6. Grid and Infrastructure

The Vehicle Technologies Office (VTO) supports early-stage research and development (R&D) to generate knowledge upon which industry can develop and deploy innovative energy technologies for the efficient and secure transportation of people and goods across America. VTO focuses on research that industry either does not have the technical capability to undertake or is too far from market realization to merit sufficient industry focus and critical mass. In addition, VTO leverages the unique capabilities and world-class expertise of the national laboratory system to develop new innovations for significant energy-efficiency improvement. VTO is also uniquely positioned to address early-stage challenges due to its strategic public-private research partnerships with industry (e.g., U.S. DRIVE and 21st Century Truck Partnerships) that leverage relevant technical and market expertise, prevent duplication, ensure public funding remains focused on the most critical R&D barriers that are the proper role of government, and accelerate progress—at no cost to the Government.

The Grid and Infrastructure (GI) subprogram identifies systems pathways and conducts research to develop and harmonize a robust, interoperable electric vehicle (EV) charging and grid infrastructure that incorporates advanced charging technologies and distributed energy resources. The GI subprogram includes four focus areas. EV/Electric Vehicle Supply Equipment (EVSE)/Grid Interoperability and Control efforts focus on technologies and tools to enable seamless interoperability and control that maximizes charging convenience and minimizes grid impacts. EV Grid Integration and Services R&D identifies system requirements and researches V1G and vehicle-to-grid (V2G) technologies that optimizes vehicle charging efficiency, minimizes systems disruptions, and facilitates integration of distributed energy resources. Extreme Fast-Charging activities identify and assess system requirements and conduct research to enable extreme fast-charging while minimizing grid impacts. Finally, High-Power Static/Dynamic Wireless Charging focuses on conducting feasibility studies and technology R&D of high-power static and dynamic wireless charging to enable additional consumer charging options and greater vehicle autonomy.

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.

Table 6-1 – Project Feedback

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
gi001	Medium- and Heavy-Duty Vehicle Field Evaluations	Kenneth Kelly (NREL)	6-5	3.25	3.25	3.63	3.25	**3.30**
gi029	Advanced Vehicle Testing and Evaluation	Jeremy Diez (Intertek)	6-9	3.50	3.33	3.33	3.33	**3.38**
gi030	Advanced Technology Vehicle Lab Benchmarking (Level 1 and Level 2)	Kevin Stutenberg (ANL)	6-12	3.60	3.60	3.70	2.90	**3.53**
gi095	EV-Smart Grid Research and Interoperability Activities	Keith Hardy (ANL)	6-16	3.30	3.50	3.70	3.30	**3.45**
gi096	Wireless and Conductive Charging Testing to Support Code and Standards	Barney Carlson (INL)	6-20	3.58	3.75	3.67	3.50	**3.67**
gi115	Zero Emission Drayage Truck Demonstration (ZECT I)	Matt Miyasato (SCAQMD)	6-24	3.50	3.13	3.38	3.38	**3.28**
gi116	Hydrogen Fuel-Cell Electric Hybrid Truck and Zero Emission Delivery Vehicle Deployment	Andrew DeCandis (Houston-Galveston Area Council)	6-28	2.33	2.08	2.17	1.92	**2.14**
gi157	UTEMPRA—Unitary Thermal Energy Management for Propulsion Range Augmentation	Sourav Chowdhury (Mahle Behr USA, Inc.)	6-35	3.00	3.00	3.08	2.83	**2.99**

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
gi158	Zero Emission Cargo Transport II: San Pedro Bay Ports Hybrid and Fuel Cell Electric Vehicle Project	Joseph Impullitti (SCAQMD)	6-41	2.88	2.88	2.88	2.50	**2.83**
gi161	Multi-Speed Transmission for Commercial Delivery Medium-Duty Plug-In Electric Drive Vehicles	Bulent Chavdar (Eaton)	6-45	3.50	3.30	3.40	3.20	**3.35**
gi165	Design and Implementation of a Thermal Load Reduction System in a Hyundai PHEV	Cory Kreutzer (NREL)	6-48	3.25	3.08	3.08	3.08	**3.13**
gi187	Comprehensive Assessment of On- and Off-Board Vehicle-to-Grid Technology Performance and Impacts on Battery and the Grid	Sunil Chhaya (EPRI)	6-53	3.00	3.08	3.33	2.83	**3.06**
gi188	Bi-Directional Wireless Power Flow for Medium-Duty Vehicle-Grid Connectivity	Mike Ippoliti (CALSTART)	6-58	2.75	2.50	3.08	2.83	**2.68**
gi189	Electric Truck with Range-Extending Engine (ETREE)	John Kresse (Cummins)	6-62	2.79	3.07	3.00	2.86	**2.96**
gi190	Medium-Duty Urban Range Extended Connected Powertrain (MURECP)	Alexander Freitag (Bosch)	6-69	3.36	3.29	3.64	3.50	**3.38**

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
gi191	Medium-Duty Vehicle Powertrain Electrification and Demonstration	Wiley McCoy (McLaren)	6-73	3.60	3.60	3.80	3.50	**3.61**
gi192	Hybridization of Class 8 Line Haul And Regional Refrigeration Trucks CRADA	Dean Deter (ORNL)	6-78	3.60	3.30	3.30	3.20	**3.36**
Overall Average				**3.19**	**3.14**	**3.29**	**3.04**	**3.16**

Presentation Number: gi001
Presentation Title: Medium- and Heavy-Duty Vehicle Field Evaluations
Principal Investigator: Kenneth Kelly (National Renewable Energy Laboratory)

Presenter
Robert Prohaska, National Renewable Energy Laboratory

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.

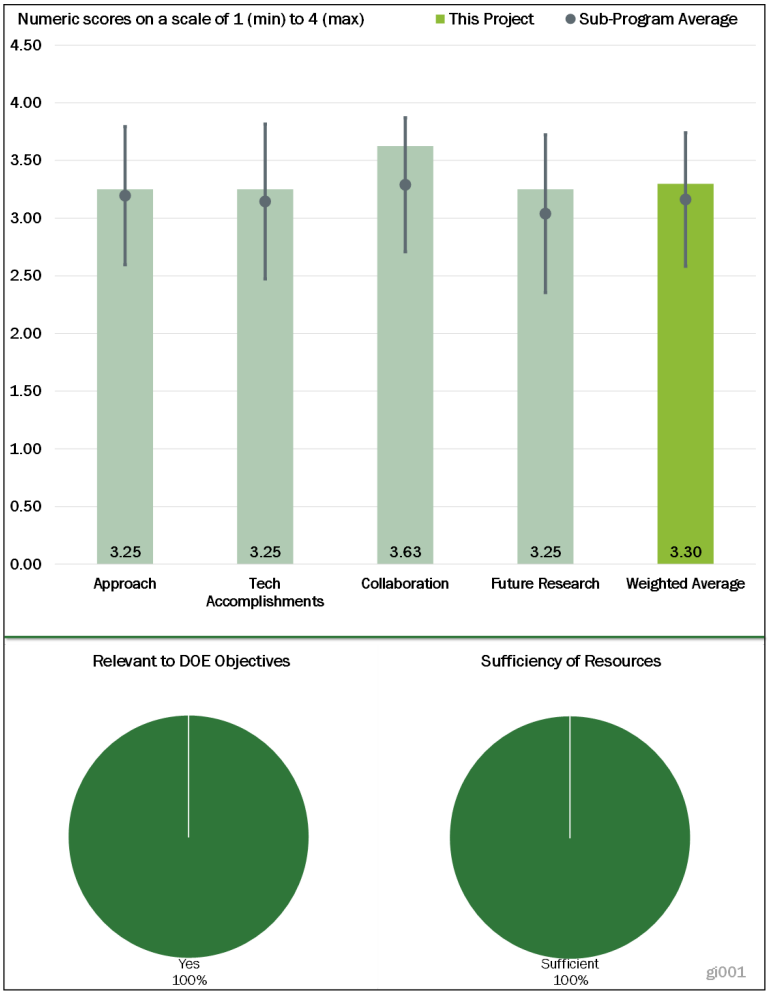

Figure 6-1 - Presentation Number: gi001 Presentation Title: Medium- and Heavy-Duty Vehicle Field Evaluations Principal Investigator: Kenneth Kelly (National Renewable Energy Laboratory)

