project was getting visibility in the general population through the statewide AFV Expositions. There was no information on how many sales were generated from these efforts or if the expositions would result in infrastructure development. The reviewer noted that all of these projects should be measured by deployed vehicles, and planned or installed infrastructure.

Reviewer 4:

The reviewer found that the project appeared to be on schedule. Several activities had been completed, including the development of statewide AFV assessment tools, literature reviews and a series of statewide AFV Expos and training sessions.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer noted that an excellent project team was assembled to carry out this project, with numerous public and private entities involved. The reviewer identified communication among project partners across the state as one of the major long-term benefits of this project (i.e., they should continue to work together after the completion of the project).

Reviewer 2:

The reviewer commented that collaboration and coordination among program participants appeared to be strong.

Reviewer 3:

The reviewer noted that while not listed as members of the project, the project had worked closely with local industry stakeholders, such as utilities, who ultimately provided in-kind contributions and additional funding. The project was working closely with the other designated coalitions in the state, and several organizations hoping to move toward coalition status. The reviewer remarked that through all of these, the project brought together a number of key state/local stakeholders, including local government/administrative organizations and organizations, such as the League of Cities, that were opening doors to important ultimate stakeholders. The reviewer observed how the project capitalized on an opportunity working with the local Work Force Board to use Department of Labor funds, available locally due to layoffs from the Space Shuttle Program, for first responders training. The reviewer pointed out that the PI suggested that similar Department of Labor funding may be available in other areas.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer pointed out that Florida seemed to be an area of the country primed for rapid expansion of the alternative fuels market. The reviewer noted that many external factors, including large amounts of state funding, had accelerated this process, but the involvement of the local collaborators was essential to its statewide success.

Reviewer 2:

The reviewer noted that the project was working to expand the market potential for multiple alternative fuels throughout the state of Florida, a state that perhaps has not had as much success to date as might have been anticipated. It is hoped that this project might really help Florida move forward, and the reviewer noted that this could be a sizeable contribution, if successful.

Reviewer 3:

The reviewer said that the project should contribute to local/regional alternative fuel market expansion, through the activities accomplished to date and the completion of the remaining project activities.

Reviewer 4:

The reviewer commented that there did not seem to be any information on how this project was going to expand ownership of AFVs or the development of infrastructure.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer stated that this project supported the DOE objectives of petroleum displacement by reducing barriers associated with the adoption of alternative and advance vehicle technologies in the project target areas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Reviewer 2:
The reviewer commented that the project was focused on expanding the use of multiple alternative fuels throughout the state.

Reviewer 3:
The reviewer said that the project supported the overall DOE objectives although many of the program elements, most notably the barriers analysis, and demonstrated that those barriers identified were not unique to Florida and could be just as well addressed on a broader regional basis.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

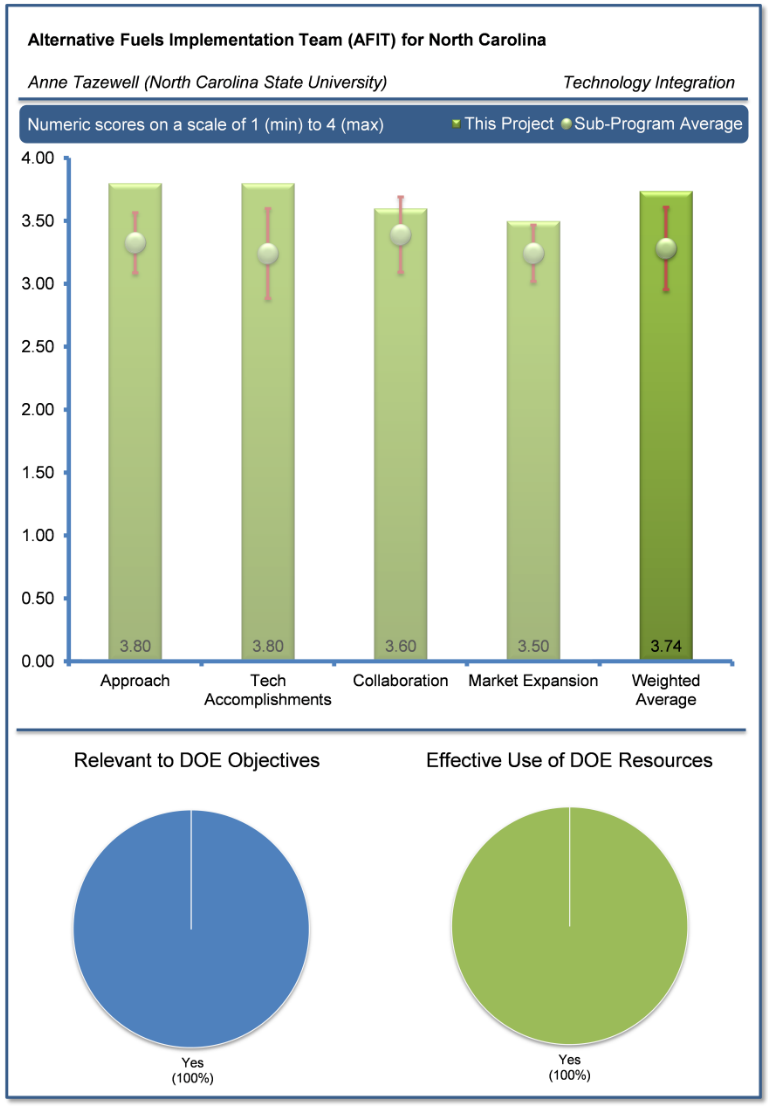
Reviewer 1:
The reviewer said that this was the type of project that many regions needed, and is best done on a regional basis. Results, however, would still likely point to a need for funding for infrastructure.

Reviewer 2:
The reviewer pointed out that many of the program elements were not unique to Florida and could effectively be developed for a broader region. However, according to the reviewer, it was critical that the local collaborators be actively involved in the program deployment to assure success.

Reviewer 3:
The reviewer stated that one area reviewers should have asked questions about was the fleet recognition program. This should be coordinated with DOE's fleet outreach program to ensure that the project is not duplicating efforts. The reviewer recommended that the recognition of fleets was something that all the Clean Cities should do under the same umbrella, with similar or the same criteria for evaluating success.

Reviewer 4:
The reviewer said that in lieu of funding for hardware (i.e., vehicles and fueling sites), the use of DOE funding to lay the groundwork for such purchases was critically important. The reviewer commented that these projects that supported implementation strategies and activities, such as barrier removal, should assist with market transformation in the local/regional target area. If a more significant level of funding were to become available in the future, these activities, combined with funding for hardware, would be the preferred strategy for targeted market expansion.

Alternative Fuels Implementation Team (AFIT) for North Carolina: Anne Tazewell (North Carolina State University) - ti053



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the project provided an effective approach to accomplishing the project objectives. Good detail is provided on the Approach and Milestone slides with regard to the planned tasks and activities. The reviewer found that the Policy, Barrier Reduction, Safety/Training and Market Development/Outreach initiatives appear to be appropriate for the project scope.

Reviewer 2:

The reviewer said that this was a comprehensive program with creative elements and customization not found in the program elements of the other projects.

Reviewer 3:

The reviewer said that the project had a straightforward and thorough approach, evaluated the existing landscape, worked with stakeholders to develop barrier reduction strategies, and conducted both broad and one-on-one outreach. To conduct training, the project consolidated the opportunity by holding a low-cost conference (Southeast Alternative Fuel Conference and Expo). The reviewer noted that the project includes an alternative fuels users database, and was also focused on getting AFVs on the state purchase schedule, a key step to greater utilization of alternative fuels in North Carolina, and an approach that needed to be replicated elsewhere.

Reviewer 4:

The reviewer noted that the examination of state signage policies undertaken by this team was a new initiative. The reviewer expressed disappointment that the focus was on North Carolina when the partners in the project included several other states. The project was able to demonstrate that the efforts of the partners had resulted in more AFVs being covered by state contracts and that sellers of vehicles had reported increased interest and sales as a result. The reviewer noted that the state contracts also included infrastructure. The reviewer said that this was a positive step forward.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer observed that significant progress had been made towards achieving project goals. All initiatives and activities appeared to be on track for completion by the project end date. The reviewer did not identify any concerns.

Reviewer 2:

The reviewer said that the signage program and petroleum displacement toolkits showed originality, creativity and impressive results in a broad geographic area. The reviewer remarked that the project provided a good template for others to follow and replicate.

Reviewer 3:

The reviewer noted that the project established quarterly meetings and monthly coordination calls, and published a relatively thorough survey of relevant state policies/incentives across six states. The reviewer noted that the project had already achieved expansion of state contracts both for AFVs and alternative fuels, and had worked on signage policies and worked with state organizations to change approaches. In North Carolina, through the efforts of the project, the state Department of Transportation established a "scarce fuel" policy to address alternative fuel signage, a potential model approach for application elsewhere. The reviewer noted that the project is also working with national fuel industry organizations to move things forward with the Federal Highway Administration concerning signage. The reviewer observed that a North Carolina alternative fuel user database had been developed, including 53 fleets. Overall, the reviewer found that the project had already developed many of the tools promised under the task.

Reviewer 4:

The reviewer said that the experiment with the purchase of mailing addresses for households with FFVs from the North Carolina Department of Motor Vehicles is a great initiative. The plan is to mail those households within a short driving distance of three E85 stations a postcard coupon to be used at the stations. The reviewer suggested that the project team needed to track the initial response and find a way to determine if the initial customers using the coupon returned for future purchases. The reviewer said that these metrics should determine the long-term value of the postcard campaign to retailers and – if successful in creating repeat business – should be exportable to other programs in the country.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer observed that an excellent project team was assembled to carry out this project, with numerous public and private entities involved. Communication among project partners appeared to be appropriate for a project of this scope.

Reviewer 2:

The reviewer said that the broad reach of this program was well organized and coordinated with collaborators in multiple states.

Reviewer 3:

The reviewer noted that this project brought together eight Clean Cities Coalitions, the largest utility in America, industry, and government agencies. The project had already hosted 116 representatives at planning charrettes. The reviewer noted that the project surveyed biofuel suppliers/distributors, and got responses from 55. The project was collaborating with retailers/distributors on biofuel promotion events. The reviewer found that the project appeared to be bringing together the key organizations needed to identify barriers/solutions and to implement suggestions.

Reviewer 4:

The reviewer pointed out that the development of a Southeast Regional Alternative Fuels Conference was a large endeavor. Fortunately, this conference appeared to have the support of the partners in the project and external sponsors. The reviewer suggested that this program team needed to find a clear way of documenting how this conference achieved more vehicle sales and more alternative fuel infrastructure.

Reviewer 5:

The reviewer was a little unclear about how the other coalitions were tied into the project or whether this was mostly a North Carolina project.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:
The reviewer remarked that the project should contribute to local/regional alternative fuel market expansion, through the activities accomplished to date and the completion of the remaining project activities. The reviewer said that noteworthy activities that should continue are the continued work with the North Carolina Department of Transportation on signage and CMAQ funded initiatives, as well as the work on the state bid process to include alternative fuel offerings.

Reviewer 2:
The reviewer said that getting vehicles and fueling infrastructure on the state services bid was an important step, and sharing lessons learned with other areas will help advance the use of alternative fuels.

Reviewer 3:
The reviewer found that the programs developed, toolkits developed and events planned will provide the region with invaluable assets for growing its alternative fuels market.

Reviewer 4:
The reviewer said that some of the project was regional, and some was North Carolina-specific. Overall, according to this reviewer, the project should help to expand the use of alternative fuels regionally through specific focus on overcoming key barriers, though levels of effort for surrounding states are clearly less and, thus, direct results outside of North Carolina would not be as high. The project would create models for use elsewhere, however, and the policies/incentives and outreach (conference) were regional in nature.

Reviewer 5:
The reviewer said that it was too early to tell how this project would support new infrastructure, but, according to the reviewer, the team was laying a good foundation for expansion.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer concluded that every program element had the potential to positively impact DOE's objectives.

Reviewer 2:
The reviewer noted that the project was focused on increasing the use of multiple alternative fuels, both within North Carolina, and ultimately, the region.

Reviewer 3:
The reviewer noted that this project supported the DOE objectives of petroleum displacement by reducing the barriers associated with the adoption of alternative and advanced vehicle technologies in the project target areas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:
The reviewer remarked that it was an excellent utilization of resources and worthy of future support.

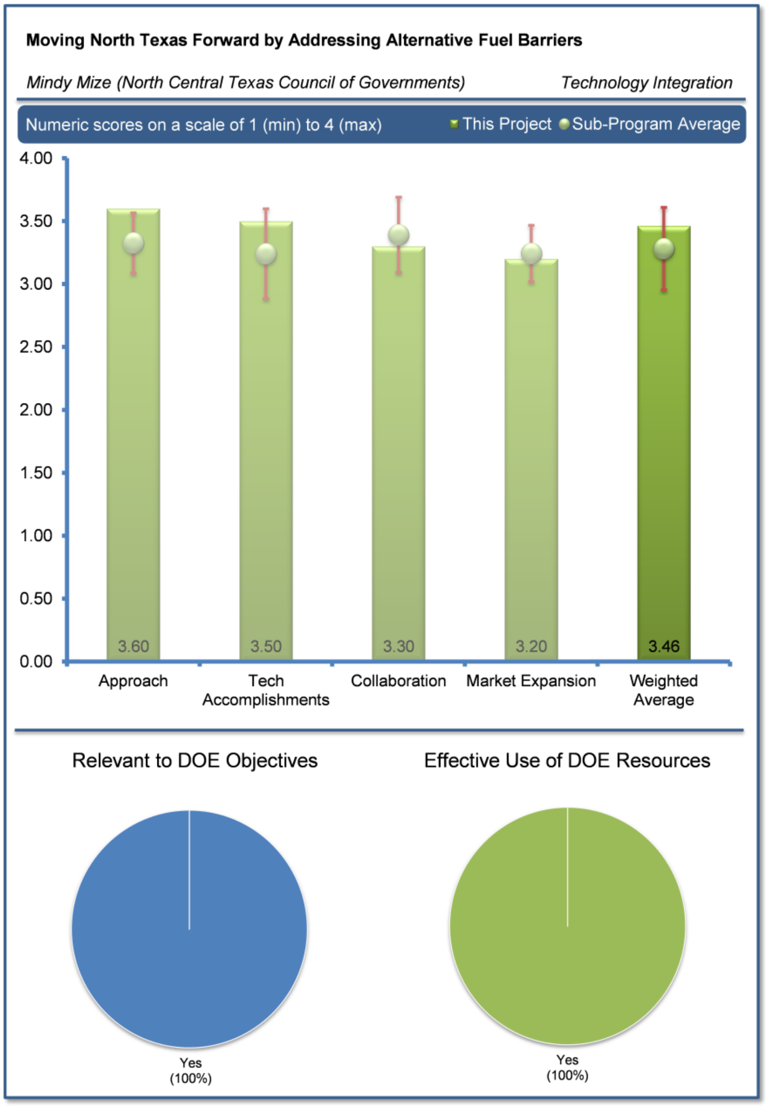
Reviewer 2:
The reviewer said that this appeared to be a relatively well-run example of this type of project, largely due to the expertise and dedication of the PI, but the project should provide particularly useful examples of what many regions need to do, and the cooperation among the

states/coalitions seemed to be a model of how to do it. The reviewer remarked that clear, targeted tasking appeared to be the key in getting coordinators, including those working on other similar projects, working together appropriately.

Reviewer 3:

The reviewer commented that in lieu of funding for hardware (i.e., vehicles and fueling sites), the use of DOE funding to lay the groundwork for such purchases is critically important. These projects that support implementation strategies and activities, such as barrier removal, should assist with market transformation in the local/regional target area. The reviewer remarked that if a more significant level of funding were to become available in the future, these activities combined with funding for hardware would be the preferred strategy for targeted market expansion.

Moving North Texas Forward by Addressing Alternative Fuel Barriers: Mindy Mize (North Central Texas Council of Governments) - ti054



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Project approach to deployment of alternative fuel vehicles, infrastructure, and related efforts - the degree to which the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said that the use of CMAQ funding and the inclusion of the programs in the State Implementation Plan (SIP) are excellent ideas. Providing more information to other areas on how to take advantage of alternative fuel programs in SIPs will help advance alternative fuel deployment.

Reviewer 2:

The reviewer said that the project provides an effective approach to accomplishing the project objectives. Excellent detail is provided on the Approach and Milestone slides with regards to the planned tasks and activities. Policy, Barrier Reduction, Safety/Training and Market Development/Outreach initiatives appeared to be appropriate for the project scope.

Reviewer 3:

The reviewer said that this team was looking at the inclusion of AFVs and infrastructure within the SIP, under the Clean Air Act, as a potential reason for greater deployment of AFVs. The reviewer acknowledged that this was a new approach and it would be interesting to see how this initiative will play out over the next few years.

Reviewer 4:

The reviewer concluded that this seemed to be a well-organized effort to address alternative fuel vehicle deployment issues within the framework of the local jurisdictions, state regulators, collaborators, educators and fleets.

Reviewer 5:

The reviewer noted that the project included a thorough and straightforward approach, with a key emphasis on training, to address the needs of a large number of local jurisdictions (234 in total). Unlike some of the other similar projects, this one had a relatively broad scope of alternative fuels, including emphasis on propane and biodiesel, in addition to NG and electricity.

Question 2: Project accomplishments and progress toward overall project and DOE goals - the degree to which progress has been made, measured against performance indicators and demonstrated toward project and DOE goals.

Reviewer 1:

The reviewer said that significant progress had been made towards achieving project goals. All initiatives and activities appeared to be on track for completion by the project end date. The reviewer identified no concerns.