Reviewer 1:
The reviewer stated that the National Renewable Energy Laboratory (NREL) has consistently addressed a critical advanced vehicle technical barrier of a lack of unbiased data by using real-world examples and robust data collection protocols. The team is approaching the problem with a logical process to identify fleets and vocations and to collect appropriate data for sufficient time periods. Selection criteria for new fleets are very thorough and appropriate, and make good use of limited time and resources to address most important vocations. The reviewer observed a good mix of NREL-collected and original equipment manufacturer (OEM) provided data, and opined that the focus on disseminating information to the community is critical. The team's ability to expand the use of the data set to support funding opportunity announcement (FOA) activities and external work such as U.S. Environmental Protection Agency fuel efficiency regulations maintains the relevance of the data set.

Relative to project selection, it appeared to this reviewer that there has been more of a push for zero emission vehicles and electrified vehicles recently as a result of the general "feel" of the industry and U.S. Department of Energy (DOE) priorities. The reviewer suggested it is important for the team to focus on technologies that show significant fuel efficiency savings and to represent technologies that are of most interest to the community. Additionally, it was clearly understood by the reviewer that the selection process is somewhat subjective.

Reviewer 2:
The reviewer stated this project is a comprehensive demonstration project of advanced powertrains in a variety of applications where the potential for reduced petroleum consumption is pronounced. The previous year's reviewer comment that methods for determining changing payload weight is still relevant and needs to be

addressed. Otherwise, this reviewer opined that the fuel economy data are not all that useful. The reviewer commented that in addition to dynamometer testing, real-world driving emissions (RDE) testing with a portable emissions measurement system (PEMS) unit could be a useful method for understanding both fuel economy and emissions in real-world driving. RDE testing could be used to help quantify differences in fuel economy based on payload weight, and modeling could be used to estimate fleet vehicle payload based on the fuel economy that the vehicles are achieving.

The reviewer said the project team did a good job addressing all the issues in its approach.

Reviewer 3:

The reviewer observed a good project, but it is not well integrated with other efforts. Instead of a straight across-the-board comparison, the reviewer opined that it is a mish-mash comparison of apples and oranges. The reviewer said hybrid-hydraulics are compared with diesels but it is not clear if they are the same size running on the same duty cycle and same route. The reviewer indicated that battery-electric buses (35 foot) are compared with compressed natural gas buses (40 and 42 foot).The reviewer said maintenance costs are a major factor in fleets deciding which alternative fuel vehicle to go with, yet all the data presented was solely on fuel economy or fuel efficiency. The reviewer questioned if the data actually show that there is less wear and tear on brakes and tires with hybrids. The reviewer also questioned how hybrid-hydraulic refuse trucks compare with electric-battery refuse trucks or natural gas refuse trucks. The reviewer suggested that all these alternative fuel trucks and buses should be compared against one standard (e.g., diesel).

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

Reviewer 1:

The reviewer said the project team has demonstrated an extensive set of very detailed advanced vehicle characteristics that expand the understanding of how these vehicles perform in real-world service and how fleets are using these vehicles, including how the vehicles are generally used. The reviewer noted the Miami-Dade work included some independent verification of the manufacturer fuel efficiency improvement claims for the hydraulic hybrid system and this independent assessment is a very important aspect of the project. The reviewer stated the team is showing its results in ways that are very visual and demonstrate major findings. The creative use of existing data channels to derive fueling maps that illustrate conventional and hybrid vehicle engine operation is helping inform future research. The reviewer indicated it is important to collect maintenance data for the advanced vehicles that are in use as there may be benefits or drawbacks from a cost standpoint here.

The reviewer said the Foothill Transit work includes very detailed route and drive cycle analysis that shows the benefit of an extensive data collection activity. The team has demonstrated several interesting data interactions here (e.g., acceleration rates versus number of stops to highlight how different vehicle types are used differently). The reviewer opined that creativity of the team in analyzing the data sets and picking these data cross-references is essential to success.

The reviewer said the V2G school bus project is helpful as it is addressing areas of interest to many people in the industry, specifically the potential for electric-drive school buses and the opportunity for V2G services to increase the business case value for these vehicles. The reviewer indicated it is good to see the data being used to support an ongoing FOA award with Blue Bird to leverage DOE funding.

Reviewer 2:

The reviewer stated the project progress appears to be on schedule despite having multiple deployments and fleets to monitor. The tasks beginning in Fiscal Year (FY) 2017 should be able to be completed in FY 2018.

Reviewer 3:
The reviewer noted the goals were all addressed and progress is acceptable.

Reviewer 4:
The reviewer commented that fuel savings have been shown, but as previously indicated, fleets make choices based on total life-cycle costs rather than just fuel. The reviewer explained that life cycle costs include maintenance and operations, and these must be considered. The reviewer pointed out that nothing on maintenance costs was presented.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated this project would be impossible without collaborators and the project team has the right ones. The project team showed an extensive list of collaborators that covered the range from participation with vehicles and data to direct funds-in for activities. The reviewer commented that in a project such as this, which has applicability beyond the VTO, research work should include external collaborators; the project team has done so. The funding from several California agencies is important to include as these agencies are very involved in deploying and testing these vehicles. There is opportunity for getting this data into the broader fleet DNA database. The reviewer noted the industry participation is a testament to the trust that these organizations have in the project team for collecting and protecting data while reporting useful results.

Reviewer 2:
The reviewer opined that the collaborations are the strength of this project. The various consortia indicate strong industry representation. The reviewer commented that collaborations with academia could allow for more extensive modeling and analysis and could strengthen the outcomes of this project.

Reviewer 3:
The reviewer stated the project team has all the correct players to be successful on this project's goals.

Reviewer 4:
The reviewer noted that battery suppliers and other energy storage system (ESS) providers are not included in the collaboration and coordination.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 plan appears feasible and significant challenges have been identified. The reviewer remarked the overall project outcome should include as much overarching conclusions on the various technologies, including cross-comparisons, as possible, in order to inform future projects that will use these conclusions in developing proposals.

Reviewer 2:
The reviewer stated it looks like the project team covered all contingencies for future research.

Reviewer 3:
The reviewer noted the team has picked an interesting set of future vehicles to study, but pointed out that they are all electric drive. The reviewer suggested it may be useful to consider other vehicle types, and offered that there may be an opportunity to examine trucks with SuperTruck technologies and determine the real-world fuel efficiency improvements to connect back to DOE VTO R&D. The reviewer noted the results of the off-cycle

fuel savings from the plug-in hybrid electric vehicle (PHEV) bucket truck will be interesting as this is the area where this technology should demonstrate benefits.

Reviewer 4:
The reviewer commented that future work needs to include collection of maintenance cost data, mean time (or miles) between failures due to alternative fuel technology, and information on the duty cycle. The reviewer pointed that use of alternative fuel for power take-off (e.g., in automobile carriers, booms, bucket trucks, cherry-pickers, etc.) needs to be considered separately and that fuel economy (miles per gallon [mpg]) or fuel efficiency are completely inappropriate measurement tools.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer remarked that data collection and analysis products directly support DOE objectives for petroleum displacement. This occurs through assisting fleets in making decisions about new technology deployments and refinement of upcoming technologies via work with external partners on FOA awards.

Reviewer 2:
The reviewer noted deployment projects are always useful to obtain real-world data on usage and performance. The variety of technologies incorporated into this project is laudable and the outcomes should provide meaningful insight into these technologies.

Reviewer 3:
The reviewer asserted that improving MPG and idle reduction are addressed.

Reviewer 4:
The reviewer remarked it is important to ascertain how much petroleum is displaced by alternative 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 observed that the project team has developed a robust data collection protocol, a systematic approach for identifying and working with partners, and a set of tools that allow for storage and analysis of data collected. Because of this groundwork, the reviewer indicated that resources identified for ongoing activities appeared to be sufficient to achieve stated goals.

Reviewer 2:
The reviewer stated the resources appear to be sufficient for this project. The industry partners provide significant cost share; this is another project strength in leveraging industry resources while also helping the project team develop novel technologies.

Reviewer 3:
The reviewer indicated that all the resources appear to work well.

Reviewer 4:
The reviewer commented that the resources may be slightly excessive and was generous in marking that they are sufficient. The reviewer explained that for this kind of money, a larger sample size and more data on maintenance costs would have been expected.

Presentation Number: gi029
Presentation Title: Advanced Vehicle Testing and Evaluation
Principal Investigator: Jeremy Diez (Intertek)

Presenter
Jeremy Diez, Intertek

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 noted this project attempts to gather data and performance trends for advanced technology vehicles and their fueling infrastructure. In such, multi-vehicle and real-world fleet information is necessary to support the data collection. The reviewer indicated this project has well defined objectives and appears to be successful thus far in completing its goals.

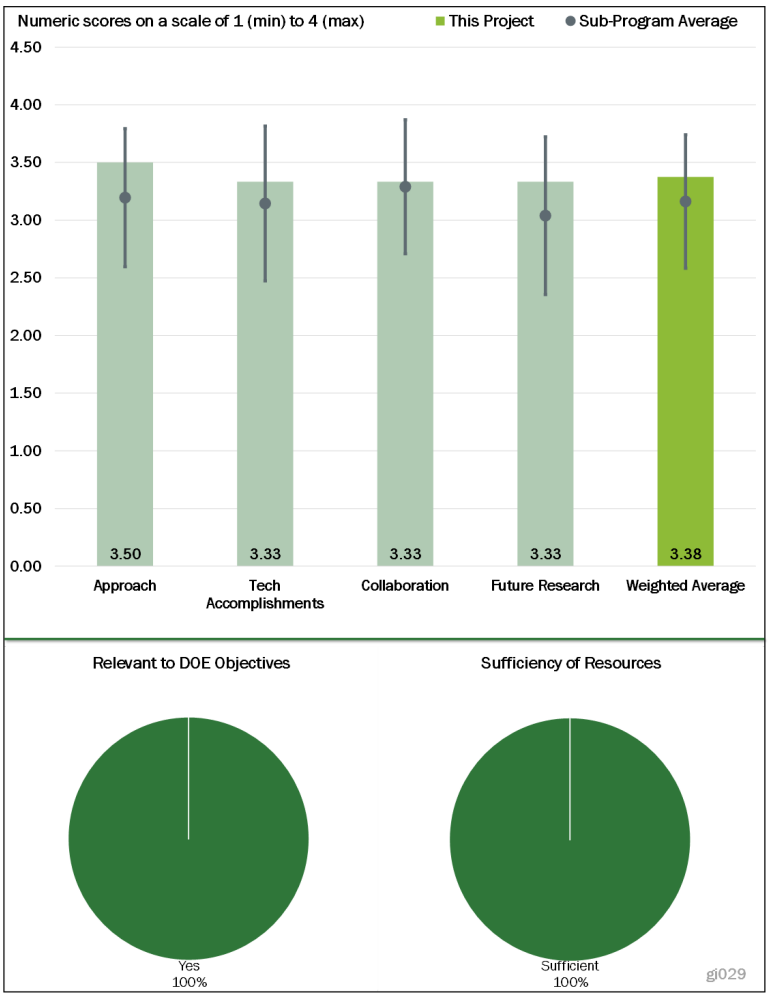

Figure 6-2 - Presentation Number: gi029 Presentation Title: Advanced Vehicle Testing and Evaluation Principal Investigator: Jeremy Diez (Intertek)

Reviewer 2:
The reviewer remarked the project needs a certain number of identical vehicles of a type in the fleet to produce enough data to make analysis meaningful. With the recent inadequate levels of funding, which allowed for one vehicle purchased in 2016, this is apparently less and less likely to occur. The reviewer stated that the de-emphasis and lack of support by top-level DOE leadership of this type of vehicle testing also would seem to make it difficult to continue even if alternative sources of vehicles can be developed (e.g., OEM donations).

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

Reviewer 1:
The reviewer said that given the resources available, technical progress has been very good. Fleet results were able to confirm engineering hunches (e.g., poor performance of non-liquid cooled electric vehicle (EV) batteries in a hot environment) as well as surfacing other issues. The reviewer noted that the data collected is useful to the public generally and to the OEMs for certain studies for which data collection is not extensive enough (e.g., real-world driving accessory load data).

Reviewer 2:
The reviewer indicated that per a prior comment, this program appears to be meeting the defined objectives and is gathering quality data for analysis.

Reviewer 3:
The reviewer noted that some of the evaluated vehicles (smart vehicles) include additional smart charge communication features. If evaluated, these features might further support project objectives, particularly those related to charging/maintenance cost evaluation and advanced vehicle charging technologies benchmarking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that collaboration was necessary to execute the work and there was a well-organized and coordinated division of labor between Intertek, Idaho National Laboratory (INL) and Argonne National Laboratory (ANL).

Reviewer 2:
The reviewer stated that collaboration with three separate national laboratories and EZ Messenger is solid in skill diversity and describes each function well. Intertek appears to be somewhat independent at this time in driving the fleet activity

Reviewer 3:
The reviewer suggested to expand project integration to encompass other OEMs with advanced vehicle charging solutions such as higher power. The reviewer suggested adding direct current (DC) EVSE charging equipment from other major vendors to further support the fueling infrastructure benchmark 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 the proposed work is a reasonable attempt to grapple with the changing direction of DOE research and is highly contingent on future funding. It would seem to be imperiled because it does not meet the criteria of work at technology readiness level two or three. The reviewer questioned if non-DOE sources of vehicles and/or funding can be realized, and whether top management will support this work.