Reviewer 2:

The reviewer found that the project had made a great deal of progress. The project had completed evaluations of policies, etc., and drafted policies/strategies. The reviewer noted that the project was in the process of gathering public input on strategies. The project ran into a few snags along the way in the SIP area, though that seems to be back on track, if somewhat delayed. The reviewer observed that the project had completed a Propane Engine Summit, with (80 attendees on-site and 750 on-line, as well as most of the promised training. The project saw some surprises on training in that CNG was lightly attended, while biodiesel was heavily attended. The project developed an AFV parking program, including policies, signs, and a phone application contest.

Reviewer 3:

The reviewer commented that tangible results had been accomplished in policy initiatives, barrier reduction, safety/training and market development. Especially appealing was the customization of materials to address local needs.

Reviewer 4:

The reviewer found that the project team was hitting its milestones effectively.

Question 3: Collaboration and coordination with Project Partners - the degree to which the appropriate partners are involved in the project work and the effectiveness of collaboration between and among partners.

Reviewer 1:

The reviewer commented that success in collaboration and coordination with broad coalitions seems to have been achieved.

Reviewer 2:

The reviewer observed that there were 234 governments within the region covered by this grant. Just getting a few to agree on the same fire marshal standards to installation of infrastructure would be a major accomplishment. The reviewer acknowledged that some of this had actually occurred.

Reviewer 3:

The reviewer noted that in addition to sub-recipient partners, the project was teaming with a number of the necessary implementers, including vehicle providers, local governments, and technical colleges. Those identified in the presentation formed a possibly shorter list than anticipated, especially with regard to vehicle providers, particularly given the progress the project has made. At the same time, a particular beneficial approach was relying upon fleet champions to explain successes and needs to other fleets. The reviewer said that this was seen as critical with so many different governmental jurisdictions with widely varying levels of understanding and policies.

Reviewer 4:

The reviewer observed that an effective project team was assembled to carry out this project, with numerous public and private entities involved. Communication among project partners appeared to be appropriate for a project of this scope.

Question 4: Alternative fuel market expansion potential - the degree to which the project has the potential to contribute to a sustainable alternative fuel vehicle market, including the potential to reduce barriers to large scale alternative fuel vehicle market penetration and the potential to be successfully replicated in other geographic areas.

Reviewer 1:

The reviewer said that there seemed to be strong possibilities with a host of alternative fuels in this market.

Reviewer 2:

The reviewer commented that the project was working to expand the use of multiple alternative fuels, including several fuels not as widely used in Texas (electric and biodiesel). The reviewer suggested that several of the products developed should serve as models for other regions.

Reviewer 3:

The reviewer said that the project should contribute to local/regional alternative fuel market expansion, through the activities accomplished to date and the completion of the remaining project activities. The reviewer remarked that noteworthy activities that should contribute are the work related to incorporating alternative fuel measures into the SIP, as well as the work on EV regulatory barriers.

Reviewer 4:

The reviewer remarked that the project team had put forth the effort necessary to educate more policy and regulatory developers and fuel users about alternative fuels. The reviewer commented that it was not clear that this effort had paid off in new infrastructure or vehicle purchases.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said that program elements in electric, propane and NG had broad appeal among stakeholders; the program elements were indicative of a rapid expansion of the infrastructure necessary to support greater fleet utilization.

Reviewer 2:

The reviewer said that the project was expanding the use of multiple alternative fuels to reduce petroleum use.

Reviewer 3:

The reviewer found that this project supported the DOE objectives of petroleum displacement by reducing barriers associated with the adoption of alternative and advanced vehicle technologies in the project target areas, as well as providing for adequate supporting fueling infrastructure for these vehicles.

Question 6: Use of Resources - are DOE funds being used wisely? Should DOE fund similar efforts in the future? If not, what would be a better use of DOE resources to achieve alternative fuel vehicle and infrastructure expansion?

Reviewer 1:

The reviewer concluded that this seemed to be a successful program worthy of continued support.

Reviewer 2:

The reviewer commented that many of the steps in this project were what regions/coalitions needed to do. The next need was for DOE to take the results of this and similar projects and provide the best examples for use by other coalitions. According to the reviewer, infrastructure would also likely still need funding in many areas of the country, in addition to funding projects focused on training, outreach, planning, etc., like the subject project.

Reviewer 3:

The reviewer commented that in lieu of funding for hardware, i.e., vehicles and fueling sites, the use of DOE funding to lay the groundwork for such purchases was critically important. These projects that support implementation strategies and activities, such as barrier removal, should assist with market transformation in the local/regional target area. The reviewer remarked that if a more significant level of funding were to become available in the future, these activities, combined with funding for hardware, would be the preferred strategy for targeted market expansion.

Acronyms and Abbreviations

Acronym	Definition
AFDC	Alternative Fuels Data Center
AFV	Alternative Fuel Vehicle
AMPO	Association of Metropolitan Planning Organizations
AMR	Annual Merit Review
B20	Biodiesel blend of 20% neat biodiesel
CALSTART	
CARB	California Air Resources Board
CEC	California Energy Commission
CEO	Chief executive officer
CMAQ	Congestion Mitigation and Air Quality Program
CNG	Compressed natural gas
CTFIP	Central Texas Fuel Independence Project
DEER	Directions in Engine-Efficiency and Emissions Research Conference
DGE	Diesel gallon equivalent
DOE	Department of Energy
EPRI	Electric Power Research Institute
EV	Electric Vehicle
FFV	Flex-fuel vehicles
GATE	Graduate Automotive Technology Education
GHG	Greenhouse Gases
GGE	Gasoline gallon equivalent
GIS	Geographic Information Systems
GTI	Gas Technologies Institute
H_2	Hydrogen
HEV	Hybrid Electric Vehicle
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MPO	Metropolitan Planning Organization
NAFTC	National Alternative Fuels Training Consortium
NASEO	National Association of State Energy Officials
NFPA	National Fire Protection Association
NG	Natural gas
NGV	Natural gas vehicles
NYSERDA	New York State Energy Research and Development Authority
OEM	Original Equipment Manufacturer
P3NGV	Pennsylvania Partnership to Promote Natural Gas Vehicles
PERC	Propane Education and Research Council
PEV	Plug-in electric vehicle
PI	Principal Investigator
R&D	Research and development
SCAQMD	South Coast Air Quality Management District

SEO	State Energy Office
SIP	State Implementation Plan
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TIGER	
VTO	Vehicle Technologies Office

9. Vehicle Analysis

The Vehicle Analysis (VAN) subprogram provides testing and analysis relevant to the Vehicle Technologies Office (VTO). The subprogram mission is to plan, execute, and communicate technology, societal, economic, and interdisciplinary analyses for the U.S. Department of Energy (DOE), the Office of Energy Efficiency and Renewable Energy (EERE), VTO, and external stakeholders. Overarching activities within this subprogram serve to develop and deploy vehicle technologies that reduce the use of petroleum while maintaining performance, power, and comfort, and help people access and use efficient, clean vehicles that meet their transportation needs.

Along with work in individual technologies such as combustion engines, batteries, electric drive systems, and fuels, VTO funds research that explores how to connect these components and systems together in the most effective, efficient way possible. Much of this work uses specialized equipment and software that VTO developed in partnership with the national laboratories, including the industry-leading modeling software Autonomie. To inform its activities, VTO also collects and reports its research results, data on individual advanced vehicles, and information on the transportation industry.

Researchers use these approaches to combine multiple technologies within an overarching “vehicle systems perspective”:

- Benchmarking is the process of collecting a standard set of baseline data for a component or entire vehicle. Researchers can use this data to validate models that simulate vehicles or compare it to data from new technologies to see how much they improve on existing ones.
- Vehicle modeling and simulation tools allow researchers to save time and money by building “virtual vehicles” where they can simulate the use of different technologies before building actual components.
- Integration, validation, and testing tools and procedures help researchers combine and test multiple physical components as well as entire vehicles in consistent, cost-effective ways.

Along with improving vehicle technologies, other software packages developed by the national laboratories help researchers better understand consumer behavior, vehicles’ environmental effects, the societal benefits of different technologies, and trends in the transportation system.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram’s activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Jacob Ward (U.S. Department of Energy) – van000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer said that the overall strategy was covered very well, particularly with the inclusion of the pyramid to show how everything builds on top of a foundation.

Reviewer 2:
The reviewer said yes, and explained that the program area plans, executes and communicates analysis for the VTO.

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Reviewer 1:
The reviewer pointed out a $3 million budget per year for 5 years to support data, modelling, and analysis with most of the activity being conducted at Argonne National Laboratory (ANL) and Oak Ridge National Laboratory (ORNL). The reviewer observed that this seems to have a good balance between mid- and long-range analysis support.

Reviewer 2:
The reviewer noted that there was some more emphasis on near-term research and development (R&D), for example, annual updates to models, etc. This reviewer did not mean to imply the models themselves, only research near-term timelines. Rather, according to the reviewer, the projects themselves seemed to be somewhat conservative and short-term in scope. This reviewer did not see anything in the way of a long-term vision such as combining all the models into one, or creating a common user interface for all models/analyses, or a grand plan to validate all models using a new robust validation process (all examples).

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer commented that an important issue is predicting the cost of transportation in 2035 and beyond. The reviewer noted that issues around fuel uncertainty, and the status of electrification technology, were identified as uncertainties that represent challenges to accurately predict trends and impact.

Reviewer 2:
The reviewer noted that important issues and challenges were identified somewhat, but this reviewer would have appreciated a summary slide on this.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer said yes, provides a robust transportation analysis that speaks for itself. The reviewer also observed a strong foundation of data, relevant models and insightful analysis.

Reviewer 2:
The reviewer commented that plans were identified somewhat in the future work sections, but not in great detail at least within the presentation.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer remarked that yes, all progress was compared with 2013 explicitly.

Reviewer 2:

According to the reviewer, the presentation described annual reports that discuss progress on an annual basis. Data books, market reports, and U.S. DOE levelized cost of driving (LCD) were examples of continuing work benchmarked against previous years.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:

The reviewer said yes, and elaborated that every project seemed to address some aspect of the broad problems and barriers of VTO.

Reviewer 2:

The reviewer said yes, and observed the projects in this technology area to be increasing public domain information and publications. The reviewer stated that the program appeared to be measuring and modelling the correct issues.

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:

The reviewer said yes, and suggested reading this reviewer's previous comments about bolder, longer term vision for analyses.

Reviewer 2:

The reviewer said yes. The reviewer commented that the analysis portfolio included data acquisition and analysis, modelling and simulation, emissions and environment modelling, market penetration, macro-economic accounting and integrated analysis. The reviewer perceived the program had a comprehensive action plan.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:

The reviewer noted good progress in the efforts to update the Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation (GREET) model to provide a user-friendly graphical user interface (GUI). The reviewer remarked that the program was working to fill in the gaps with great tools.

Reviewer 2:

This reviewer suggested deferring to individual comments on each project. For this reviewer, nothing stood out during the overview presentation.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:

The reviewer responded yes, and commented that the operative words here were "as appropriate". The reviewer stated that the projects are not all novel or innovative as they are models that have been honed over many years. However, as far as this reviewer could tell, the models were novel and innovative when needed (e.g., positive feedback model for projecting different policy scenarios).

Reviewer 2:

The reviewer said yes, and provided cradle-to grave analysis with ANL and the fuel cell team as an example.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:

The reviewer said yes, and commented that ORNL, ANL, Sandia National Laboratories (SNL), the National Renewable Energy Laboratory (NREL), and other industry partners were involved.

Reviewer 2:

The reviewer said for the most part, although much of the work is concentrated within DOE. Speaking from experience, this reviewer remarked that there are many other agencies that could contribute/support a lot of this work, and the reviewer believed this broader collaboration would benefit all parties involved.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:

The reviewer said yes.

Reviewer 2:

The reviewer indicated that with existing partners, the collaboration does appear effective.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:

The reviewer was satisfied with existing tools. The reviewer noted a good portfolio, and no gaps were presented or discussed.

Reviewer 2:

The reviewer did not see any major gaps, although this reviewer would defer to individual project comments for more detail here.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:

The reviewer would like to know if sufficient and robust cost models are available. The reviewer noted that there was not sufficient detail presented to identify any gaps in this area, but the reviewer questioned if further development in this regard might be helpful.

Reviewer 2:

The reviewer did not pick up on this in a general sense.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:

The reviewer said probably, but the reviewer would again refer to individual feedback for each project for specifics.

Reviewer 2:

The reviewer suggested that the presentation should better articulate barriers and areas needing outside support.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:

The reviewer said no.

Reviewer 2:

The reviewer remarked nothing that has not already been discussed somewhere in comments.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:

The reviewer said no.

Reviewer 2:

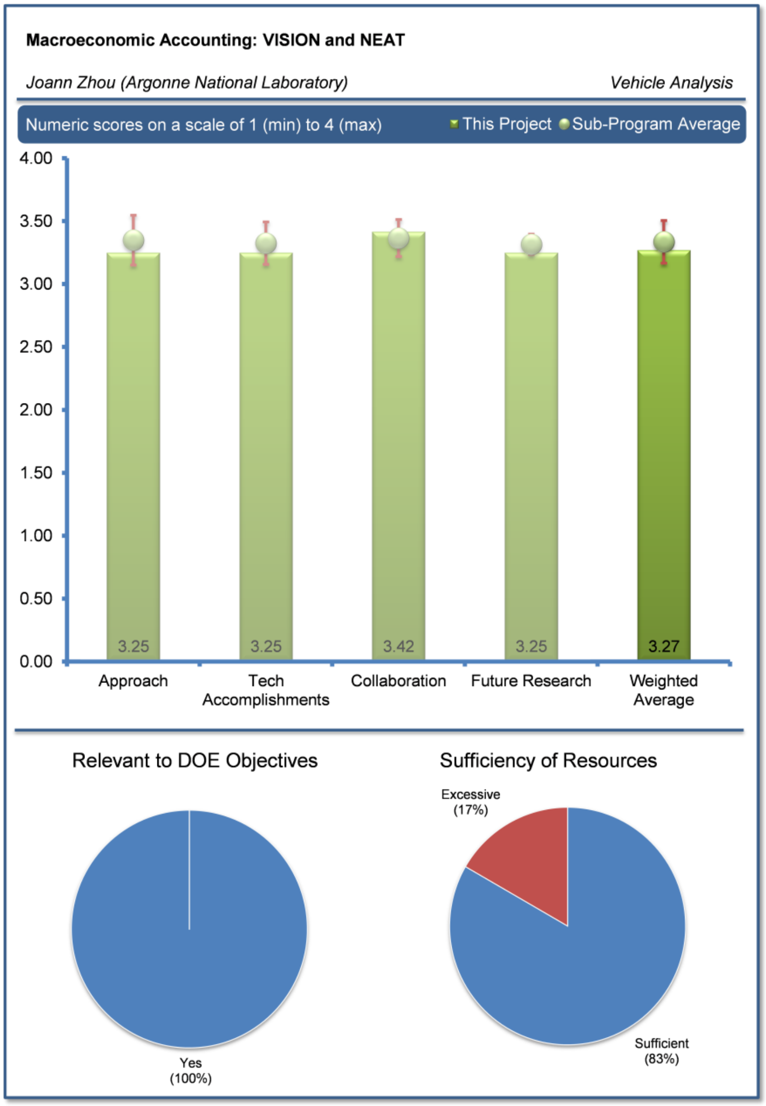
The reviewer intimated that much of the analyses are forward looking extrapolations based on many assumptions. According to this reviewer, like the weather forecasts, all future analyses will be wrong but some will be less wrong than others. It is this reviewer's belief that the accuracy of these predictive models can be improved through a very robust model validation program. Validation does not mean one predictive model output equals another, or one model is calibrated to equal another model through tuning parameters. For this reviewer, this is a house of cards. Rather, a robust validation program would involve, for example, using what you think is a well-tuned predictive model and feeding the inputs with old data that was known at a certain point in time while seeing if the output matches what actually happened afterward. As an example, this reviewer conceived of a model that predicts vehicle miles traveled (VMT) based on a set of inputs that would then be fed all the data that was known on January 1, 2006, and then evaluated to see how well it predicts VMT through 2014. How well these predictions are made flows into a validation maturity rating for the model. The reviewer concluded that if a model gets a low rating, then it is probably valuable to understand why and to refine it.

Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Macroeconomic Accounting: VISION and NEAT	Joann Zhou (Argonne National Laboratory)	9-8	3.25	3.25	3.42	3.25	3.27
Applied Modeling and Simulation: Autonomie	Aymeric Rousseau (Argonne National Laboratory)	9-12	3.50	3.33	3.50	3.33	3.40
Transportation Energy Data Book, Market Report, and Fact of the Week	Stacy Davis (Oak Ridge National Laboratory)	9-16	3.58	3.67	3.33	3.25	3.55
Oil Security Metrics Model: OSMM	Changzheng Liu (Oak Ridge National Laboratory)	9-20	3.08	3.25	3.08	3.33	3.20
EV Sales Updates	Joann Zhou (Argonne National Laboratory)	9-24	3.25	3.17	3.50	3.33	3.25
Market Penetration Modeling: HTEB, LV Choice, and StoCo	Alicia Birky (TA Engineering, Inc.)	9-28	3.20	3.20	3.40	3.30	3.24
LAVE-Trans Model	Changzheng Liu (Oak Ridge National Laboratory)	9-32	3.58	3.42	3.33	3.42	3.45
Overall Average			**3.35**	**3.33**	**3.37**	**3.32**	**3.34**

Macroeconomic Accounting: VISION and NEAT: Joann Zhou (Argonne National Laboratory) - van006



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

NEAT and VISION are key models for the industry, this reviewer stated. The reviewer added that long-term views are necessary, albeit usually ignored by the private sector.

Reviewer 2:

The reviewer said the approach appeared to be sound, but had questions concerning how the model was validated and hence its accuracy.

Reviewer 3:

The reviewer indicated that the approach to modeling energy and greenhouse gases (GHG) made sense, but that there was little explanation of how the underlying assumptions were developed. The reviewer regarded assumptions concerning next-generation biofuels as particularly optimistic, and saw little evidence to support this view in light of the struggling industry's current status. This reviewer also questioned the usefulness of projections out as far as 2100, noting the difficulty of projecting even as far as 2050. Suggesting that data collection also be reviewed, the reviewer noted the acknowledgement that pipeline data was old and that much of the input data and assumptions come from research groups rather than from real case studies. It is important, the reviewer added, that data be obtained from industry sources on, for example, the performance of powertrains and the variation of VMT among different vehicles and technologies.

Reviewer 4:

The reviewer perceived that the pipeline gas model could be upgraded to account for the effects of gas flaring. Likewise, the model could be expanded to include off-highway, non-freight modes such as commercial rail, marine and air. Battery electric vehicle (BEV) growth in the Class 5 truck segment is also an area that could be included in the medium-duty commercial vehicle sector, the reviewer commented.

Reviewer 5:

The reviewer found the approach, including the data inputs and methods, to be sound and appropriate. The models, their general purpose, and the issues they address were clearly articulated, the reviewer said. However, the precise technical barriers that these models' findings and results help overcome could be defined in finer detail.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The reviewer considered that this project could be the most important presented at this year's Annual Merit Review (AMR).

Reviewer 2:
In the view of this reviewer, the project's accomplishments indicate clear progress toward its goals and those of DOE. The reviewer was also impressed by the long-term modeling results, and by the broad use of the model within DOE offices and in other major government estimates and analyses of energy use. The reviewer deemed the achievement of similar outcomes for the NEAT model to be a clear goal going forward.

Reviewer 3:
The reviewer said that accomplishments are solid. However, it is unclear how well the model had been validated. The reviewer was not convinced that all factors are considered in the model such as rebound effect (VMT up when fuel cost down due to lower demand). Noting that the model is essentially one of the transportation systems, the reviewer found it unclear how well actual, known transportation networks have been integrated into the model and suspected this factor may have been overly generalized.

Reviewer 4:
The VISION model has been used by national and state policy makers, the reviewer noted, and is definitely helping those groups to advance DOE goals. This reviewer found the NEAT model output interesting and welcomed its inclusion of upstream energy use. The reviewer asked if this model has been compared to others that attempt to predict future transportation splits.

Reviewer 5:
Technical progress appears to be on schedule, in the opinion of this reviewer.

Reviewer 6:
The reviewer urged that the model's performance relative to Annual Energy Outlook (AEO) projections and calibrations be examined to ensure that calibration methods are not distorting model projections beyond the last AEO projection year. The reviewer advised that the method used for extended projections (beyond 2040) should be evaluated against other long-term models to ensure consistency.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted the identification of considerable, strong coordination that ensured strong input from diverse, expert sources, validation of the modeling assumptions, and its use by other leading research groups and government agencies.

Reviewer 2:
The reviewer deemed the project accomplishments excellent, noting the over 400 users who comprise a diverse user base representing DOE, the U.S. Department of Transportation (DOT) and other agencies.

Reviewer 3:
The reviewer termed the project collaborators appropriate, citing the Energy Information Administration (EIA), ORNL, TA Engineering, and NREL, specifically.

Reviewer 4:
This reviewer also noted the VISION model's use by other DOE groups but noted that no mention had been made of its verification by private industry or transport sector groups.

Reviewer 5:

The magnitude of the project, in the opinion of this reviewer, makes collaboration absolutely necessary. The reviewer would welcome greater collaboration with the private sector to ensure the effort was not wholly an academic exercise, but was unsure such collaboration was happening.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

Making the tools widely available on their separate website was an idea the reviewer strongly approved. The reviewer also suggested employing more resources for data collection.

Reviewer 2:

Proposed future work seemed logical to this reviewer, if modest. In view of the project's scope and funding level, however, the reviewer deemed this appropriate. The reviewer suggested the addition of a feedback loop to account for the rebound effect.

Reviewer 3:

The reviewer reported that proposed future research would include commercial marine and other passenger modes in marine and rail. The reviewer suggested that impacts on the defense sector (e.g., tactical and combat vehicles) be considered for inclusion in future work.

Reviewer 4:

Noting that proposed future work includes annual updates of current data, as well as new and enhanced features and website development, the reviewer expressed the view that the critically important need identified by the presenter (and other session attendees) is for research concerning medium- and heavy-duty (HD) vehicle characteristics, uses, activities and survival. Further, the reviewer stated that while the project team appears to be proposing further tweaking of the model, there seems to be broad agreement that a serious impediment to rigorous, reliable modeling of medium- and heavy-duty trucks is a deficiency of real, current data, especially since the discontinuation of the Vehicle Inventory and Use Survey (VIUS).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer said the project directly relates to petroleum displacement, assuming the model is accurate.

Reviewer 2:

The reviewer stated that the project supports development of appropriate tools for energy and GHG analysis.

Reviewer 3:

The reviewer affirmed that the VISION model offers important and relevant contributions to the energy research and policy community, and expressed the hope that the NEAT model would, also, when complete.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the level of funding for this work seems correct.

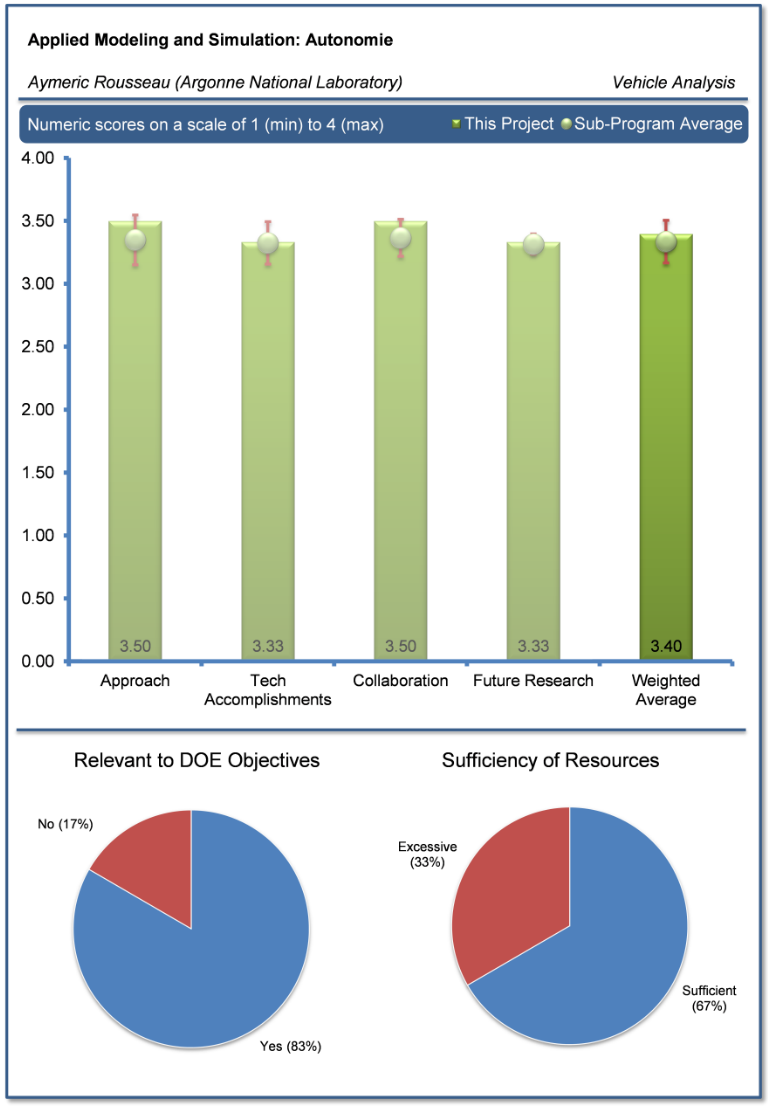
Reviewer 2:

The reviewer said no resource barriers had been identified that require additional or different resources.

Reviewer 3:

The reviewer commented that while the research offers strong contributions, its use of medium- and HD vehicle data known to be imperfect makes it an example of DOE's excessive focus on modeling and insufficient focus on the fundamental, real-world data needed to ensure the model's rigor.

Applied Modeling and Simulation: Autonomie: Aymeric Rousseau (Argonne National Laboratory) - van008



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer termed the approach as very sound and efficient. Additionally, this person described use of an existing model as the core of the project as an excellent way to leverage resources.

Reviewer 2:

The reviewer approved the idea of developing a process enabling numerous variables to be handled efficiently, particularly if it can be integrated with the Autonomie model. To this reviewer, the project appeared to be on track, the model to be well structured, and the project to be founded on a clear conception of the ultimate product of two years' work. While also deeming the project to be integrated with other efforts (because its results will support other DOE work), this reviewer expressed concern that it will be hard to keep track of all the assumptions with so many data points. The reviewer cautioned that if another research group takes the output of the model and uses it in their own models without fully understanding the assumptions and variables used in this model, there will be poor quality results.

Reviewer 3:

The reviewer termed the approach appropriate. Noting that the question had arisen of whether actual vehicle configurations were modeled and the answer that representative vehicles and technologies were modeled, the reviewer speculated that it may be worthwhile to assess whether actual configurations are included in the combinations of technologies and vehicle types and to include those combinations if they are not covered.

Reviewer 4:

The reviewer expressed the belief that the modeling effort does indeed assist in addressing barriers represented by computational modeling methods and complex benefits analysis, as claimed in the presentation, but was more skeptical of its value in addressing risk aversion, technology advances, and cost. The reviewer said those latter factors are better addressed by consumer behavior research, vehicle simulation and validation, and vehicle teardown research, all of which feed into this project. That aside, the reviewer said, the approach described and the input data used appeared to be state-of-the-art.

Reviewer 5:

The reviewer expressed the view that knowing some 89,000 simulations support the results of Autonomie is of considerable value to any serious transport analyst. Because reviewers have not seen the tool itself, this expert stated it is difficult to assess how technical barriers have been dealt with; however, the 80,000 simulations engender confidence that most technical limitations have been addressed.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer deemed technical accomplishments to have been as planned and noted no apparent gaps.

Reviewer 2:

Terming the overall project as excellent and the database analysis tool clearly very powerful, this reviewer was less clear on the user-friendliness of the graphical user interface.

Reviewer 3:

The reviewer speculated that if the aim of this model is to show how predicted research and development (R&D) improvements will affect the transport industry, then it definitely helps towards DOE goals as it will show other research groups from which areas of R&D that they could get the best results. The reviewer was left with the impression that the model, and the results from the model, will be for internal use only. This reviewer opined that this perhaps dilutes some of its benefits as this way only internal DOE research groups will be able to view the results and be able to assess which R&D programs are worth investing in.

Reviewer 4:

The reviewer believed the analysis could benefit from alternative baseline assumptions from other federal agencies that consider estimates of conventional internal combustion engine technology performance and cost.

Reviewer 5:

The reviewer considered it too early in the project fully to evaluate the accomplishments (including a database analysis tool) because the modeling effort has not been completed and final results have not been presented.

Reviewer 6:

The reviewer termed the technical accomplishments and progress to not be outstanding, because final results will not be available until the project’s next phase.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted strong collaboration with partners Argonne National Laboratory (ANL), ONRL, NREL, and U.S. Driving Research and Innovation for Vehicle Efficiency and Energy (U.S. DRIVE).

Reviewer 2:

This reviewer stated that operating a model of the magnitude typified by Autonomie requires a high degree of collaboration, which the presentation showed to be the case. The reviewer emphasized the importance of involving the private transport sector in the project.

Reviewer 3:

Acknowledging strong collaboration within DOE, one reviewer suggested the possibility of further collaborative opportunities outside the Department with, for example, EPA, DOT, original equipment manufacturers (OEMs), etc. Such collaboration could be customized or incorporated into the analysis requirements of these agencies. Wider collaboration was mentioned toward the end of the presentation, the reviewer noted, but no details were provided.

Reviewer 4:

The reviewer noted the project's coordination and collaboration with U.S. DRIVE, ANL, NREL and ORNL and urged that ways be found to ensure the work is exposed beyond the national laboratories and U.S. DRIVE to greater leverage the investment, and thus to broaden its impact. Universities, DOT, and EPA are key practitioners that are largely unaware of many of these DOE modeling activities and would gain from better understanding the research as it is being conducted, and later as it is completed. Such partnerships, in this reviewer's view, would ensure that everyone's research is state-of-the-art and applied to the most pressing and timely research questions.

Reviewer 5:

The reviewer saw this project as aggregating, digesting and disseminating information, and believed this demands collaboration with other institutions. Its reliance on external expertise to set some of its assumptions was viewed as a good use of resources, provided such outside collaborators are unbiased and representative of a range of sectors and areas. The reviewer directed attention to Slide 15, which showed most model inputs come from research groups. If data were also derived from real life, the reviewer speculated, the model's accuracy might be improved. The reviewer cited U.S.DRIVE as a good source of data from OEMs and suggested further that household surveys and other forms of real-life data could enhance modeling of how technical improvements perform on the road. The importance of such sources could increase in coming years when a higher proportion of the on-road fleet consists of electric vehicles (EVs), fuel cell vehicles (FCVs), natural gas vehicles (NGVs), etc. This reviewer also suggested collaboration with the EV sales project, which is attempting to obtain real automobile usage data.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer indicated that the presenter had identified a clear path through 2014-15 to complete the work, improve the analysis, and distribute the product to the national laboratories.

Reviewer 2:

The reviewer felt the proposed future research was limited to evolutionary changes and suggested that soliciting customer feedback on the tool or the data might develop some revolutionary future research that could be of particular benefit to non-DOE users of the model.

Reviewer 3:

This reviewer was left with the impression that the only fuels under consideration are gasoline, diesel fuel and ethanol, and wondered about the inclusion of advanced biofuels, mentioning renewable diesel fuel (in commercial use nationally) and renewable gasoline. The reviewer noted that there are several biofuel technologies that, if production can be successfully scaled up to hit Renewable Fuel Standard 2 (RFS) targets, could substantially change model outputs. The reviewer also inquired if it was planned to examine earlier simulations to assess their accuracy, based on technology improvements that have been achieved. The model could be used retrospectively to examine changes in the automation space to determine if such step changes could have been predicted using the model, the reviewer suggested.

Reviewer 4:

Noting that future work includes distribution of database analysis tools to other national laboratories, the reviewer asked about the possibility of its being made available to other organizations, observing that reports were available via the website, but that analytical tools were said not to be available.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer labeled the project as highly relevant, and noted that it was mandated statutorily.

Reviewer 2:

Noting that the model will be employed to analyze the usefulness of DOE's investment, the reviewer predicted its major use would lie in aggregating R&D data from a wide range of sources. The reviewer urged care that all assumptions underlying provided data and employed by model users be understood and made explicit. The reviewer also wondered if, once a critical number of assumptions were incorporated, results would begin to lose significance.

Reviewer 3:

The project, the reviewer indicated, provides an effective modeling tool to assess the impacts of technologies.

Reviewer 4:

While terming this project somewhat relevant to several internal DOE activities, the reviewer was unclear as to the degree of relevance, and was unsatisfied with the specificity of the response to a request for examples of the value of the work in improved decision making. According to the presenter, the reviewer said, the work had originally helped justify the Government Performance and Results Act (GPRA), but had since expanded to other uses, such as informing market penetration and connecting real-world data to DOE forecasting. In response to a question concerning the project's linkage to the 2017-25 Corporate Average Fuel Economy (CAFE) and carbon dioxide emission standards, which the reviewer considered the most important and pressing vehicle technology issue facing the United States, the reviewer noted that the presenter was unable to forge a connection with the work, its objectives, results, or its baseline vehicle characteristics. The reviewer said this showed the work was not aimed at being externally relevant other than to DOE's national laboratories. The reviewer expressed the hope that by the end of the project, a stronger answer will be available to the question of how exactly this work is a relevant contribution to the research world.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found it difficult to judge, discerning little transparency as to how the funding had been spent. Because the project is only two years old, the reviewer observed that heavy early funding may be justified. The reviewer speculated that beyond that period this project's funding will be folded into that for the Autonomie project, which would be bolstered in recognition of the additional modeling work.

Reviewer 2:

According to the reviewer, the presentation summary showed that the number of technologies has increased significantly and the number of combinations modeled should be evaluated. Further, the reviewer explained it was unclear whether project resources should be adjusted.