Reviewer 2:
The reviewer commented the proposed future work describes the general trends of the technology and is a logical and beneficial next step.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer commented this project supports DOE objectives by identifying performance/areas of improvements in vehicle technology and fueling infrastructure, as well as identifying interoperability issues that could result in a bad customer experience and reduce mass market adoption of new technology.

Reviewer 2:
The reviewer indicated the project is independent confirmation of benefits of advanced technology vehicles. At the same time, the project provides the public detailed information on real-world ownership experience and performance.

Reviewer 3:
The reviewer said though these fleet programs are very grinding in execution, they are necessary to quantifying data which support the overall goals of increased efficiency and electrification.

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 resources are dwindling, but appear sufficient to meet the scaled-back goals.

Reviewer 2:
Though expensive, this reviewer opined that these long-term projects are worth the investment of capital.

Presentation Number: gi030
Presentation Title: Advanced Technology Vehicle Lab Benchmarking (Level 1 and Level 2)
Principal Investigator: Kevin Stutenberg (Argonne National Laboratory)

Presenter
Henning Lohse-Busch, Argonne National Laboratory

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 this project is extremely important as it is the data input to the policy making, modeling and strategic decision-making process. The reviewer commented that when ANL goes through and generates these learnings it informs these folks to make decisions that are based on the actual capabilities and sensitivities of the vehicles.

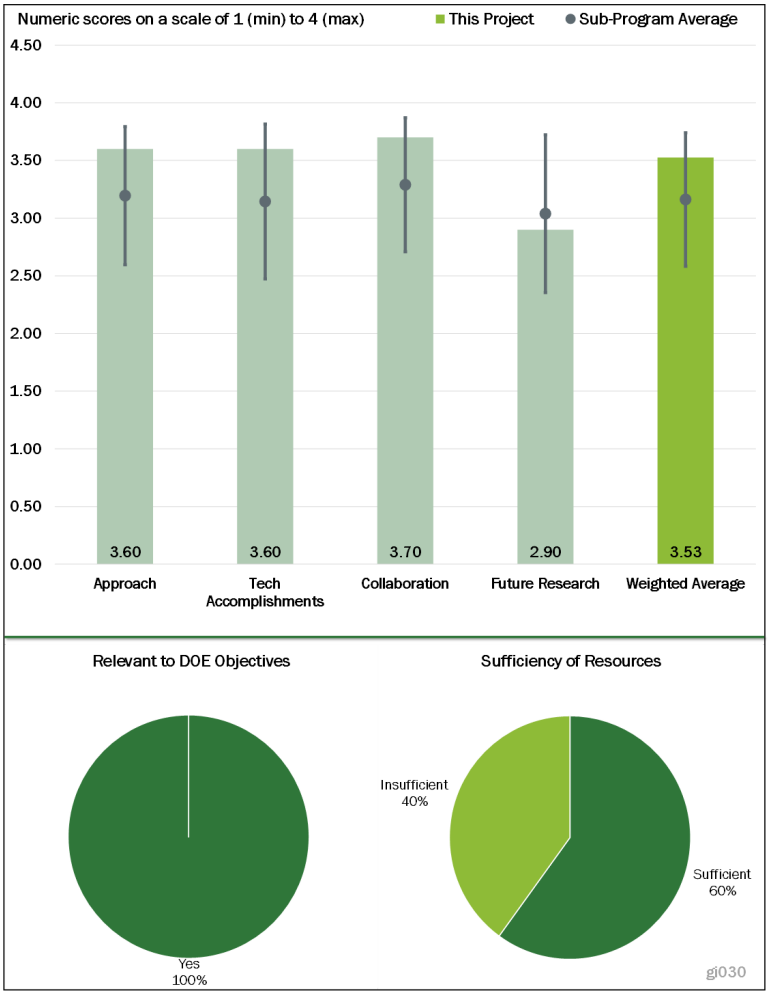

Figure 6-3 - Presentation Number: gi030 Presentation Title: Advanced Technology Vehicle Lab Benchmarking (Level 1 and Level 2) Principal Investigator: Kevin Stutenberg (Argonne National Laboratory)

Reviewer 2:
The reviewer stated the test facility, procedures and staff are well prepared for the task of vehicle benchmarking.

Reviewer 3:
The reviewer has been reviewing the Advanced Vehicle Testing Activity work for quite a few years , and stated the project team at ANL has been very good about incorporating feedback and improving their approach to the extent possible. The reviewer suggested one improvement that could be made is to perhaps track the usage of the Advanced Powertrain Research Facility (APRF) data more carefully to quantify the benefits in some fashion along the lines of the NREL Transportation Secure Data Center database, where users have to create a login before downloading the data.

Reviewer 4:
The reviewer noted it would be helpful for the review to be a little more specific as to the criteria for vehicle selection. The reviewer understood that this is a collaborative process but asked what the primary decision factors are for choice of vehicles. The reviewer suggested the project team provide the criteria for the specific choices for current review year and to explain why level one, two, and specific type of analysis was 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 towards DOE goals.

Reviewer 1:
The reviewer commented this area of review is generally excellent. The team has provided insights and data into advanced technology vehicles that would generally only be available inside OEM engineering staffs. The reviewer said the project team also provides another useful information source on competitor products to the OEM United States Driving Research and Innovation for Vehicle efficiency and Energy (U.S. DRIVE) partners. APRF work also helps to inform government regulators with useful, fact-based information.

Reviewer 2:
The reviewer stated, given the resource limitations, the technical accomplishments and progress are quite acceptable. One area that could perhaps be improved would be running the 'special' cycles that identify the limitations of the various powertrain elements. The reviewer noted these cycles tend to drive the sizing of various components and indirectly influence the fuel consumption and petroleum displacement.

Reviewer 3:
The reviewer underscored that the emphasis on off-cycle emissions and fuel economy (FE) benefits is the most important aspect of emissions control and fuel economy for these complicated vehicles going forward. This is something that this effort has done a great job of in terms of Heating, Ventilating, and air-conditioning (HVAC) loads, coolant thermal storage. The dynamometer is very important for doing this type of work, because of its ability to control the environment, but off-cycle emissions will be more important in the future. The reviewer inquired about the role for portable emissions measurement systems under these efforts. The reviewer continued that once connected vehicles become a real vehicle (next generation is this reviewer's expectation), then the on-cycle emissions and FE will become less relevant.

Reviewer 4:
This reviewer observed a track record of multi-year performance to data generation and archival for public and private use. The reviewer noted a good analysis of comparing a battery electric vehicle versus a PHEV.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted good cooperation with both INL for the hybrid fleet data, and with Oak Ridge National Laboratory (ORNL) on testing electric motors and power electronics, and with NREL on several other projects. The reviewer stated the recent report that NREL put out on real world light-duty (LD) vehicle efficiency, which was supported by APRF testing, was very informative.

Reviewer 2:
The reviewer wanted to see more coordination with other parts of ANL and DOE. The reviewer stated the D3 database is outstandingly transparent. The availability of these data makes validation of custom models very robust and respected. The reviewer also noted that, on the other hand, none of the models that are available from DOE include validation using the D3 database. The reviewer indicated that DOE does not publish the model and the validation data at the same time. Outside academia users interested in using Autonomie models of the Prius (for example) have to develop their own model and validate against D3. There is so much new emphasis on validation and verification (see American Society of Mechanical Engineers literature or work at Sandia National Laboratories/Lawrence Livermore National Laboratory). The reviewer expressed interest in having a quantification of Autonomie's validation error and predictive error, which is why a coordinated effort would be great, and would contribute to the rigor of ANL's modeling efforts.