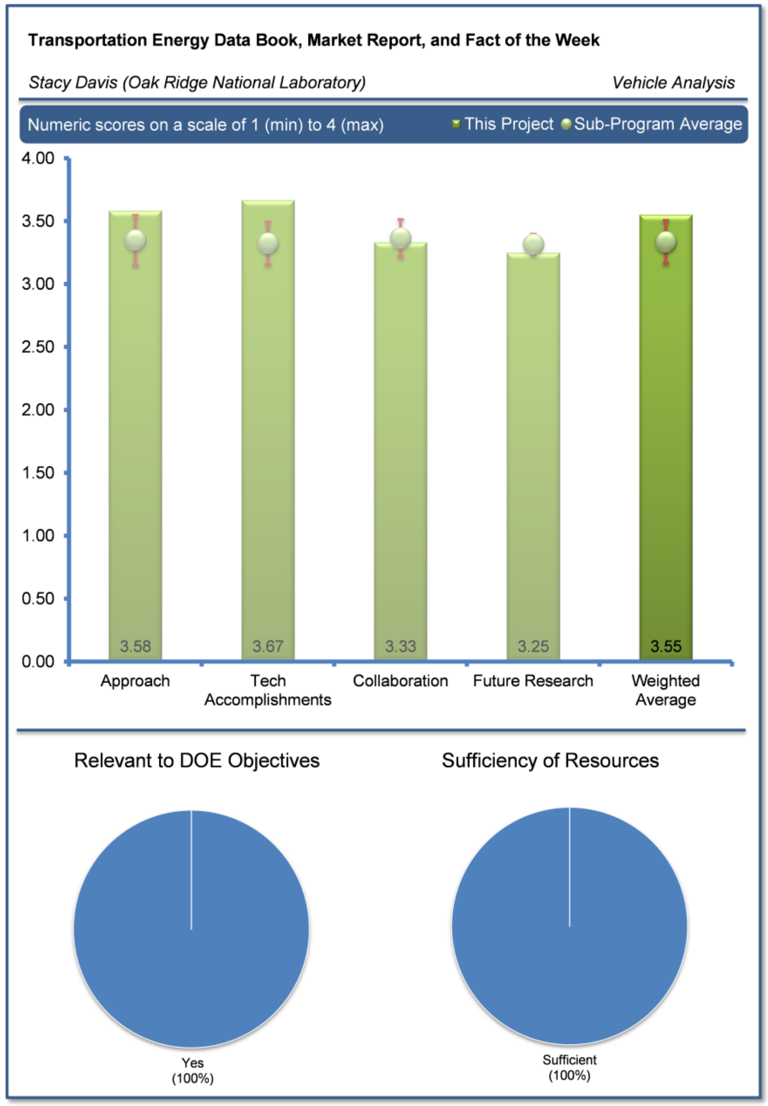
Reviewer 3:

Although calling this great work, the reviewer said it seemed less ambitious than would be suggested by its $500,000 annual budget (co-funded by Vehicle Systems and Analysis). The reviewer could not exclude the possibility of having missed important details (e.g., software costs, etc.) that could easily justify that yearly sum.

Reviewer 4:

The reviewer said the project could be significantly relevant, given its scale and again expressed the hope that a better case could be made for the work by the time of the 2015 AMR.

Transportation Energy Data Book, Market Report, and Fact of the Week: Stacy Davis (Oak Ridge National Laboratory) - van009



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer called the process excellent and said it was apparent it had been finely honed over many years. Noting that the presenter had said the process includes a continuous improvement perspective to ensure the product and process always evolve, the reviewer said that seeing examples of this, or at least mention of it in the presentation, may further strengthen this already excellent process.

Reviewer 2:

The reviewer rated the approach excellent and explained the reason it had not been rated outstanding was that the group working on the two publications and the fact of the week seems to rely on other government agencies, but only one private-sector source/partner – Infobank. DOE has access to the most comprehensive data sources, the reviewer acknowledged, but said it is important to ensure that privately collected data is taken into account.

Reviewer 3:

The reviewer called the approach sound, the methodology and results proven and asked if there is an opportunity to print fewer copies of the Data Book and to assess if a portion of the user group would prefer to rely on the website for access, thus saving printing costs and materials. The reviewer also said it would be interesting to evaluate whether the on-line questions were coming from subscribers of the data books or from those who primarily use the website for information access.

Reviewer 4:

The reviewer said the project is less about overcoming technical barriers than about overcoming very significant practical, institutional, public understanding and outreach barriers in its unique and comprehensive syntheses of information. The project is excellent in addressing these barriers, the reviewer said, and is well-designed and clearly well linked to many actions by DOE and other government agencies. The approach – discovery, numerous due-diligence steps, outreach – is strong, the reviewer said.

Reviewer 5:

The reviewer wondered whether, if basic analysis and calculations were consuming a lot of hours, time could be saved by working with other groups doing the same work, or if the aim of the Data Book is to be independent from other data book producers and working groups. Even if these data books are the best available, those who have provided the data (national laboratories, auto manufacturers, etc.) will have analyzed the data they provide and done unit conversions. Could those working on this project request data in certain formats or standard units, the reviewer asked. The reviewer also acknowledged that some people prefer the hardcopy format of the Data

Book, but noted that if the numbers of those continue to decline, it might be advisable just to publish an interactive PDF of the book. Users could print this out, if desired, or use it online, clicking on icons or tables and graphs to take them to the underlying data sets. Finally, the reviewer asked if a search engine function could be added to the fact of the week so that users could see all facts relating to, for example, FCVs or HD vehicles.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

Rating the technical accomplishments as excellent overall, the reviewer suggested the team consider a formal feedback mechanism for Data Book customers. The reviewer was sure excellent feedback was currently available from some customers, but felt tracking an overall feedback score as well as gathering formal feedback in words would likely improve this further.

Reviewer 2:

The reviewer said progress and indicators of the project's accomplishments are very clear and impressive. Steadily increasing citations in government reports, universities, and popular media are clear testament to the importance of the Transportation Energy Data Book (TEDB), and its 1,300-copy distribution and 6,000 to 9,000 visits to the website per month show high popularity and usefulness, the reviewer continued. The progress of the newer Vehicle Technologies Market Report (VTMR) also impressed the reviewer, who noted web traffic having increased to 5,000 visits per month in March 2014. The reviewer said the fact that 61% of visitors and 53% of new visitors to the VTO site come from the Fact of the Week shows great progress for VTO's outreach efforts and the general public's understanding of many of DOE's broader energy work.

Reviewer 3:

The reviewer indicated that the book, web page, and Fact of the Week all inform the public about main transportation trends and issues. The reviewer said it is good for the industry to have in DOE an unbiased data aggregator. The reviewer considered the most important technical achievement is to have tracked and maintained transport data for over 30 years.

Reviewer 4:

The reviewer noted the project is ongoing and has projected improvements, so it was difficult to answer this question. If the data from the Data Books is being used in DOE models, the reviewer said, this is a good use of it and shows it is working toward DOE goals. However, no specific examples were provided of how the book is used by DOE models or analysts, which made it quite hard to judge this aspect of the project.

Reviewer 5:

Noting there had been a brief period when the website was down for maintenance and could not be updated, the reviewer asked if maintenance could be done in off hours to minimize downtime.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer noted previously that gathering feedback from a representative sample of users after the product is published would be best, and reiterated this comment. The reviewer also said it was clear there was strong collaboration on the input side of the product/data book.

Reviewer 2:

The reviewer said there appeared to be good collaboration with other institutions including EIA, DOT, ANL, Wards, EPA, the Census Bureau, NREL, and others.

Reviewer 3:

The reviewer commented that good management of all collaborations with EIA, EPA, DOT, Census Bureau, ANL, NREL, and Wards is important to allow all the restricted-use and hard-to-find data to be publicly used, re-used, and updated. Outreach of the TEDB, VRTM, and Fact of the Week to a wider audience (e.g., through the web, with Excel data available, via the publications and response to inquiries) ensures that DOE is well connected and is critically valuable writ large.

Reviewer 4:

The reviewer acknowledged the importance of collaboration with industry that provides data, but said the question is how the project team is collaborating with users of the data. This reviewer queried how accessible the team is to users with questions or suggestions. It seems there is a well-defined process for producing the reports and Fact of the Week, but it is unclear to this reviewer how flexible these processes are or how likely they are to change based on market needs.

Reviewer 5:

Noting that the data is used by and probably taken from other institutions, the reviewer said it appeared all analysis, data aggregation and calculations are done fresh for each book. The reviewer said this process could probably be accelerated and improved by working with other departments who also might perform the calculations. Referring to a comment that the definitions of certain vehicle classes change over the years, making it hard for the project team to redefine things or compare to previous years' classifications, the reviewer suggested a discussion with national laboratories and OEMs about how they do such reclassifications could result in a standard being developed that would help clarify.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer deemed efforts to continue to add and vet good data as excellent.

Reviewer 2:

The reviewer stated the plan is sufficient.

Reviewer 3:

The reviewer believed the proposed future research was somewhat unimaginative because it consists mostly of updating the book with the latest figures. If this is truly the mission, acknowledging the long, steady tradition of the Data Book, then perhaps this question is not as applicable. With more comprehensive feedback, on the other hand, the reviewer believed it possible that customers themselves might have some important suggestions for future research.

Reviewer 4:

This reviewer noted that future work involves doing the same thing as in previous years, and thus found it hard to judge this question. The reviewer assumed that informal feedback was used to improve the book for next year. Because much work goes into compiling these books, the reviewer intimated that it seems it would be difficult to make significant developments or improvements with the resources provided.

Reviewer 5:

The reviewer said it seemed the project team aims to continue doing what it has been doing to date. This seemed reaction-based to the reviewer, who expressed the opinion that change would come only when absolutely necessary and would therefore come too late. Holistic overviews of this type tend to lose relevancy very quickly, the reviewer said, so perhaps splitting the Data Book or the web-based report into sections that are updated periodically would have greater value to users.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer stated that knowing the data first is extremely important to subsequently implementing policies and/or researching methods to displace petroleum, and commented that the Data Book clearly fills that need.

Reviewer 2:

This project is highly relevant in aiding and amplifying all the U.S. government's efforts (by EPA, DOE, DOT, etc.) to increase awareness and availability of data on all things related to energy and transportation, the reviewer said.

Reviewer 3:

The reviewer observed that the TEDB is reaching 1,300 individuals deeply involved in the industry, calling this a very strong readership. The reviewer added VTMR appears to be gaining momentum, and thanks to the Fact of the Week, a lot of information in it is being made available to the general public. The reviewer said that 60% of visitors and 53% of new visitors arriving at the VTO's website are attributable to the Fact of the Week.

Reviewer 4:

This project, by providing detailed data on U.S. transport, definitely helps inform other private and public transport groups, in the opinion of this reviewer.

Reviewer 5:

The reviewer said that this project provides a useful data resource for the government and the public.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer expressed that with such a history of flat funding for a steady product, the resources appear to be well honed.

Reviewer 2:

The reviewer stated that no barriers were identified that required additional resources.

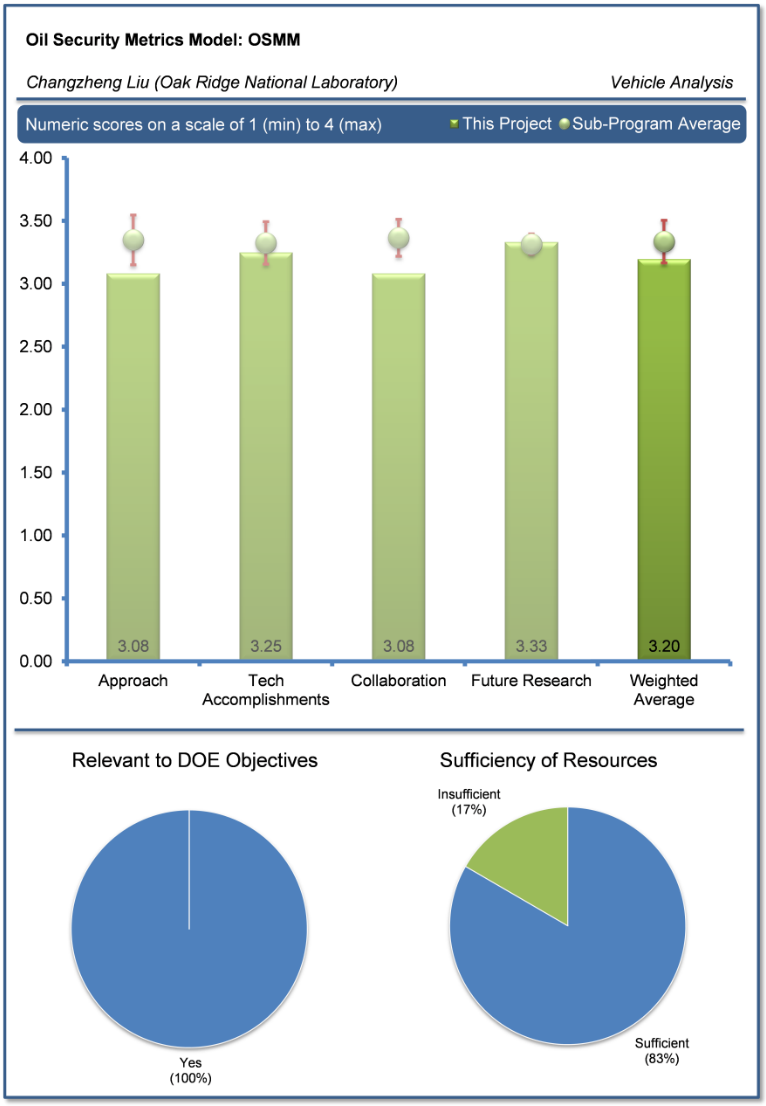
Reviewer 3:

The reviewer said the TEDB and VTMR appear to have sufficient DOE funding and do an excellent job researching and troubleshooting issues that arise from compiling some 300 sources of information, and summarizing and presenting these to users. From the question-and-answer period, however, the reviewer got the impression that some insufficiencies exist in fundamental data collection areas, namely in collecting medium- and HD vehicle sales, use, activity and market characteristics data. Since the defunding of VIUS, the reviewer indicated there has been only limited rigorous data on which researchers and government agencies can base sound, well-grounded conclusions concerning what is going on in this important and growing U.S. transportation energy use sector. This essentially forces TEDB to repackage and publish relatively old data for HD vehicles, the reviewer concluded.

Reviewer 4:

The reviewer indicated there was not much input on this.

Oil Security Metrics Model: OSMM: Changzheng Liu (Oak Ridge National Laboratory) - van010



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer said this work is definitely needed and is a great way to demonstrate why alternative energy development is so important for U.S. energy security and to show the hidden cost of reliance on fossil fuels. If the only aim is to show the cost of importing oil and how price shocks might affect those costs, the model is sufficient, the reviewer said. However, if the model does not take into account the types and qualities of imported oil, it cannot model how much oil will be displaced by EVs or biofuels. For example, if all imported oil is light crude with a large gasoline fraction, increasing the penetration of renewable diesel fuel or increasing the use of liquefied natural gas (LNG) in HD engines might not reduce importation of oil, the reviewer said. If light crude is imported but used mainly as chemical feedstock rather than for gasoline production, increasing penetration of EVs might not reduce the importation of this type of crude. The reviewer said the reason oil data used in this project takes the form it does is because it comes from AEO and is not characterized by type, so perhaps the next step in the project should be to seek more detailed data elsewhere than just AEO.

Reviewer 2:

The reviewer indicated that the approach does a good job addressing the target questions of quantifying the value of reducing petroleum use and measuring the costs of petroleum dependence and of utilizing the best available methods and updated data to study these questions.

Reviewer 3:

The reviewer said that there is an opportunity to improve the project with recognition of the effect domestic natural gas production will have on oil consumption and foreign oil dependence.

Reviewer 4:

The assumption that oil prices will continue to rise despite more shale oil discoveries, flat VMT, falling demand and displacement by alternatives may not be valid, in the view of this expert. The reviewer continued that Slide 4 of the presentation presents this assumption as a given and it may creep into the overall modeling approach in unintended ways. There is a school of thought, the reviewer added, that holds a dramatic global oversupply of oil will develop and prices could collapse. It was not clear to this reviewer what affect this would have on this project.

Reviewer 5:

This type of analysis is not new, having been carried out by many private and public companies for a long time, this reviewer noted. Furthermore, its approach seemed quite general to the reviewer in its assumption that all crude oils are the same and therefore fungible. The reviewer pointed out that supply shocks in countries with specific crude categories have proved that the fungibility of crude oils is high, but not absolute.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer indicated the supply shock simulator is definitely a solid accomplishment, as are others such as the uncertainty analysis of oil dependence as a percent of gross domestic product (GDP), but added that it was not clear how much rebound effect is factored into the analysis.

Reviewer 2:

The reviewer reiterated that the accomplishment is good if the aim is to show how much money the United States is spending on oil, and how future oil shocks could affect the United States. However, this reviewer expressed uncertainty of the use of this data (apart from for publicity's sake) if further modelling is not done with regards to looking at how alternative energy penetration in the advanced transport market would affect oil use in the United States. The reviewer continued that perhaps this model could use some of the outputs from other DOE models that look at advanced transport penetration and compare it to the types of fossil fuels it displaces. The reviewer said that this information could then be used to discern which type of oil imports from whole countries, would be displaced and how this would affect other related markets like chemicals and power. The reviewer asked what would be the knock on effects, for instance.

Reviewer 3:

The reviewer commented that the work appears to be on schedule. This reviewer recounted that the project is 90% complete on milestones set for June 30 and asked if these would be 100% complete by June 30. The reviewer referenced price elasticities and competitive oil prices, oil supply shock algorithm, and preliminary results on U.S. oil dependence cost estimation.

Reviewer 4:

Observing that the work is not yet complete, the reviewer said the results presented for the 90% completed task on wealth transfer and potential GDP loss show the project's progress in achieving its goals has been good and it appears to be headed toward delivering useful, novel results.

Reviewer 5:

The reviewer indicated it was not clear how this contributes to DOE's goals. The reviewer further stated that U.S. energy independence seems to be an issue well debated and quantified. Implementation of policy to ensure it is achieved appears to be more important than spending resources in quantifying the size of the energy gap.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

Collaboration is adequate, in the view of this commenter, but not excellent. The reviewer said this is an important model that seemingly should be either incorporated into more agencies' planning or at least more agencies should be stakeholders.

Reviewer 2:

The reviewer said the collaboration partners were appropriate, including ORNL, the University of Tennessee and ANL. The reviewer wondered if it might be relevant to consider the effect of natural gas production and consumption and how they will affect U.S. oil dependence, and suggested consideration be given to collaborating with natural gas consumption models.