Reviewer 3:
The reviewer stated there are collaborations and/or connections with most of the salient automotive entities and are generally excellent.

Reviewer 4:
This reviewer suggested evaluating how the ATVL work fits into the network of national laboratories doing other vehicle benchmarking and analysis with minimal redundancy, and acknowledged that this may be a more appropriate consideration for DOE. Further, the reviewer offered that a laboratory "matrix" of who focuses on what would be useful to those not integral to the resource allocation process.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 the future work appears to be gravitating towards connected and automated vehicles (CAVs) and smart transport. This is perhaps a longer-term strategy that, from an OEM's perspective, is perhaps not entirely justifiable. However, the reviewer believed that many of the changes that are likely to be brought about with the increasing presence of CAVs should be studied, and in the absence of a concerted effort on the part of the industry, and to ensure standards development and compatibility of technology, it is perhaps, at least in part, the responsibility of the national laboratories.

Reviewer 2:
The reviewer wanted to see more future research on off-cycle emissions including portable emissions measurement systems. This becomes even more important as DOE's emphasis on CAVs grows as these vehicles may be difficult to evaluate outside of the real-world.

Reviewer 3:
The reviewer commented the forecast was somewhat hazy, given the changes in VTO research direction. It is clear that the project focus must change from benchmarking but the nature and sources of future work streams are not clear.

Reviewer 4:
The reviewer noted there is not much insight here only talk about past accomplishments not the future work. A few categories appear highlighted on slide but no description of where this may, or should, be head in the short-to-intermediate term different from the past.

Reviewer 5:
The reviewer reported the proposed future work of vehicle to grid, vehicle as sensor and four-wheel drive CAVs upgrade is not clearly defined.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer commented the project supports the DOE objective with physical data and analysis. Data further enhances codes and standards and provides an independent petroleum displacement insight which is generally not published by OEMs.

Reviewer 2:
The reviewer reported the benchmarking activity is useful for educating regulatory authorities on the advantages and benefits of vehicles that reduce petroleum consumption through advanced technology deployment.

Reviewer 3:
The reviewer stated access to unbiased data of various vehicles with advanced technology helps the overall 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 it is great that this facility is being used by outside industry partners, which seem to be providing resources and support to the ANL facility.

Reviewer 2:
The reviewer said while the milestones are noted, they do not appear to have due dates, the funding resources seem insufficient to keep the APRF resources fully committed, relative to the volume of work done in the past.

Reviewer 3:
The reviewer observed that the nature of the work does not lend itself to specific milestones. The impression is that work will fit the funding level by definition. The reviewer said if there is less funding, there will be fewer tests and analyses.

Reviewer 4:
The reviewer commented that ideally, it should be unnecessary for the laboratories to rely on funding from commercial sources for survival. There should also be a continuity of funding maintained to ensure that the laboratories do not bleed all the talent that they have acquired and developed over several years.

Reviewer 5:
The reviewer noted the proposed future work and associated resources needs further elaboration.

Presentation Number: gi095
Presentation Title: EV-Smart Grid Research and Interoperability Activities
Principal Investigator: Keith Hardy (Argonne National Laboratory)

Presenter
Keith Hardy, Argonne National Laboratory

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 this project seems to interactively match its approach to the barriers and it is well-designed and feasible. This project seems to have a good approach.

Reviewer 2:
The reviewer acknowledged that overall, given the constraints, the project does a great job in addressing the barriers.

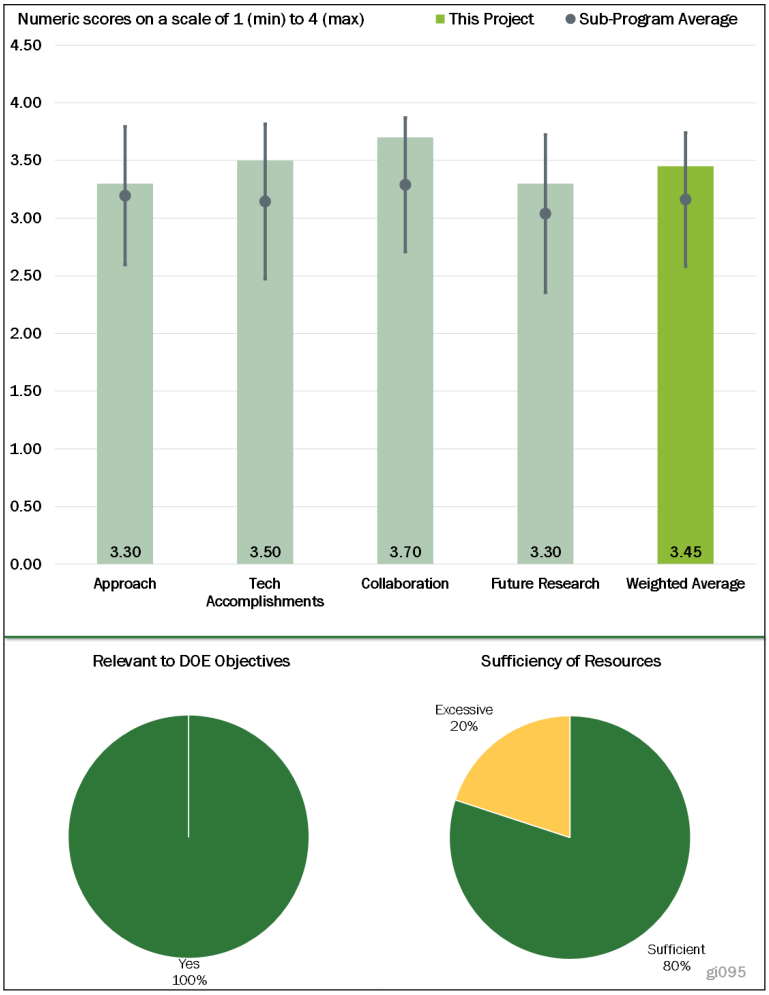

Figure 6-4 - Presentation Number: gi095 Presentation Title: EV-Smart Grid Research and Interoperability Activities Principal Investigator: Keith Hardy (Argonne National Laboratory)

Reviewer 3:
The reviewer liked the approach. The reviewer definitely liked the vision of a universal interface for grid connected devices including the vision of the smart energy plaza. The "hands on" approach helped solidify the approach and application.

Reviewer 4:
The reviewer noted with such a broad project scope, it is difficult to truly access strategy and progress. The reviewer suggested focusing on led activities and goals and how those specific goals are met with R&D. This reviewer recommended showing alignment with other regions in R&D and E-mobility focus points, and the areas that have the best coordination. The reviewer encouraged the project team to highlight regions (e.g., China) that are not aligning and how support needs to be adjusted.

Reviewer 5:
The reviewer commented the approach slide restates activities and categories rather than an "approach." The reviewer questions what the overall methodology to converge standards and interoperability is. The reviewer asked where the gaps are and how priorities are being set to address 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 towards DOE goals.

Reviewer 1:
The reviewer would have a lot of trouble trying to improve the approach. The reviewer stated this seems like great work.

Reviewer 2:
The reviewer said there is good progress in developing open source software and is well placed to coordinate with various organizations and across continents.