Reviewer 3:
The reviewer stated project coordination among the University of Tennessee, ANL and ORNL appeared to be good, but that there appeared to be relatively limited collaboration beyond that immediate group of researchers. The reviewer wondered if there might be interest in connecting the research outside that group.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
Calling the proposed future work valid and valuable, although not revolutionary in scope, the reviewer said making the model more user-friendly and improving the shock simulator (for example) are important pieces of work.

Reviewer 2:
The reviewer said all the proposed work sounds valuable and suggested further work could be focused on getting better oil import data and in modeling the effect of key programs such as zero-emission vehicles and RFS2 might have on oil dependence.

Reviewer 3:
The efforts discussed – to finalize the model, include an Organization of the Petroleum Exporting Countries supply shock simulator in 2014 and an analysis of the transition to an e-drive fleet in 2015 – seemed to the reviewer to be good areas for future work.

Reviewer 4:
Noting that the project has identified the potential impacts of EVs and alternative fuels, the reviewer asked for clearer articulation of how to include alternative energy sources, natural gas, EVs, hydrogen, biofuels, and renewable fuels in the model.

Reviewer 5:
The reviewer was unsure how much more research on this topic is required. The main question seemed to have been answered and future work to be just a matter of updating.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The rigorous efforts of the researchers to reassess the importance of and outlook for oil security into the future is highly relevant, in the opinion of this reviewer, considering current geopolitics and major changes in the world oil market. The reviewer also acknowledged the researchers' goal of increasing public understanding and expressed the hope that the project team would ensure some effort was devoted to press releases, the TEDB, dissemination of their results at conferences, etc. to bring these results to a wider audience.

Reviewer 2:
The reviewer said the model is very important for reducing petroleum use. Although it needs some refinement in its assumptions and tolerance for variations in inputs, the reviewer stated that it serves a role for policy makers to make better decisions on future energy policy.

Reviewer 3:
The reviewer agreed that the project is showing the government and general public the cost to the country of importing oil. However, if the model is not disseminated outside DOE, the reviewer said, it is less clear how it is advancing DOE goals.

Reviewer 4:
The reviewer expressed that model focuses primarily on oil projections, not on alternative fuel impacts. Scenario analyses would be useful, given the wide variability of predicted effects.

Reviewer 5:

The reviewer acknowledged that the model quantifies the size of the displacement required; but once quantified, the reviewer was unclear about how the project is necessary.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

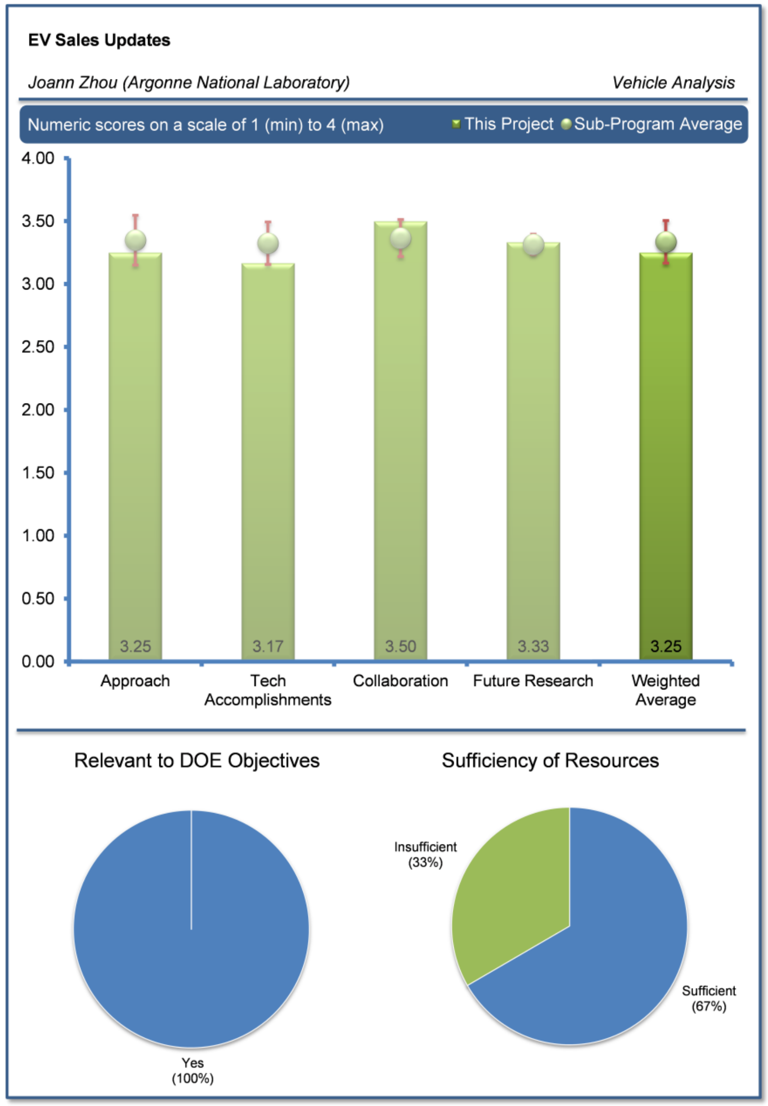
Reviewer 1:

The reviewer said the $100,000 funding level makes the project a decent bargain and suggested consideration be given to increasing funding to permit the scope to be expanded to include better validation and overall model improvements.

Reviewer 2:

No resource barriers were identified that require additional or different resources, in the view of this reviewer.

EV Sales Updates: Joann Zhou (Argonne National Laboratory) - van011



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer indicated that the project is a great example of how national laboratories can use data produced by private organizations to build their long-term forecasts. The reviewer added that it is important for the advanced transport industry to have the thought leaders in the national laboratories using all available data in the market.

Reviewer 2:

The reviewer said the approach is sound and the project appears to be doing a good job of addressing the lack of available data on electric drive vehicle sales, use and costs and the uncertainty of projections. The reviewer said that improving the various DOE forecasting models' uncertainty is a very good objective, although it was not quite clear how the project will reduce the uncertainty and variability of DOE models' EV projections. The reviewer looked forward to seeing the results of later project stages.

Reviewer 3:

The reviewer stated the approach appears sound and effective in producing the intended product.

Reviewer 4:

Noting that the e-drive vehicle policy matrix includes fiscal subsidies to consumers, the reviewer suggested that social incentives, such as access to high-occupancy vehicle (HOV) lanes, reserved parking, etc., for EVs also be included.

Reviewer 5:

The reviewer noted that virtually all data used in this project is from third parties – primarily Navigant – and asked if its accuracy has been evaluated, as some of it (e.g., the National Household survey) appears to be very old and thus probably more misleading than helpful with regard to EV usage. Other parts of the work involve some aggregation and analysis, such as compiling EV sales data and the policy matrix, which is probably done by other government and non-government groups. Thus, the reviewer found it difficult to determine if the data aggregation and compilation done under this project is unique. Certainly a lot of private companies already do this, observed the reviewer. Because others do such work, the reviewer opined that it would make more sense simply to pay Navigant, or some other group, more so they could compile the data and produce the charts for DOE/VTO. This reviewer explained that the issue with this is that VTO might not trust the outcome of the data, but already relies so heavily on Navigant data. The reviewer found the presentation slide concerning Japan and the factors that could affect EV sales to be interesting, and further suggested that doing this analysis to predict EV sales could be a helpful exercise.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer deemed all the accomplishments to be significant, but said it was unclear how important this project actually is to other models or projects. It could be very important, the reviewer acknowledged, but that did not come across in the presentation. The reviewer also noted that evaluating depreciation is tricky due to OEM incentives and other factors (e.g., Tesla's guaranteeing a re-sale value after some period of time). The reviewer found it unclear how well the project is covering these types of market distortions. Identifying the differences in model outputs, is very important, but the reviewer was left unsatisfied that this was well-understood. Nor was the reviewer sure that this is an accomplishment, unless the reference was purely to identifying model outputs' differing sensitivities and outputs.

Reviewer 2:

This reviewer found the accomplishments shown (e.g., China, Japan, the EU, Navigant forecast, policy matrix, etc.) very interesting and looked forward to seeing all these results.

Reviewer 3:

The reviewer said it appeared that most of the project data collection and processing had been done and that the analysis was now underway. The reviewer anticipated that the analysis should prove interesting and useful, but that it and a portion of the data need to be made available to the public, as it would be a shame if this effort failed to make it beyond the DOE's firewall.

Reviewer 4:

Noting that progress appeared to be on schedule, the reviewer called attention to the barriers section where lack of available historical data on sales, advanced vehicle usage and cost components was mentioned. The reviewer believed this might benefit from additional input regarding component cost, which could also contribute to ongoing work related to total-cost-of-ownership data for plug-in electric vehicles and comparable conventional vehicles.

Reviewer 5:

The reviewer believed the analysis could benefit from better understanding of the technology labels from various data sources, offering as an example the question of whether all hybrid vehicle sales data include vehicles of similar design and capability.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said there appears to be good collaboration with national laboratories, TA Engineering, Navigant and other entities in Asia and the United Kingdom.

Reviewer 2:

The reviewer noted that the project team had worked with four or five national laboratories to achieve accomplishment four (i.e., comparing various different models), but that few other collaborations were mentioned. Perhaps, the reviewer speculated, working with other groups would be a good way to get more up-to-date information on EV usage. The reviewer also noted there was no mention of whether these models were going to be aligned, or whether or how the output of this work will be used. The reviewer wondered if it would make sense for all makers of these models to discuss whether these differences matter.

Reviewer 3:

The reviewer stated coordination with Hybridcars.com, European Automotive Industry Newsletter, Kelley Blue Book, National Automobile Dealers Association, Navigant Research, Tsinghua University, ORNL, NREL, Sandia National Laboratories and TA Engineering, Inc. is clearly an important part of making this project work. The reviewer suggested that the project researchers, including Tsinghua University and Navigant, work together toward an arrangement that would allow all partners to share their data more completely. The project team should be willing to do so, the reviewer said, in view of the increased exposure the project team is getting through DOE, as The Polk Co. and Ward's Auto do via their contributions to the TEDB.

Reviewer 4:

The reviewer said some very similar studies had been seen at Transportation Research Board that had come to different conclusions, for example, on how hybrid vehicles are used by their drivers. The reviewer believed this should be addressed in some way, at least by creating some cross-collaboration with various DOT entities, and that more collaboration in general would bolster the project.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

Completing the rest of the planned 2014 research seemed straightforward and highly valuable to this reviewer.

Reviewer 2:

The reviewer looked forward to the upcoming reports on usage trends, levelized cost of energy, and model comparison.

Reviewer 3:

The future work plan appeared satisfactory, in this reviewer's opinion.

Reviewer 4:

The reviewer believed further work on EV sales by battery type and capacity, using other data sources to improve understanding of EV purchase decisions, and work on total cost of ownership (TCO), are all excellent ideas for future work. In the reviewer's opinion, if TCO work is done, collaboration with other public and private groups already doing such work would save considerable time. The reviewer also mentioned examination of how EV choices are affected by the availability of charging infrastructure and power at charging points, as well as how electricity price affects EV purchase decisions (i.e., how regional variations in TCO affect EV sales), as possible areas of future work. The reviewer offered the opinion that collaboration with EV manufacturers would be very useful, as manufacturers will have surveyed their customers regarding their satisfaction with and use of the vehicles, and will have opinions on how to influence customers to purchase EVs. The reviewer believed that this information could be of interest.

Reviewer 5:

The reviewer found the proposed future research interesting but perceived that it did not connect to the bigger picture. The reviewer did not see how the proposed work would help or who was asking for it.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

The reviewer considered tracking EV penetration data and modeling future usage to be extremely important for the industry and that this project is an effort that needs to continue. It should, in the opinion of this reviewer, be one of the main objectives of VTO to ensure the results of this analysis are known to industry players.

Reviewer 2:

This research is clearly related to petroleum displacement, in the opinion of the reviewer, as it directly tracks this variable through purchase of fuel-efficient vehicles.

Reviewer 3:

The reviewer stated that a better understanding of the EV market can only help DOE better support this growing market.

Reviewer 4:

The reviewer said the project is relevant to EV sales analysis.

Reviewer 5:

The reviewer said the project is highly relevant, as many researchers and policy makers are drawing conclusions and making decisions with limited data on what drives EV sales, activity, etc. The reviewer noted references to the fact that some of the data and results are available (or not) to the VTO analysis team in their full form and gave the examples of Navigant and the Chinese data. The reviewer opined that research resulting from such significant DOE funding and resources should be made fully available if the aim is to make it fully relevant. Making all the research publicly available in full, not just partially and not behind technical journal paywalls, should be a DOE goal for all the work it supports.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer, noting that some two-thirds of the project budget went to pay for data from Navigant, perceived the project perhaps needs more resources to enable it to do some of its own survey work and source its data from other areas and groups. Collecting data with other organizations on consumer use of EVs and household transport use in general, the reviewer said, would be a good use of additional funds, because relying on a 2009 household survey probably does not yield very good results.

Reviewer 2:

While no specific requests were made for additional resources, the reviewer stated there was some indication that additional input data on cost and vehicle usage patterns would be desirable.

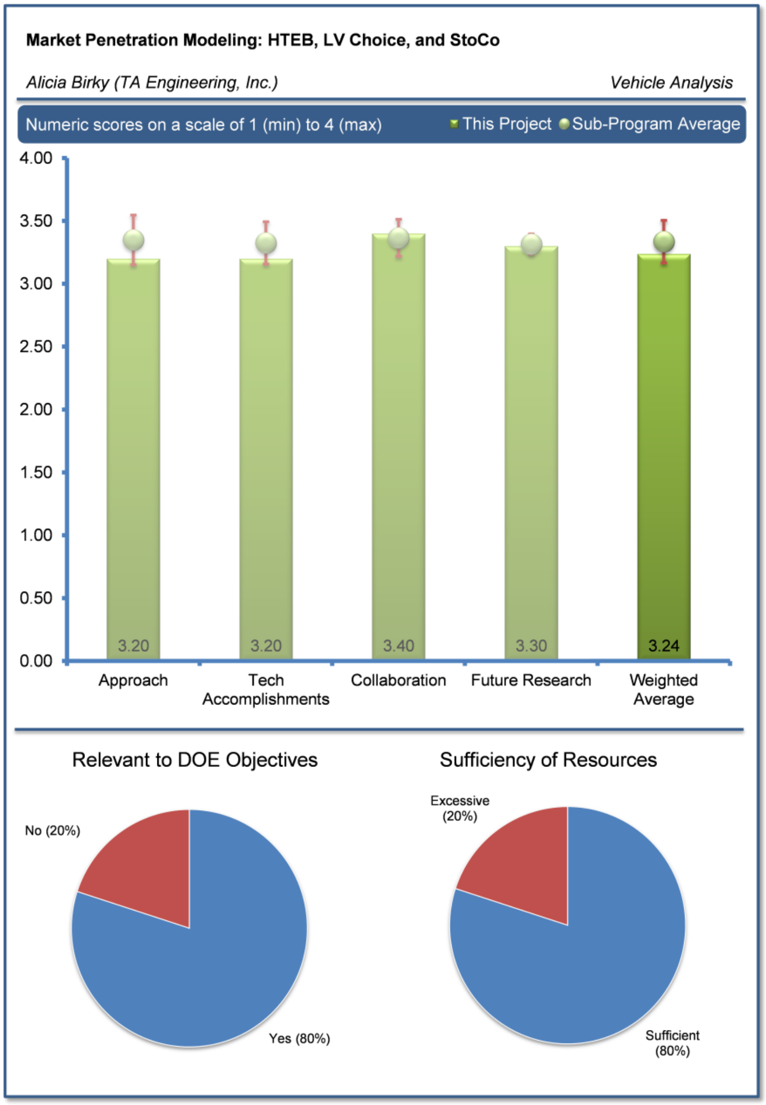
Reviewer 3:

Ideally, the reviewer said that far greater effort and resources would be put into understanding the emerging electric-drive vehicle market. DOE, the reviewer continued, could use projects like this, as well as collaborations in the wider research community to better understand what policy and underlying factors are driving differential EV sales and use around the United States and internationally. In view of the long-term implications for energy, climate, and U.S. leadership in the automotive industry, DOE could take an even more active interest than it does in helping the world understand the leading policies that will spur the EV market, the reviewer concluded.

Reviewer 4:

The reviewer believed the small budget for this task to be sufficient and would not suggest it be increased without answers to the broader question of what the impact would be.

Market Penetration Modeling: HTEB, LV Choice, and StoCo: Alicia Birky (TA Engineering, Inc.) - van012



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer describes the Heavy-Truck Energy Balance/dynamic (HTEBdyn) project as improving the model by accepting criticism and feedback, specifically from the trucking industry, which is a great way to compare the model to real-life data. If the purpose of the HTEBdyn project is to model the energy use of heavy trucks as accurately as possible, it appears to be doing this well, the reviewer said, and to be trying actively to improve the model and to overcome existing barriers. The TRUCK model, the reviewer said, is being developed to fill the gap in knowledge about alternative energy penetration in the HD truck sector and thus is definitely overcoming barriers.

Reviewer 2:

The HTEB model could benefit from a more complete inclusion of maintenance expenses in the total-cost-of-operation evaluation, in the opinion of this reviewer. The TRUCK and LV Choice models might also benefit from more detailed total-cost-of-operation factors, including maintenance cost (scheduled and unscheduled), as an effective way of differentiating technologies and identifying both the benefits and risks associated with introducing new technologies.