Reviewer 3:
The reviewer liked the cooperation of the industry and government in the U.S. and Europe, as well as with standardization bodies. Obviously, this still needs to have an outreach to Asia to make it truly global.

Reviewer 4:
The reviewer commented that progress for FY 2017 seemed good, but it is difficult to determine where funding was applied and to which efforts. The reviewer questioned why the temperatures did not line up (other than 23° C testing) to identify variations in test procedures or equipment, if it was supported through this funding and no other research.

The reviewer understood that hardware development is important to researchers. However, it would be great to see alternatives to making vehicle hardware cheap enough so that accurately measured EVSE energy data could be compared with EVSE value. The reviewer explained that this would provide "check" without needing someone running around with a meter to check every EVSE. If it is cost prohibitive, the reviewer suggested letting WATSON do it for a quick cost analysis to indicate why the lab should be making such a device. The reviewer indicated it is Important to show why wireless is needed at ANL and INL, and what were the different use cases. Although the Smart Charge adapter seemed like a good development, this reviewer recommended that it would be good to establish whether this is a significant U.S. issue. The reviewer questioned whether the cost for this effort was significant for petroleum displacement.

Reviewer 5:
The reviewer stated that much progress has been made with real open source hardware available (assuming all are highly relevant). The reviewer questioned what is the extent of the licensing interest mentioned and wondered if there are agreements in place or imminent with OEMs of significant scale. In addition, the reviewer questioned what the conclusion of the reference vehicle testing is as pertains to interoperability. It is not clear from the slide what the objective and relevant accomplishment was.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said collaboration is excellent but, the project team needs to get Asian cooperation to make it global. United States and Europe is a good start, but not good enough for automotive is a global marketplace.

Reviewer 2:
The reviewer stated collaborations appears the major strength of the effort by ANL.

Reviewer 3:
The reviewer indicated the project has extensive collaboration efforts, and is fundamentally well-integrated with other institutions.

Reviewer 4:
The reviewer noted there is no question that the project team has broad network of collaborators, but questions if there is a main focus point to assure prioritization of activities to increase market penetration or the use of EVs and EVSEs.

The reviewer suggested checking for repeated effort versus testing which needs to be repeated at multiple locations to validate procedure and equipment.

Reviewer 5:
The reviewer commented testing of the BMW i3 at both ANL and at Joint Research Center appears to have yielded dividends. The two sets of results compare quite well. The presenter stated that there has been good progress in harmonizing with Europe. However, according to the presenter, there has been less progress in harmonizing with China. Given that the regulatory environment in China will likely push towards electrification faster, it is perhaps worthwhile to invest extra effort in harmonizing with them 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 commented the proposed plan looks good. The reviewer asked if the 'ultra-fast' charging would require more effort or resources to look into the effect on the grid if more of these come online simultaneously, or, are the effects quite well understood.

Reviewer 2:
The reviewer remarked decision points and alternative plans were not discussed, but it seems obvious that this project evolves as the conditions change.

Reviewer 3:
The reviewer stated the project team needs the same enthusiasm for the future vision, as you have had up to this point.

Reviewer 4:
The reviewer said that High Power DC charging is noted in future work. The reviewer questioned if the relevancy of 400 kW charging been established. There seems to be a need for more definition prior to spending funding on standardization of technology. Tesla's 125-145 kW chargers were developed without government participation. The reviewer asked if that charging rate has been deemed a successful application. In addition, the reviewer wonders what effort has been done to understand the impact of these chargers and the required investment to populate an appropriate network and which OEMs have signed on to the 400kW.

It will be good to see the use of Energy Plaza for future research, and grid modernization efforts. The reviewer asked if there is a projected end date to this project.

Reviewer 5:
The reviewer observed the interoperability center appears to know where it wants to go but the logic of the future activities and priorities is not well defined. The reviewer asked where DOE needs to concentrate its limited funding for the biggest industry and global standards/interoperability impact. In addition, the reviewer inquired about what is the very top obstacle to break down.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer stated the project obviously supports the DOE mission thru expanded E-Mobility but the question is return on investment (ROI). The reviewer indicated that since it is sometimes difficult to understand the funding streams for the different activities, it is difficult to relate the accomplishments to increased E-mobility, and therefore hard to establish impact of effort.

Reviewer 2:
The reviewer stated increased electrification displaces petroleum use.

Reviewer 3:
The reviewer applauded the project since it shows how you can improve electrical charging if you move to standardization in the marketplace. The reviewer also liked this project due to the outreach to the European community and to ensure that worldwide standards can be chaperoned into application

Reviewer 4:
The reviewer understood the effort needed and the potential benefits in harmonizing procedures. The reviewer suggested it should make the products more affordable to the customer and encourage faster adoption.

The reviewer noted that the principal investigator (PI) did a good job of identifying key project attributes for interoperability and an excellent job of collaboration. It was suggested by this reviewer that some easy to follow bookkeeping needs to be done.

Reviewer 5:
The reviewer stated standards development is a particular enabler for the electrification advancements.

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 as described, it seems that the program is appropriately funded.

Reviewer 2:
The reviewer noted the project team really needs to put a push onto Asia and questioned if it is resources that is hindering the project team.

Reviewer 3:
The reviewer remarked that issues of tracking funding to a specific activity and specific results, have been previously noted.

Reviewer 4:
The reviewer stated it is unclear how that much fiscal year funding focused on key priorities is consumed efficiently. This reviewer observed significant activity with some gems of advancement for the industry/DOE objectives, and questioned if too much funding goes to hardware and travel. This reviewer's impression was that an actual budget review by DOE VTO is needed to be sure all the spending is used for greatest impact.

Presentation Number: gi096
Presentation Title: Wireless and Conductive Charging Testing to Support Code and Standards
Principal Investigator: Barney Carlson (Idaho National Laboratory)

Presenter
Barney Carlson, Idaho National Laboratory

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 the approach and execution of this project demonstrates superior engineering skills and resource allocations to a complicated enabling technology to vehicle electrification. Non-contact charging and the future of reverse flow are essential in technology acceptance and growth

Reviewer 2:
The reviewer indicated the project seems well-structured and uses feedback to adjust to technical barriers.

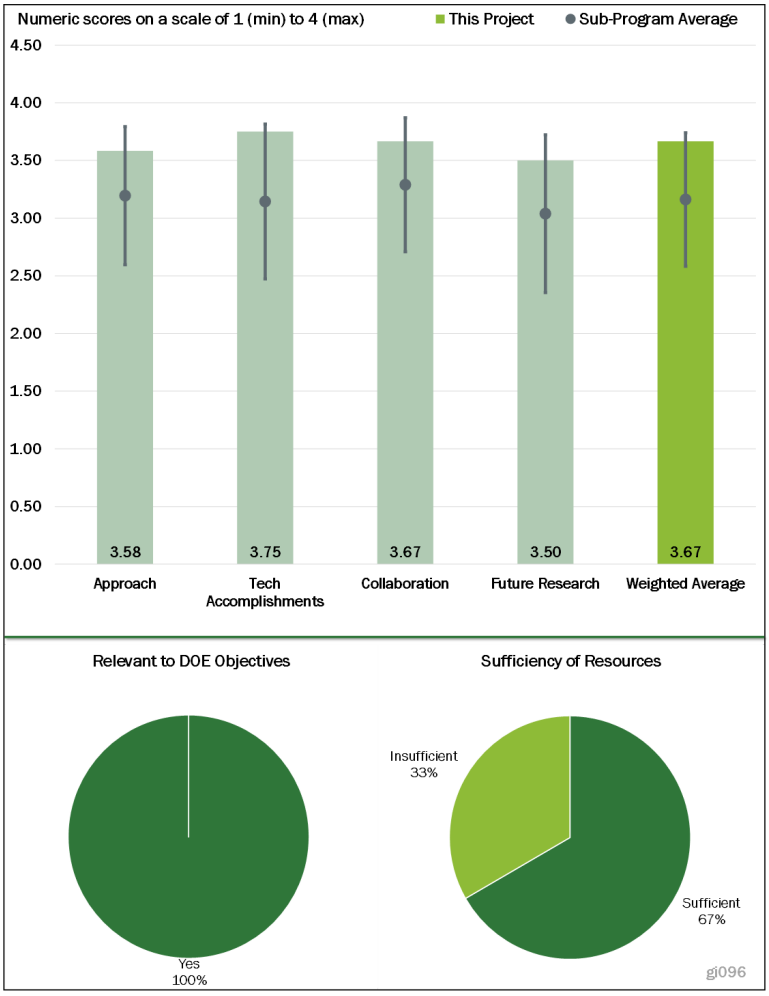

Figure 6-5 - Presentation Number: gi096 Presentation Title: Wireless & Conductive Charging Testing to Support Code and Standards Principal Investigator: Barney Carlson (Idaho National Laboratory)

Reviewer 3:
The reviewer said the approach taken meets all the requirements for executing the objectives stated.

Reviewer 4:
The reviewer acknowledged INL has vast experience in testing to support standards and has the knowledge to establish a robust approach for testing new technology. This case is an example of their fully developed capability in this area.

Reviewer 5:
The reviewer commented the technical barriers are very well identified and addressed.

Reviewer 6:
The reviewer stated the approach is somewhat difficult to follow. The laboratory is highlighted and tasks and activities performed are listed. The reviewer noted the approach to the big picture problem and opportunity to be solved is not presented in a most organized way.

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

Reviewer 1:
The reviewer commented the accomplishments of this project are excellent to the objectives pursued in charging system characterization and well supported in the collaborative efforts with Hyundai, TDK, and a host of competitors in the interoperability analysis.

Reviewer 2:
The reviewer said this project seems to have made excellent progress.

Reviewer 3:
The reviewer stated the project has made excellent progress, achieved all objectives planned to date and provided excellent support to standards activities.

Reviewer 4:
The reviewer said INL continues to advance their work in the measurement of wireless power transfer (WPT) and support Society of Automotive Engineers (SAE) standards committees. The reviewer noted the project has great insights on greatly varying behavior of charging systems in response to voltage sags.

Reviewer 5:
The reviewer reported that test results are very impressive.

Reviewer 6:
The reviewer remarked that in testing new technology for standards development there is always some risk in conducting a most complete array of tests to deal with the many varied conditions that a device may be subjected to. This approach and the accomplishments are very comprehensive but there is no way to assume that all barriers will be overcome.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted good collaboration with industry. The reviewer said it Seems there would be additional laboratories interested in collaborating and being involved with WPT. The reviewer suggested that additional vehicle OEM involvement seems a natural next step.

Reviewer 2:
The reviewer stated this project seems to be very collaborative.

Reviewer 3:
The reviewer observed all stakeholders are represented and communication has been effective.

Reviewer 4:
The reviewer noted collaborations cover all the necessary stakeholders and the testing is across a wide number of systems.

Reviewer 5:
The reviewer acknowledged that by leveraging efforts from competitors in the commercial markets and having success in an interoperability analysis, collaboration can meet the “needs” of the technology by supporting safe deployment of wireless charging.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 the project seems to have an excellent plan for future development.

Reviewer 2:
The reviewer reported the future work is well thought out, but highly contingent on funding. It appears that if DOE funding is unavailable, the project will be forced to shut down unless some of the standards committees being supported step up to the plate.

Reviewer 3:
The reviewer stated future proposed work, especially in cybersecurity, is extremely significant to the success of the EV technology. The reviewer noted the hope is that resources are allocated accordingly.

Reviewer 4:
The reviewer acknowledged the work is very comprehensive. The reviewer suggested it would be nice to see an expansion to characterize other environmental factors on charging performance and efficiency, such as ambient temperature.

Reviewer 5:
The reviewer commented the future work tied to continued standards development. The reviewer noted it is not too clear exactly where the technical frontier is and what are the next steps to address.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer commented the increasing the ease of electricity use will decrease petroleum consumption.

Reviewer 2:
The reviewer remarked that by furthering beyond the fundamental barriers for wide-spread acceptance of EVs (in this case convenient wireless charging), this project supports the premise for all DOE programs and will assist in the reduction of petroleum dependence for energy.

Reviewer 3:
The reviewer indicated that higher adoption rates of EVs can be fostered by availability of wireless charging systems to increase convenience of owning an EV. Higher transfer rates are required as greater energy storage capacity comes to new EVs. The reviewer said petroleum will be displaced with each added EV to the national fleet.

Reviewer 4:
The reviewer observed it is necessary to develop well informed EV charging codes and standards to ensure that our transition away from petroleum is well guided. This work serves as a fantastic guide for the current state of wireless and conductive charging technologies.

Reviewer 5:
The reviewer noted that clearly, as a key support for standards development, the work is relevant and not likely to be naturally led by industry without DOE prompting.

Reviewer 6:
The reviewer noted the project helps in the development of standards and technology for EV-oriented transportation and reveals issues that need to be addressed that impact the grid.

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 the project seems to do a lot of work for the money. The project includes both complete and efficient test protocols which indicated a well-trained workforce.

Reviewer 2:
The reviewer commented though no shortage of resources was noted, the accomplishments of this project was very fruitful on the budget that it was provided.

Reviewer 3:
The reviewer said funding has been just sufficient to meet the promised work stream. The funding has been dwindling, which puts future work in jeopardy.

Reviewer 4:
The reviewer noted that resources look very light in the last fiscal year. The reviewer questioned if the forecast is to increase in this area. It appears the project is in wind down mode versus satisfying the procedure development in such unchartered territory as WPT.

Reviewer 5:
The reviewer noted that given the scope of work it looks like the funding is a limitation.

Presentation Number: gi115
Presentation Title: Zero Emission Drayage Truck Demonstration (ZECT I)
Principal Investigator: Matt Miyasato (SCAQMD)

Presenter
Joseph Impullitti, SCAQMD

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 the project has a great approach addressing all barriers.

Reviewer 2:
The reviewer noted the project has a good scope of Class eight product with strong partners for fleet use. There is also good use of early data to help with market understanding of the application for the technology. The reviewer remarked the project still needs to devise an appropriate driver feedback process and produce reports that relate kinetic intensity to type of driving in the various clusters of driving types and benefits of technologies.