Reviewer 3:

The reviewer noted that a legacy model was used on a time-step basis, but was unsure if the approach to regenerative braking is robust. Regenerative braking, the reviewer said, has a huge impact on vehicle efficiency, and the recoverable kinetic energy depends, at a minimum, on battery chemistry and temperature, ambient temperature, driving history, control strategy, state of charge, real-time maximum charging rate, etc. The assumption that any available braking energy is used seemed over-simplified to this reviewer, who suggested applying a regenerative efficiency curve as a function of initial braking speed, braking rate (which the reviewer said appears to be capped at 0.3 g currently), and perhaps one or two other parameters. Acknowledging that this recommendation might give the impression the reviewer was swinging the pendulum back the other way in view of the fact that the project approach was described at last year's AMR was too complicated, the reviewer nonetheless said personal experience indicated that is necessary to make this a reasonably accurate model.

Reviewer 4:

Noting that the presenter had discussed approaches to several work streams, the reviewer commented that the approach to the HTEB energy balance modeling might not be using state-of-the-art assumptions. The reviewer observed that the presenter could not readily discuss the baseline vehicle on which the energy balance analyses were based. While there was discussion of advanced technologies, e.g., hybridization, waste heat recovery, the reviewer said there was limited discussion of the incorporation of incremental powertrain technologies – accessory improvement, engine downspeeding with dual-clutch transmissions, etc. – that are much more likely to be widely deployed in the real world as a result of the EPA/NHTSA Phase 1 and 2 HD standards. The reviewer offered as an example whether the project's HD vehicle model be validated against a base engine, a 2014-2018-compliant engine, and incremental engine efficiency.

Summarizing, the reviewer expressed the hope that the project will be able, going forward, to demonstrate in its final reporting that it is indeed a sound approach. The reviewer deemed the TRUCK HD vehicle modeling approach as sound, although it appeared to be an oversight that Class 2b and 3 trucks, which make up a very significant portion of the medium-duty and HD fleet, are not included. As for the LVChoice model, the reviewer considered it too early in the project to say whether that light-duty vehicle market assessment tool represents a rigorous approach that is well-designed, feasible and integrated with other efforts compared to the very substantial and numerous modeling efforts at national laboratories, universities and other government agencies.

Reviewer 5:

Citing a lack of experience in the HD truck sector, the reviewer declined to comment on this project.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:

The reviewer said the outputs of the project are very useful and powerful if the model and underlying assumptions are assumed to be correct.

Reviewer 2:

This reviewer said the project did a good job laying out the accomplishments to date and satisfactory completion of milestones, also to date.

Reviewer 3:

The reviewer felt the HTEB and TRUCK model projects fill gaps in DOE's knowledge of heavy trucks and their outputs will feed into other DOE models and GPRA. The reviewer regarded as less clear the purpose of the LVChoice model, because it seemed to model the same thing as the AEO, albeit without CAFE inputs and the full National Energy Modeling System suite, and therefore delivers different results. Those outputs, the reviewer noted, change significantly with changes in assumptions, indicating the model is very sensitive, so that using the results of just one of its simulations could give a distorted view of the future.

Reviewer 4:

The reviewer noted that some of the project milestones appear to be behind schedule, particularly those for April and May, such as the user guide and documentation for HTEBdyn. For LVChoice, the reviewer added, the May 30 update to AEO 2014 is 0% complete, as is the final analysis of common inputs with sensitivity, targeted for completion on June 13, 2014.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The project gets data from AEO and works with a number of national laboratories, the reviewer remarked. The comparison of outputs from AEO and LVChoice models show that thought is being given to examining the work of other research groups.

Reviewer 2:

The reviewer said there appears to be good collaboration with ANL, NREL, ORNL, EIA, VTO and with SuperTruck partners Daimler (Daimler Trucks North America), Cummins, Navistar and Volvo.

Reviewer 3:
The reviewer said the project's collaborations and partner seem very good and named ANL, NREL, ORNL EIA and industry partners of SuperTruck.

Reviewer 4:
The reviewer thought the subject had been covered very quickly, but said the collaboration with OEMs and other DOE laboratories seemed adequate.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted many excellent ideas for future research.

Reviewer 2:
The reviewer said the proposed future work seems relevant and appropriate.

Reviewer 3:
The project, in the opinion of this reviewer, showed clearly delineated future project steps to complete the work ahead successfully.

Reviewer 4:
The reviewer said that Slide 28 described that adoption rates for the TRUCK model are taken from a late 1990's survey, the results of which are possibly out of date. Even if they are not, the reviewer asserted the importance of having this double-checked. The reviewer recommended that future work include updating adoption rate numbers and attempting to find a truck population survey newer than from 2002, and speculated that the project team's relationship with industry players and association could assist in this effort. A survey could be put together by this group and sent to key players, the reviewer offered.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The project is very relevant, in the view of this reviewer, because this particular type of data is required to be known for petroleum displacement, especially in this case for medium- and heavy-duty trucks.

Reviewer 2:
The reviewer asserted that gaining a better understanding of how HD trucks work and how alternative energy can be used in this sector definitely helps DOE. The reviewer believed it was less clear how the LVChoice model fits in with other DOE models.

Reviewer 3:
The work provided a modeling toolset for planning and evaluating technical targets for fuel consumption and GHG benefits, in the opinion of this reviewer.

Reviewer 4:
The reviewer said the presentation discussion of how the project was validated against the Autonomie simulation model (after the work was substantially completed) begged the question of why DOE does not use the extensively vetted, peer-reviewed Autonomie model to analyze HD vehicle technology improvement and DOE's technology goals rather than this very simple HTEB model. In response to the question of whether previous efforts related to this project were made available, the reviewer said the presenter indicated the project team could see if the DOE sponsor was inclined to share any of the memos, reports, and models related to those efforts. The reviewer expressed the belief that to ensure project relevance, all such DOE-funded reports, models, and data should be made widely available and to the fullest extent possible. Further, the reviewer hoped that all of this project's associated work streams, past and future, will be posted.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This reviewer said that the project seems to be funded at the proper level.

Reviewer 2:

The reviewer recommended that once the models themselves have had sufficient work done on them, resources should be reallocated within the project to exploring how to gain access to more up-to-date data on truck population and adoption numbers.

Reviewer 3:

Resources appeared to be sufficient, the reviewer said, and no barriers were identified requiring additional or different resources.

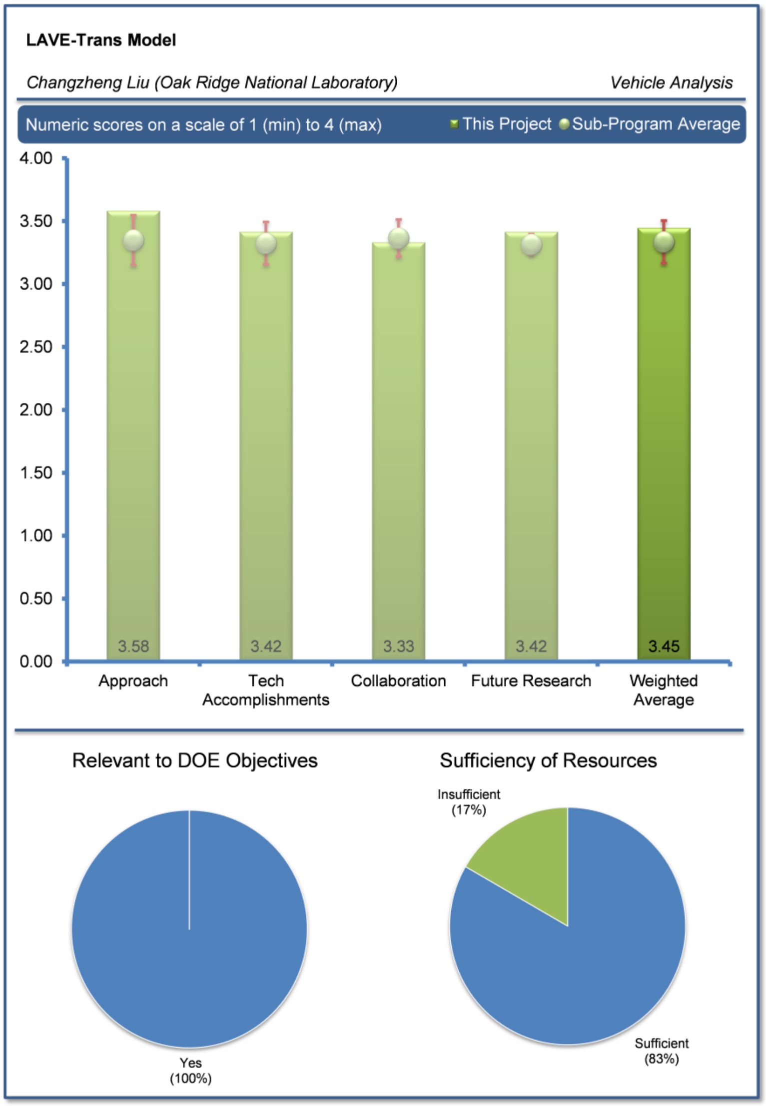
Reviewer 4:

The reviewer reiterated the view that the HTEB work does not appear to employ state-of-the-art approaches compared to HD vehicle simulation work by others at national energy laboratories (i.e., Autonomie) or at other agencies such as EPA and DOT. In addition, the reviewer said fleet modeling with TRUCK and LVChoice appear to overlap significantly with the many fleet models done by or for DOE (e.g., VISION), and therefore seem to be creating duplicative work.

Reviewer 5:

In general, the reviewer believed the approach and method seemed sound. However, it was unclear to this reviewer if the results are of use or interest to involved parties, nor was it clear how redundant this model is to those developed by ANL.

LAVE-Trans Model: Changzheng Liu (Oak Ridge National Laboratory) - van013



Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer observed an excellent approach, overall. The use of feedback loops is a particularly strong feature and one not often seen in other models. The reviewer discerned a possible issue regarding model validation; however, it would be very valuable to find any similar product or technology from history from which this model accurately predicts the known outcome.

Reviewer 2:

Understanding the interplay among technologies, consumer markets, policies and infrastructure is, in the opinion of this reviewer, a great project idea, and focusing on the market barriers and feedback loops seems like the best approach. Likewise, including consumer behavior is essential, but the reviewer questioned how such data was sourced, how up-to-date data are, and whether they are linked to the work of Ms. Joann Zhou of ANL (i.e., van006 and van010). The reviewer said there are a few models within VTO's work that require good consumer behavior data, that should work together to source it.

Reviewer 3:

Petroleum and carbon dioxide reduction goals consider the full effect of well-to-wheels impact on GHGs, the reviewer said. Vehicle technologies also consider the use of renewable and alternative fuels to be one of the relevant technology areas in this model. The reviewer believed the Monte Carlo simulation approach is valid and relevant for this type of analysis.

Reviewer 4:

The reviewer credited the presenter with having discussed a clear, strong and rigorous approach to modeling the future vehicle fleet. The approach, the reviewer went on, is well-suited to the targeted barriers of better understanding alternative fuel vehicle/energy transitions, powertrain costs, manufacturer and consumer behavior and the role of policy.

Reviewer 5:

This project appeared to the reviewer to be redundant to VISION, NEAT and Autonomie. Nor was it clear to the reviewer why the project is necessary when, in the reviewer's opinion, the same question is being answered in more detail by other projects presented in this session.

Question 2: Technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals.

Reviewer 1:
The accomplishments of the project were seen by this reviewer to be very valuable, including the net present value (NPV) over time of subsidies, for example. A piece of the presentation that was not entirely clear to the reviewer was whether this was more about the model technology or the scenarios run through the model. For example, the reviewer asked, is this projecting that fuel cell vehicles will overtake the vehicle market by 2050, or merely an example of what would happen if incentives were provided for FCVs. The reviewer found that Slide 12 was very powerful and accurate, and recommended it be shown to Congress.

Reviewer 2:
The reviewer was impressed by the work to date presented in the slides on LAVE-Trans, saying it appeared the model has broken new ground in its level of rigor in accounting for best-available knowledge of consumer behavior, technology, and its associated cost evolution and regulations, with very meaningful results.

Reviewer 3:
The reviewer found the results of the comparison of policy and non-policy on Slide 7 interesting and recommended their dissemination to policy makers. Likewise, the reviewer described the comparison of subsidy NPV to the benefits due to transition is also really interesting.

Reviewer 4:
The reviewer found technical accomplishments to be generally on track with targets, but cited the exceptions of those slated for June 30 were only 90% complete regarding representation of hydrogen infrastructure and preliminary results on the costs and benefits of the transition electric drive. The reviewer expressed concern that these goals might not be met on schedule.

Reviewer 5:
If this is an adapted version of a model built by International Council on Clean Transportation (ICCT), then the reviewer would like to know why ICCT is not working on it.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer found that collaboration with partners seemed appropriate, citing work with National Research Council (NRC), ICCT, ANL, and outside experts such as David Greene of the University of Tennessee.

Reviewer 2:
The reviewer believed the project team is clearly collaborating with other institutions, as the project only models external assumptions (e.g., CAFE and other policy scenarios).

Reviewer 3:
The reviewer believed collaboration was excellent overall but noted there is always room to improve, suggesting DOT and EPA would be very interested in being involved.

Reviewer 4:
Noting that current collaboration is entirely with other research groups, the reviewer said other good partners would be industry groups, which would help in getting the best input data as well as feedback.

Reviewer 5:
Coordination with the various groups (i.e., NRC, ICCT, University of Tennessee, and ANL) seemed to this reviewer to be well-coordinated to ensure the work would be well-positioned to impact relevant research groups. The reviewer recommended the project team also consider connecting with analysts at EPA, the California Air Resources Board, Plug-in Electric Vehicle Collaborative,

Northeast States for Coordinated Air Use Management, and infrastructure providers to increase the link between their work and relevant decision-making about vehicle technology, costs, infrastructure and policy and their timing.

Question 4: Proposed future research – the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer expressed the belief that the proposed future work is all spot-on, commenting only that comparison and cross-validation with other consumer choice models should probably be expanded to the DOT CAFE consumer choice model, and perhaps backward validated with some other technology to see how valid it would be historically.

Reviewer 2:

All the 2014-15 work proposed is good and sensible, in the opinion of this reviewer, who noted in particular that researchers' proposed efforts to provide insights on the conditions that underlie potential tipping points would offer an excellent and novel addition to the broader dialogue among researchers and decision makers in this space.

Reviewer 3:

The reviewer indicated that the plan is appropriate, particularly collaboration with other DOE consumer choice models. It is unclear, the reviewer went on, how the multiple models available can best be coordinated or interpreted to provide meaningful results without appearing to be contradictory. The reviewer urged that care be taken to avoid too many models that detract from the clarity of reporting the results of combined modeling efforts.

Reviewer 4:

The reviewer said great idea to compare with those of other consumer choice models, and to analyze the tipping points.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:

This project appeared to this reviewer to be one of the better and more important models in the effort to displace petroleum. Having mathematical backup for the opportunity afforded by offering incentives is very powerful, the reviewer said.

Reviewer 2:

This reviewer stated that the model serves to add clarity to the prediction of the light alternative-energy vehicle impact and to the transition process.

Reviewer 3:

The reviewer called this work highly relevant to major decisions that automakers, policy makers and infrastructure providers are attempting to make.

Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer said the amount spent on this project is a bargain and suggested simultaneously increasing both the budget and the scope in pursuit of the premier model in this area.

Reviewer 1:

The reviewer stated that this work is well-warranted and quite high-value for the level of funding it is currently receiving. If the researchers further develop their methods to connect to local and state policy-making discussions of the role of state and local HOV lane access, public fast-charging infrastructure, etc., the reviewer continued, the work might warrant greater funding.

Reviewer 2:

Any additional funding, in the opinion of this reviewer, should be shared with other researcher groups that want to further investigate consumer adoption, or to collect real data on transport use.

Reviewer 3:

No barriers were identified by this reviewer that required additional or different resources.

Acronyms and Abbreviations

Acronym	Definition
AEO	Annual Energy Outlook
AMR	Annual Merit Review
ANL	Argonne National Laboratory
BEV	Battery electric vehicle
CAFE	Corporate Average Fuel Economy
DOE	Department of Energy
DOT	Department of Transportation
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EV	Electric vehicle
FCV	Fuel cell vehicle
GDP	Gross domestic product
GHG	Greenhouse Gas
GPRA	Government Performance and Results Act
GREET	Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation
GUI	Graphical user interface
HD	Heavy-duty
HOV	High-occupancy vehicle
LCD	Levelized cost of driving
LNG	Liquefied natural gas
NEAT	
NGV	Natural gas vehicles
NPV	Net present value
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
R&D	Research and development
RFS	Renewable Fuel Standard
SNL	Sandia National Laboratories
TCO	Total cost of ownership
TEDB	Transportation Energy Data Book
US DRIVE	U.S. Driving Research and Innovation for Vehicle Efficiency and Energy sustainability
VAN	Vehicle Analysis subprogram
VISION	
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle miles traveled
VTMR	Vehicle Technologies Market Report
VTO	Vehicle Technologies Office

10. Acronyms

Acronym	Definition
1D	One Dimensional
3D	Three Dimensional
A/C	Air-Conditioning
ABR	Advanced Battery Research
AC	Alternating current
ACEC	Advanced Combustion and Emissions Control
AEC	Advanced Engine Combustion
AEO	Annual Energy Outlook
AER	All-electric range
AEV	All-electric vehicle
AFCI	Advanced Fuel Cycle Initiative
AFDC	Alternative Fuels Data Center
AFR	Air to Fuel Ratio
AFV	Alternative Fuel Vehicle
Ag	Silver
Ah	Ampere-hour
AHD	Advanced Hybrid Drives
AHSS	Advanced high-strength steel
AKI	Anti-Knock Index
Al	Aluminum
ALD	Atomic Layer Deposition
AMPO	Association of Metropolitan Planning Organizations
AMR	Annual Merit Review
AMT	Air maintenance technology
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
APEEM	Advanced Power Electronics and Electric Machines Program
APRF	Advanced Powertrain Research Facility (ANL)
APS	Advanced photon source
APU	Auxiliary Power Unit
AQMD	Air Quality Management Districts
ARK	Abuse Reaction Kinetics
ARL	Army Research Lab
ARPA-E	Advanced Research Projects Agency - Energy
ARRA	American Recovery and Reinvestment Act
ASC	Ammonia slip catalyst
ASTM	American Society for Testing and Materials
ATR	Attenuated Total Reflectance
Au	Gold
AVFL	Advanced Vehicle/Fuel/Lubricants

Acronym	Definition
AVFL-18	Project 18 under Advanced Vehicle/Fuel/Lubricants of the Coordinating Research Council
AVTA	Advanced Vehicle Testing Activity
B	Boron
B20	Biodiesel blend of 20% neat biodiesel
BARTA	Berks Area Regional Transport Authority
BATT	Batteries for Advanced Transportation Technologies
BES	DOE Basic Energy Sciences
BEV	Battery electric vehicle
BIM	Bonded Interface Material
BMEP	Brake Mean Effective Pressure
BMS	Battery Management System
BNL	Brookhaven National Laboratory
BP	Bandpass
BSFC	Brake-specific fuel consumption
BSG	Belt-Driven Starter-Generator
BTE	Brake thermal efficiency
C	Carbon
Ca	Calcium
CAD	Computer-aided design
CAE	Computer-aided engineering
CAEBAT	Computer-aided engineering of batteries
CAFE	Corporate Average Fuel Economy
CAMP	Cell Analysis, Modeling, and Prototyping
CAN	Controller Area Network
CARB	California Air Resources Board
CATARC	China Automotive Technology and Research Center
CCC	Co-precipitated CuO_X, CoO_y, and Ceo_2 catalyst
CD	Charge Depleting
CDC	Conventional diesel combustion
CEC	California Energy Commission
CEI	Cathode electrolyte interphase
CEO	Chief executive officer
CF	Carbon fiber
CFC	Carbon fiber composite
CFD	Computational Fluid Dynamics
CFR	Cooperative Fuel Research
CFTF	Carbon Fiber Technology Facility
CI	Compression ignition
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CMAQ	Congestion Mitigation and Air Quality Program
CMC	Carboxymethyl Cellulose
CNG	Compressed natural gas
CNT	Carbon Nanotubes

Acronym	Definition
Co	Cobalt
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COV	Coefficient of variance
CPU	Central processing unit
CPUC	California Public Utilities Commission
Cr	Chromium
CR	Compression ratio
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CS	Charge Sustaining
CSC	Cold Start Concept
CSM	Colorado School of Mines
CSTR	Continually stirred tank reactor
CT	Computed tomography
CTFIP	Central Texas Fuel Independence Project
Cu	Copper
CV	Combustion vessel
CZ	Ceria-zirconia
D3	Downloadable Dynamometer Database
DC	Direct current
DEDOHC	Dioxohexane dicarboxylate
D-EGR	Dedicated-Exhaust Gas Recirculation
DEER	Directions in Engine-Efficiency and Emissions Research Conference
DFT	Density Functional Theory
DGE	Diesel gallon equivalent
DI	Direct Injection
DIC	Digital Image Correlation
DISI	Direct Injection Spark Ignited
DOC	Diesel oxidation catalyst
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	Dual-phase steel
DPF	Diesel particulate filter
DQA	Data Quality Act
DSC	Differential Scanning Calorimetry
DSNY	City of New York Department of Sanitation
DSRC	Dedicated Short-Range Communications
DTBP	Di-t-butyl peroxide
DWTP	Dynamic wireless power transfer
Dy	Dysprosium
E0	0 percent ethanol blend with gasoline

Acronym	Definition
E10	10 percent ethanol blend with gasoline
E30	30 percent ethanol blend with gasoline
E85	85 percent ethanol blend with gasoline
EC	Ethylene Carbonate
ECN	Engine Collaboration Network
ECT	Electrochemical-Thermal Coupling
ECU	Engine control unit
EDLC	Electrochemical double-layer capacitors
EDR	Eigenvector dimension reduction
EDS	Energy Dispersive X-ray Spectroscopy
EDV	Electric Drive Vehicle
EE	Energy efficiency
EELS	Electron Energy Loss Spectroscopy
EERE	Energy Efficiency and Renewable Energy
EG	Ethylene glycol
EGR	Exhaust Gas Recirculation
EHN	2-ethylhexyl nitrate
EHN	ethyl hexyl nitrate
EHR	Exhaust heat recovery
EIA	Energy Information Administration
EIS	Electrochemical Impedance Spectroscopy
EPA	Environmental Protection Agency
EPR	Electron Paramagnetic Resonance
EPRI	Electric Power Research Institute
ERC	Engine Research Center
EREV	Extended Range Electric Vehicle
ESS	Energy Storage Systems
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
EXAFS	Extended X-ray Absorption Fine Structure
F	Fluorine
FACE	Fuels for Advanced Combustion Engines
FCG	Full concentration gradient
FCTO	Fuel Cell Technologies Office
FCV	Fuel cell vehicle
FE	Fuel Economy
Fe	Iron
FE	Fuel Efficiency
FE	Finite Element
FEA	Finite Element Analysis
FEC	Fluorinated ethylene carbonate
FFV	Flex-fuel vehicles
FGM	Flamelet generated manifold

Acronym	Definition
FHWA	Federal Highway Administration
FIB	Focused ion beam
FLD	Fluid dynamics
FMEP	Friction mean effective pressure
FOA	Funding Opportunity Announcement
FOT	Field operational test
FSP	Friction Stir Processing
FST	Filter sensing technologies
FSW	Friction Stir Welding
FTIR	Fourier Transform Infrared Spectroscopy
FTMPG	Freight-ton-miles per gallon
FTP	Federal Test Procedure
FY	Fiscal year
GaN	Gallium Nitride
GATE	Graduate Automotive Technology Education
GCEV	Grid-connected electric-drive vehicle
GDCI	Gasoline Direct Compression Engine
GDI	Gasoline direct injection
GDP	Gross domestic product
GE	General Electric
GFR	Glomerular filtration rate
GGE	Gasoline gallon equivalent
GHG	Greenhouse gas
GIS	Geographic Information Systems
GM	General Motors Corporation
GnP	Graphite nano-Platelets
GPF	Gasoline Particulate Filter
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GPU	Graphics Processing Unit
GREET	Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation
GSA	Advanced probing technique
GSF	Generic Speed Form
GTDI	Gasoline Turbocharged Direct Injection
GTI	Gas Technologies Institute
GUI	Graphical user interface
H_2	Hydrogen
HC	Hydrocarbon
HCCI	Homogeneous Charge Compression Ignition
HCMR	High capacity manganese rich
HD	Heavy-duty
HDD	Heavy-Duty diesel
HECC	High efficiency clean combustion

Acronym	Definition
HEDGE	High-Efficiency Dilute Gasoline Engine
HEV	Hybrid electric vehicle
HFET	Highway Fuel Economy Test
HHDDT	Heavy heavy-duty diesel truck
HHV	Hydraulic hybrid vehicle
HIL	Hardware in the Loop
HMI	Human-machine interface
HMN	Heptamethyl nonane (a.k.a. cetane, aka hexadecane)
HOV	High-occupancy vehicle
HPC	High Performance Computing
HPD	High power density
HR	High-resolution
HRR	Heat release rate
HRSXRD	High-resolution Synchrotron X-ray Diffraction
HRTEM	high-resolution transmission electron microscopy
HS	High Strength
HTHS	High-temperature, high shear
HV	High voltage
HVAC	Heating Ventilating and Air Conditioning
HVE	High-voltage fluorinated electrolyte
HVM	High-volume Manufacturing
HWFET	Highway Fuel Economy Driving Schedule
IAV	Ingenieurgesellschaft Auto und Verkehr
ICE	Internal combustion engine
ICME	Integrated Computational Material Engineering
ICT	Institute of Chemical Technology
IE	Ion exchange
IL	Ionic Liquids
IMEP	Indicated Mean Effective Pressure
INL	Idaho National Laboratory
IP	Intellectual Property
IQT	Ignition Quality Tester
IR	Infrared
ISFC	Indicated Specific Fuel Consumption
ISO	International Organization for Standardization
ITE	Indicated Thermal Efficiency
ITS JPO	Intelligent Transportation Systems Joint Program Office
JARI	Japan Automotive Research Institute
JCESR	Joint Center for Energy Storage Research
JCI	Johnson Controls, Inc.
K	Potassium
Kn	Knudsen Number
ksi	Kips per square inch

Acronym	Definition
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
L	Liter
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCCF	Low-cost carbon fiber
LCD	levelized cost of driving
LCO	Lithium Cobalt Oxide
LD	Light-duty
LEESS	Lower-energy energy storage system
LES	Large Eddy Simulation
LEV	Low Emission Vehicle
LFO	Lithium Iron Oxide
LFP	Lithium Iron Phosphate
LFT	Long fiber thermoplastic
Li	Lithium
Li_2MnO_3	Lithiated transition metal oxides
LIB	Lithium Ion Battery
LiBF4	Lithium tetrafluoroborate
LiBOB	Lithium bis(oxalato)borate
LIBS	Laser-induced breakdown spectroscopy
LIC	Lithium ion capacitor
LIF	Laser-induced fluorescence
LII	Laser-Induced Incandescence
Li-ion	Lithium Ion
LiPF6	Effective electrolyte salt for lithium-ion battery
LiPON	Lithium Phosphorous Oxynitride
LiTFSI	Lithium Bis(Trifluoromethanesulfonyl)Imide
LL	Layered lithium
LLC	Layered-layered spinel composite
LLFC	Lean Lifted-Flame Combustion
LLNL	Lawrence Livermore National Laboratory
LMNO	Ni-substituted manganese spinel oxides
LMO	Lithium Manganese Oxide
LMR	Lithium Manganese Rich
LNG	Liquefied natural gas
LNT	Lean NO_x Trap
LPG	Liquefied petroleum gas
LPL	Low-pressure loop
LSPI	Low-speed pre-ignition
LT	Low Temperature
LTC	Low-temperature combustion

Acronym	Definition
LTGC	Low Temperature Gasoline Combustion
MBC	Model based controls
MCE	Multi-cylinder engine
MD	Medium-duty
MECA	Manufacturers of Emission Controls Association
Mg	Magnesium
MGOe	Megagauss-oersteds
MIT	Massachusetts Institute of Technology
mJ	Milijoule
mL	milliliters
MLCC	Multilayer ceramic capacitor
MMV	Multi-material vehicle
MMV	Mapping, modeling and visualization
Mn	Manganese
MOU	Memorandum of Understanding
MOVES	Motor Vehicle Emissions Simulator
MPa	Megapascal
MPG	Miles per gallon
MPGe	Miles per gallon-electric
MPGe	Miles per gallon equivalent
MPO	Metropolitan Planning Organization
ms	Milliseconds
MSU	Michigan State University
MTBE	methyl tertiary butyl ether
MTNW	Measurement Technology Northwest
MTU	Michigan Technological University
N_2	Nitrogen
N_2O	Nitrous Oxide
NA	Naturally aspirated
Na	Sodium
NAFTC	National Alternative Fuels Training Consortium
NaOH	Sodium hydroxide
NASA	National Aeronautics and Space Administration
NASEO	National Association of State Energy Officials
NCA	Battery cathode material (nickel cobalt aluminum oxide)
NCM	Nickel Cobalt Manganese
Nd	Neodymium
Nd	Neodymium
NDE	Non-destructive evaluation
NDT	Non-Destructive Testing
NERSC	National Energy Research Scientific Computing Center
NF	Nanofiber
NFPA	National Fire Protection Association

Acronym	Definition
NG	Natural gas
NGV	Natural gas vehicles
NH_3	Ammonia
NHTSA	National Highway Traffic Safety Administration
Ni	Nickel
NiMH	Nickel-metal hydride
NIST	National Institute of Standards and Technology
NMC	Nickel Manganese Cobalt oxide
NMOG	Non-methane organic gases
NMP	N-Methylpyrrolidone
NMR	Nuclear Magnetic Resonance
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NOx	nitrogen oxides
NP	Nail penetration
NPV	Net present value
NREL	National Renewable Energy Laboratory
NSC	NO_x Storage Catalyst
NSF	National Science Foundation
NSR	NO_x Storage Reduction
NTC	Negative temperature coefficient
NTRC	National Transportation Research Center
NVO	Negative Valve Overlap
NYSERDA	New York State Energy Research and Development Authority
O_2	Oxygen
OAS	Open architecture standard
OBD	On-Board Diagnostics
OBD	On-board diagnostics
OEM	Original Equipment Manufacturer
OH	Hydroxide
ORC	Organic Rankine Cycle
ORNL	Oak Ridge National Laboratory
OSC	Oxygen storage capacity
OSU	Ohio State University
P	Phosphorous
P3NGV	Pennsylvania Partnership to Promote Natural Gas Vehicles
PA	Polyanhydride
PACCAR	Commercial Vehicle Manufacturer (Kenworth, Peterbilt, DAF)
PAG	polyalkylene glycol
PAH	Polycyclic aromatic hydrocarbon
PAN	Polyacrylonitrile
PCA	Principal component analysis

Acronym	Definition
PCCI	Premixed Charge Compression Ignition
PCM	Phase change material
PDT	Pulse discharge technique
PERC	Propane Education and Research Council
PEV	Plug-in electric vehicle
PFI	Port Fuel Injection
PFS	Partial fuel stratification
PGM	Platinum group metal
PHEV	Plug-in Hybrid Electric Vehicle
PHS	Press-hardened steel
PI	Principal Investigator
PLZT	Lead Zirconium Titanate
PM	Particulate matter
PM	Permanent magnet
PMP	Pontryagin Minimization Principle
PN	Particulate number
PNA	Passive NOx adsorber
PNNL	Pacific Northwest National Laboratory
POD	Proper orthogonal decomposition
PP	Polypropylene
PPC	Partially premixed combustion
ppm	Part per million
PRC	People’s Republic of China
Pt	Platinum
PTO	Power take-off
PVDF	Polyvinylidene difluoride
PWM	Pulse width modulation
PZT	Lead Zirconate Titanate
Q&A	Question and Answer
QC	Quality Control
R&D	Research and development
RANS	Reynolds-Averaged Navier Strokes
RCCI	Reactivity controlled compression ignition
RCM	Rapid compression machines
RE	Rare Earth
RF	Radio frequency
RFS	Renewable Fuel Standard
ROI	Return on investment
ROM	Reduced-Order Models
RON	Research octane number
RPM	Rotations Per Minute
RSP	Renewable super premium
Ru	Ruthenium

Acronym	Definition
S	Sulfur
SACI	Spark assisted compression ignition
SAE	Society of Automotive Engineers
Sb	Antimony
SCAQMD	South Coast Air Quality Management District
SCE	Single cylinder engine
SCR	Selective Catalytic Reduction
SCRF	Selective catalytic reduction on filters
SDAS	Secondary dendrite arm spacing
SDO	Standards definition organizations
SEI	Solid Electrolyte Interface
SEM	Scanning electron microscope
SEM	Scanning Electron Microscope
SFG	Sum frequency generation
SGIP	Smart Grid Interoperability Panel
Si	Silicon
SI	Spark Ignition
SiC	Silicon Carbon
SIDI	Spark-ignition direct-injection
SIMS	Secondary-ion mass spectrometry
SIP	State Implementation Plan
SMC	Sheet Molding Compound
Sn	Tin
SNL	Sandia National Laboratories
SOC	State of Charge
SPR	Surface Plasmon Resonance
STEM	Scanning transmission electron microscopy
SULEV	Super Low-Emission Vehicle
SUV	Sport utility vehicle
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TARDEC	U.S. Army Tank and Automotive Research, Development and Engineering Center
TBE	Turbo-back exhaust
TCO	Total cost of ownership
TCR	Thermochemical recuperation
TDC	Top dead center
TE	Thermoelectric
TEDB	Transportation Energy Data Book
TEG	Thermoelectric Generator
TEM	Transmission Electron Microscope
Ti	Titanium
TIM	Thermal interface materials
TM	Transition Metal
TMA	Tri Methyl Aluminum

Acronym	Definition
TMS	The Minerals, Metals, and Materials Society
TPGME	tri-propylene glycol methyl ether
TRACC	Transportation Research and Analysis Commuting Center
TRD	Transmission radiation detector
TWB	Tailor Welded Blanks
TWC	Three-Way Catalyst
TXM	Transmission x-ray microscope
UAB	University of Alabama at Birmingham
UC	University of California
UConn	University of Connecticut
UDDS	Urban Dynamometer Driving Schedule
UHC	Unburned hydrocarbons
UHP	Ultra high purity
UM	University of Michigan
UMTRI	University of Michigan Transportation Research Institute
US DRIVE	U.S. Driving Research and Innovation for Vehicle Efficiency and Energy sustainability
USABC	US Advanced Battery Consortium
USCAR	U.S. Council for Automotive Research
UTS	Ultimate tensile strength
UW	University of Wisconsin
UWM	University of Wisconsin-Milwaukee
V	Volt
V2G	Vehicle-to-Grid
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VC	Vinylene Carbonate
VCR	Variable compression ratio
VCT	Variable camshaft timing
VI	Viscosity index
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle miles traveled
VSS	Vehicle & System Simulation
VSST	Vehicle systems safety technology
VTMR	Vehicle Technologies Market Report
VTMS	Vehicle thermal management system
VTO	Vehicle Technologies Office
VUV	Vacuum ultraviolet
VVA	Variable Valve Actuation
WBG	Wide Bandgap
WHR	Waste Heat Recovery
WOT	Wide-open throttle
WPT	Wireless Power Transfer
WSU	Washington State University

Acronym	Definition
XAFS	X-ray absorption fine structure
XANES	X-ray Absorption Near Edge Spectroscopy
XAS	X-ray Absorption Spectroscopy
XPS	X-ray photoelectron spectroscopy
XRD	X-ray Diffraction (Crystallography)
XRF	X-ray Fluorescence
ZDDP	zinc dialkyl-dithio-phosphate
Zn	Zinc
Zr	Zirconium
ZT	Thermoelectric Figure of Merit

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11. Cross Reference

Cross Reference, Sorted by Project Investigator

Page Number *Principal Investigator, Organization. Project Title (Session)*

Page Number	*Principal Investigator, Organization. Project Title (Session)*

Cross Reference, Sorted by Organization

Page Number *Organization, Principal Investigator. Project Title (Session)*

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Page Number	*Organization, Principal Investigator. Project Title (Session)*
1-23	Peterbilt; Ken Damon. Technology and System Level Demonstration of Highly Efficient and Clean, Diesel Powered Class 8 Trucks (Vehicle & System Simulation)
1-78	PPG; Peter Votruba-Drzal. A Materials Approach to Fuel-Efficient Tires (Vehicle & System Simulation)
4-197	Robert Bosch; Claus Schnabel. Intake Air Oxygen Sensor (Advanced Combustion)
4-128	Robert Bosch; Hakan Yilmaz. Advanced Combustion Concepts - Enabling Systems and Solutions (ACCESS) for High Efficiency Light Duty Vehicles (Advanced Combustion)
2-191	Sandia National Laboratories; Christopher Orendorff. Battery Safety Testing (Energy Storage)
2-20	Sandia National Laboratories; Christopher Orendorff. Impact of Materials on Abuse Response (Energy Storage)
5-15	Sandia National Laboratories; Chuck Mueller. Fuel Effects on Mixing-Controlled Combustion Strategies for High-Efficiency Clean-Combustion Engines (Fuels Technologies)
2-177	Sandia National Laboratories; Harry Moffat. Coupled Hierarchical Models for Thermal, Mechanical, Electrical and Electrochemical Processes (Energy Storage)
4-29	Sandia National Laboratories; Isaac Ekoto. Automotive Low Temperature Gasoline Combustion Engine Research (Advanced Combustion)
4-34	Sandia National Laboratories; Joe Oefelein. Large Eddy Simulation (LES) Applied to Advanced Engine Combustion Research (Advanced Combustion)
4-20	Sandia National Laboratories; John Dec. HCCI and Stratified-Charge CI Engine Combustion Research (Advanced Combustion)
4-25	Sandia National Laboratories; Lyle Pickett. Spray Combustion Cross-Cut Engine Research (Advanced Combustion)
5-19	Sandia National Laboratories; Magnus Sjoberg. Advanced Lean-Burn DI Spark Ignition Fuels Research (Fuels Technologies)
4-10	Sandia National Laboratories; Mark Musculus. Heavy-Duty Low-Temperature and Diesel Combustion & Heavy-Duty Combustion Modeling (Advanced Combustion)
4-16	Sandia National Laboratories; Paul Miles. Light-Duty Diesel Combustion (Advanced Combustion)
1-117	SCAQMD; Brian Choe. Zero Emission Heavy Duty Drayage Truck Demonstration (Vehicle & System Simulation)
1-26	SCAQMD; Matt Myasato. SCAQMD:Plug-In Hybrid Electric Medium-Duty Commercial Fleet Demonstration and Evaluation (Vehicle & System Simulation)
2-89	Seeo; Hany Eitouni. High-Voltage Solid Polymer Batteries for Electric Drive Vehicles (Energy Storage)
3-61	Sigma Technologies International; Angelo Yializis. High Temperature DC-Bus Capacitors Cost Reduction and Performance Improvements (Advanced Power Electronics)
1-16	Smith Electric Vehicles; Robin Mackie. Smith Electric Vehicles: Advanced Vehicle Electrification + Transportation Sector Electrification (Vehicle & System Simulation)

12. Project and Program Statistics Calculations Overview

A numerical evaluation of each project within each subprogram area and a comparison to the other projects within the subprogram area necessitates a statistical comparison of the projects utilizing specific criteria. For each project, a representative set of experts in the project's field were selected to evaluate the project based upon the criteria indicated in the Introduction. Each evaluation criterion's sample mean and variance were calculated utilizing the following formulas respectively:

$$\bar{x}_{j,k} = \frac{1}{n}\sum_{i=1}^{n} x_{i,j,k}$$

$$s^2_{\bar{x}_{j,k}} = \frac{1}{(n-1)}\sum_{i=1}^{n}\left(x_{i,j,k} - \bar{x}_{j,k}\right)^2$$

where $x_{i,j,k}$ is an individual reviewer's score for that criterion and n is the number of reviewers for the given project who answered the question[3]. The index i represents an index over the reviewers assigned for the project; the index j represents an index over the projects in that specific subprogram area; the index k represents an index over the questions asked. The sample mean for each project criterion is represented in the graph by their respective bar graph value. These calculations were performed for the numeric values supplied by the reviewers for questions one through four (those questions indicated with weight values in the Introduction).

The above values $\bar{x}_{j,k}$ and $s^2_{\bar{x}_{j,k}}$ can be used to extend the evaluation to the entire subprogram. In order to calculate the variance of each subprogram criterion, the sample variances must be propagated to the calculated variance of each subprogram criterion score. The subprogram area mean and variance for each evaluation criterion are then calculated as follows:

$$\bar{X}_k = \frac{1}{m}\sum_{j=1}^{m} \bar{x}_{j,k}$$

$$Var(\bar{X}_k) = \sigma^2_{\bar{X}_k} + \frac{1}{m^2}\sum_{j=1}^{m} s^2_{\bar{x}_{j,k}} = \frac{1}{m}\sum_{j=1}^{m} \bar{x}^2_{j,k} - (\bar{X}_k)^2 + \frac{1}{m^2}\sum_{j=1}^{m} s^2_{\bar{x}_{j,k}}$$

where m is the number of projects in a subprogram area. This method of calculation allows each project to weigh evenly on each evaluation criterion of the subprogram area. The criteria means and average of the project variances values for each subprogram area (e.g., Hybrid and Vehicle Systems Technologies, Advanced Combustion Engine Technologies, Technology Integration, etc.) are represented on each project graph as the Program Area Average bullets and the red error bar ranges, respectively, for each question. In some sense, the red error bars provide a range by which projects can be evaluated by their criteria with respect to an entire subprogram area's performance. The error bar calculation was changed from the 2011 Annual Merit Review report where the expectation of the sample error was the value calculated for the error bars. This change was made so that the error bar provides a more relevant comparison for the criteria measurements of the projects to the subprogram averages.

Each question's score is assumed to be independent of the others for a given project (that is, for example, the question of the quality of the future research should have no bearing on the current accomplishments). Each project's weighted average score can then be calculated as follows[4]:

[3] If all of the reviewers do not answer all of the questions, the value of n will be different for some questions for a project.

[4] There is no need to calculate a variance for this value since it is not displayed, and it has no bearing on any future calculated value in the analysis.

$$\bar{x}_j = \frac{\sum_{k=2}^{5} w_k * \bar{x}_{j,k}}{\sum_{k=2}^{5} w_k}$$

where w_k is the weight that question k has on the overall score of the j^{th} project average $\bar{x}_j$. The value above, $\bar{x}_j$, is indicated in the graphics by the Weighted Average bar. As was done for each individual project, each question's score is assumed to be independent of the others for a given subprogram. Each subprogram's weighted average score and weighted variance can then be calculated as follows:

$$\bar{X} = \frac{\sum_{k=2}^{5} w_k * \bar{X}_k}{\sum_{k=2}^{5} w_k}$$

$$Var(\bar{X}) = \frac{\sum_{k=2}^{5} w_k^2 * Var(\bar{X}_k)}{\sum_{k=2}^{5} w_k^2}$$

These values represent the Program Area Average bullet and its red error bar in the Weighted Average column.

The answers to questions five and six are represented by pie charts below the combination bar/bullet graph.

Appendix A: Merit Review Attendees

Name	Affiliation
Rene Abarcar	Energetics Incorporated
Tarek Abdel-Baset	Tarek
Ali Abouimrane	Argonne National Laboratory
Daniel Abraham	Argonne National Laboratory
Daniel Abraham	OneD Material LLC
Judi Abraham	Conference Management Assoc.
Maria Abreu-Sepulveda	University of Rochester
Héctor Abruña	Energy Materials Center at Cornell
Salvador Aceves	Lawrence Livermore National Laboratory
Adam Homan	Cooper Tire
Jesse Adams	U.S. Department of Energy
Michael Adams	University of Georgia
Radoslav Adzic	Brookhaven National Laboratory
Kareem Afzal	PDC Machines, Inc
Eduardo Aguilera-Gomez	
Rajesh Ahluwalia	Argonne National Laboratory
Naveed Ahmed	JSR Corporation
Sayeed Ahmed	Infineon
Shabbir Ahmed	Argonne National Laboratory
Channing Ahn	U.S. Department of Energy/Caltech
Sang Hyun Ahn	National Institute of Standard and Technology
Christopher Ainscough	National Renewable Energy Laboratory, on detail to U.S. Department of Energy Fuel Cell Technologies Office
Oyelayo Ajayi	Argonne National Laboratory
Alexey Akimov	Brookhaven National Laboratory
V'Yacheslav Akkerman	Department of Mechanical and Aerospace Engineering, West Virginia University
Mohamed Alamgir	LG CHEM POWER
Fabio Albano	XALT Energy LLC
Tracy Albers	GrafTech International Holdings Inc.
Jay Albert	GE Global Research Oil & Gas Technology Center
Mark Alexander	Electric Power Research Institute
James Alkire	U.S. Department of Energy
Lawrence Allard	UT-Battelle LLC
Glenn Allen	US Hybrid Corp.
Jan Allen	U.S. Army Research Laboratory
Jeffrey Allen	Michigan Tech
Joshua Allen	Army Research Laboratory
John Allison	University of Michigan
Thomas Allison	National Institute of Standards and Technology

Name	Affiliation
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Pascal Amar	Volvo Group North America
Ruhul Amin	Massachusetts Institute of Technology
Khalil Amine	Argonne National Laboratory
Ramin Amin-Sanayei	Arkema
Amy Anderson	Oak Ridge Associated Universities
David Anderson	Vehicle Technologies Office
Iver Anderson	Ames Laboratory
Michele Anderson	Office of Naval Research
Morgan Andreae	Cummins
John Andresakis	Oak-Mitsui Technologies
Younes Ansari	The University of Texas at Austin
Joel Anstrom	Penn State University
Donald Anton	Savannah River National Labs
Laurent Antoni	CEA Liten
George Antos	National Science Foundation
Koorosh Araghi	National Aeronautics and Space Administration Energy Conversion System
Michel Archambault	Hydrogenics Corp
Brett Aristegui	U.S. Department of Energy
Neal Armstrong	University of Arizona
Cheryl Arnold	LNE Group
John Arnold	Miltec UV
David Arthur	U.S. Department of Transportation, Volpe National Transportation Systems Center
Samuel Arthur	E.I.DuPont de Nemours & Co, Inc
Kateryna Artyushkova	University of New Mexico
Haleema Asiri	King Abdullah City for Atomic and Renewable Energy
Alex Askari	Naval Surface Warfare Center
Mirela Atanasiu	Fuel Cells and Hydrogen Joint Undertaking of the European Commission
Lance Atkins	Nissan Technical Center North America
Pradeep Attibele	Fiat Chrysler Automobiles
Tom Autrey	Pacific Northwest National Laboratory
Tom Avedisian	Cornell University
Michelle Avillanoza	New West Technologies, LLC
David Avison	Madico, Inc
Abdul Awal	Cooper Tire
Katherine Ayers	Proton OnSite
Michael Aziz	Harvard University
Kristine Babick	

Name	Affiliation
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Byungchan Bae	Korea Institute of Energy Researcher
Chulsung Bae	Rensselaer Polytechnic Institute
In Tae Bae	Duracell Technical Center, Procter & Gamble
Jianming Bai	Brookhaven National Laboratory
Adam Bailey	SAE International
Lauren Bailey	National Automobile Dealers Association
Seongmin Bak	Brookhaven National Laboratory
Andrew Baker	University of Delaware
Balu Balachandran	Argonne National Laboratory
Uzmaa Balbale	National Highway Traffic Safety Administration
Perla Balbuena	Texas A&M University
Donald Baldwin	Hexagon Lincoln
Viktor Balema	Sigma-Aldrich Corp. LLC
Nitash Balsara	Lawrence Berkeley National Laboratory
Chunmei Ban	National Renewable Energy Laboratory
James Banas	JSR Micro Inc
Jai Bansal	Argonne National Laboratory
Suresh Bansal	HEV Technology Center
Christian Barba	Robert Bosch
Julie Barber	Oak Ridge Associated Universities
Nicholas Barbosa	National Institute of Standards and Technology
Ewa Bardasz	Energetics Incorporated
Javier Bareno	Argonne National Laboratory
Eric Baril	National Research Council Canada - Automotive and Surface Transportation
Nick Barilo	Pacific Northwest National Laboratory
James Barnes	Vehicle Technologies Office
Ted Barnes	Gas Technology Institute (GTI)
Brian Barnett	TIAX LLC
Garrett Barter	Sandia National Laboratories
Robert Bartolo	Department of Electrical and Computer Engineering
Doug Bathauer	Integral Technologies
Ailene Batoon	New West Technologies, LLC
Vincent Battaglia	Lawrence Berkeley National Laboratory
Olga Baturina	Naval Research Laboratory
Shannon Baxter	South Carolina Hydrogen and Fuel Cell Alliance
Tim Bays	Pacific Northwest National Laboratory
Abdullah Bazzi	Fiat Chrysler Automobiles
Alexandre Beaudet	Hinicio
Rich Bechtold	ATS
Collin Becker	Army Research Laboratory
Mike Beckman	Linde LLC
Noriko Behling	

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Mark Belchuk	Freudenberg-NOK Sealing Technologies
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Elisabeth Berger	General Motors R&D
Michael Bergin	WERC
John Bertaux	International Rectifier
Norman Bessette	Acumentrics Corporation
Marc Bétournay	Government of Canada
Daniel Betts	Be Power Tech, LLC
Joze Bevk	Harvard University
Connie Bezanson	Vehicle Technologies Office
Jacquelyn Birdsall	Toyota Motor Engineering and Manufacturing NA
Sandra Birk	Idaho National Laboratory
Alicia Birky	TA Engineering, Inc
Steven Bishel	U.S. Army Tank Automotive Research Development Engineering Center
Mauricio Blanco	Ballard Power Systems
James Blatchford	SAFE
David Blekhman	California State University Los Angeles
Richard Blint	N2Kinetics Research, LLC
Gus Block	Nuvera Fuel Cells
George Blomgren	Blomgren Consulting Services Ltd.
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Cary Bloyd	Pacific Northwest National Laboratory
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Kelly Bobek	Volvo Group North America
André Boehman	University of Michigan Department of Mechanical Engineering
Eric Boettcher	Honda R&D Americas, Inc
Richard Bogacz	New West Technologies, LLC
Theodore Bohn	Argonne National Laboratory
Kevin Bolon	U.S. Environmental Protection Agency
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Phillip Bonkoski	IAV Automotive Engineering
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Oleg Borodin	

Name	Affiliation
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Mark Bowden	Pacific Northwest National Laboratory
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Greg Bowman	Cooper Tire
Mark Bowman	PPG Industries
Robert Bowman	Oak Ridge National Laboratory
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Steven Boyd	U.S. Department of Energy
Brad Boyer	Powertrain Research
Brian Bratvold	John Deere
Damian Breen	Bay Area Air Quality Management District
Leo Breton	Vehicle Technologies Office
John Brewer	U.S. Department of Transportation Volpe National Transportation Systems Center
Rasto Brezny	Manufacturers of Emission Controls Association
Andrew Brink	Fibers and Composites Business Unit
Michael Britt	UPS
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Eric Brosha	Los Alamos National Laboratory
Jacob Brouwer	National Fuel Cell Research Center
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Craig Brown	National Institute of Standards and Technology Center for Neutron Research
Daryl Brown	Pacific Northwest National Laboratory
Katherine Brown	National Renewable Energy Laboratory
Fikile Brushett	Massachusetts Institute of Technology
Matthew Brusstar	U.S. Environmental Protection Agency National Vehicle and Fuel Emissions Laboratory
Giovanna Bucci	Massachusetts Institute of Technology
Norman Bucknor	General Motors Company
Geoffrey Budd	ITM-Power
Ratnakumar Bugga	Jet Propulsion Laboratory
Cullen Buie	Massachusetts Institute of Technology
Michael Bunce	MAHLE Powertrain
Emilio Bunel	Argonne National Laboratory
Bunnelle	ExxonMobil

Name	Affiliation
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Robert Burgess	National Renewable Energy Laboratory
John Burgman	PPG Industries
Albert Burgunder	Praxair, Inc
Kenneth Burke	National Aeronautics and Space Administration Glenn Research Center
Cory Burns	
Pamela Burns	North Central Texas Council of Governments
Anthony Burrell	Argonne National Laboratory
Tim Burress	Oak Ridge National Laboratory
F. Colin Busby	W. L. Gore & Associates
Hanno Butsch	NOW
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Stephanie Byham	SRA International
Dawson Cagle	Booz Allen Hamilton
Mei Cai	General Motors
Julie Cairns	CSA Group
Scott Calabrese Barton	Michigan State University
Marissa Caldwell	Wildcat Discovery Technologies
Christopher Campbell	Coalition for Environmental Protection, Restoration and Development
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