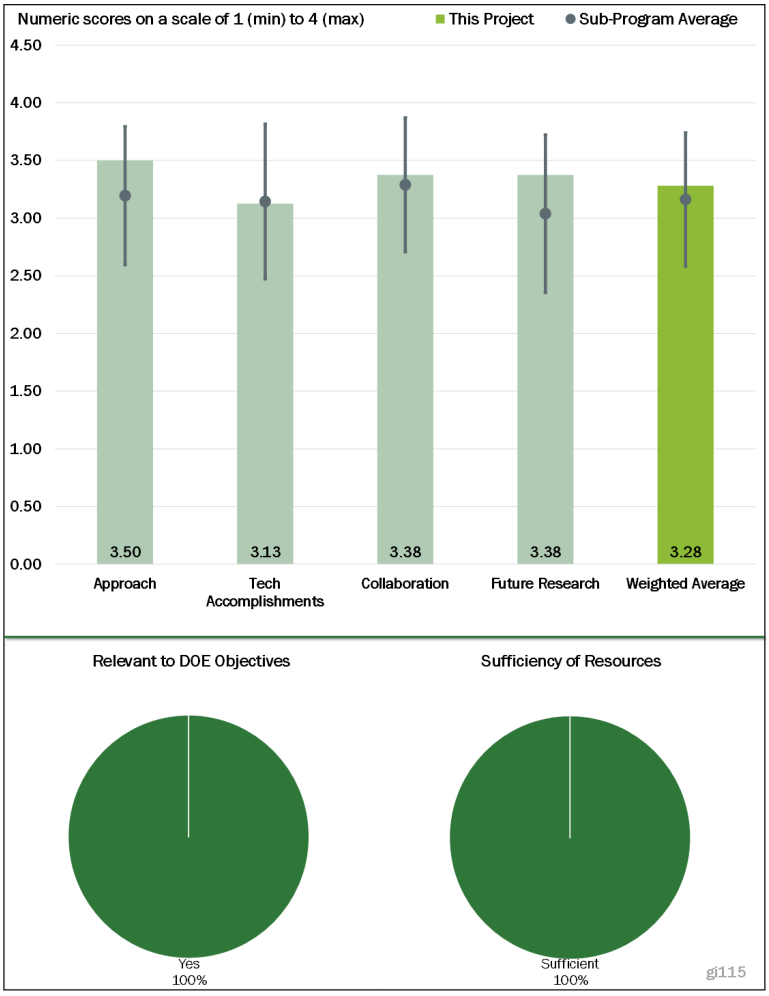

Figure 6-6 - Presentation Number: gi115 Presentation Title: Zero Emission Drayage Truck Demonstration (ZECT I) Principal Investigator: Matt Miyasato (SCAQMD)

The reviewer is looking forward to seeing hybrid vehicle data, this is critical for this project.

Reviewer 3:
The reviewer said you cannot do better than putting something into operation and seeing how it works. It is unfortunate that the electric trucks were used in such limited service, because that makes head-to-head comparison harder. The reviewer hopes that when plug-in hybrid electric truck (PHETs) are put into service, their service will not be as limited.

Reviewer 4:
The reviewer acknowledged the work is feasible, and progressing with technical barriers being addressed. However, the project is not specifically integrated into the new modeling efforts that DOE started this year. It was noted orally that the data could easily be tied into those models in 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 towards DOE goals.

Reviewer 1:
The reviewer said the project is working in the right direction to accomplish all goals.

Reviewer 2:
The reviewer noted the trucks are out there running on the road in commercial service. There is no other way to actually test a concept.

Reviewer 3:
The reviewer commented that progress is good for initial battery electric trucks (BETs), although it would be great to convince fleet partners to plan truck use to maximize range. The project could use yard bulldog to move the trailer while cab is charging, this example should increase usage percentage of vehicle. The reviewer suggested a second BET will help to identify impacts of architecture and component sizing to performance.

Hybrid electric vehicle (HEV) Truck progress is vital, particularly in clusters three and four to better understand architecture, component sizing and selection.

Reviewer 4:
The reviewer observed the project did not have any stated project targets. The goal of the project was to demonstrate the vehicles and compare against baseline vehicles. The reviewer noted that fuel savings was shown. As a demonstration project, it should still compare fuel savings to the predicted models. It is not pass or fail, but a sanity check for the standard models and drive cycles when compared to an actual end user drive cycle.

The reviewer noted the data that was collected was a great start, as it shows there is fuel savings real world. The estimated cost for a kit should also be included in this study. The project appears to be steering away from presenting cost numbers (stated orally and in the written presentation), due to the fear the numbers would not represent production numbers. The reviewer remarked that without cost numbers, it will be difficult for the project to be successful, in the goal of promoting market acceptance. Fleet owners will not adopt without knowing what the investment cost will be.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated the project has a good mix of research institutions, vehicle manufacturer's, and end fleet owners.

Reviewer 2:
The reviewer said there is a great group assembled to achieve the project goals.

Reviewer 3:
The reviewer reported there is good collaboration, which is required for a project of this size. Next phase of project should include some outreach with partners to expound on the benefits, both to the communities, the industry and the science.

The reviewer it was unfortunate about delays and component resourcing, but it was good recovery to be able to provide demonstration vehicles by separating partners.

There is a need to convert data into information to showcase the progress and technology opportunities for this type of logistics activity.

Reviewer 4:
The reviewer noted not much was said about other collaborators besides truck fleets. The reviewer suggested the project team be encouraged to run the electrics on some longer runs. It looks like the project team has range anxiety. The reviewer added that some influence over operation of the PHETs may be possible.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 future research is properly addressed.

Reviewer 2:
The reviewer observed the project is planning on completing the data collection and the project over the next 16 months. Decision points, barriers and risk mitigation were not presented, but do not really apply. The reviewer noted the technology is already deployed and functioning. And the main task is waiting for the data to be collected.

Reviewer 3:
This reviewer observed what you would expect for a project in the process of extending, and indicated there is a need to pursue options to determine truck use scenarios that maximize the difference from a base truck, or HEV versus BET (when HEVs are ready). Also, emissions from series based hybrid electric truck (HET) should not be too difficult to project, and should be included as differential from base combustion to NG which should show the value to air quality with performance gain, and reduction in consumed energy based on HET technology. The reviewer also noted that it is really important to get specific cluster type data for each technology architecture. The reviewer suggested to be included in future work should be a baseline cost analysis of the various technologies showcased in this project; NREL has some experience in this type of analysis and should be consulted.

Reviewer 4:
The reviewer noted there was little detail provided on the architecture or operating method of the PHETs.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer reported this project supports the overall DOE objective of petroleum displacement. By demonstrating hybrid and battery vehicles side by side with conventional vehicles in a real-world business, a good apple to apples comparison can be seen. It helps promote the fuels efficiency gains past an engineering simulation to a real-world usage case, which should help lead to less resistance to adaptation. Fleet operators put more faith in real world business case return on investment data, then an engineering estimate.

Reviewer 2:
The reviewer said yes, hybrid and full EV supports the DOE goals.

Reviewer 3:
The reviewer said this project is one of the better projects reviewed in 2017. This project focuses technology advancement effort in an area that all business projects show an increase in energy consumption in the coming decade, that area is logistics.

Few projects have the opportunity to both learn as much, and demonstrate critical benefits in port operations efficiency improvements. Slide 12 is an indication of the importance of focused research in Cluster two and three, but Cluster four should also be examined, particularly around other port cities.

Reviewer 4:
The reviewer remarked that any substitution of electric vehicles for diesel is a win, but acknowledged having an issue with how big a win. This reviewer reported that electricity was converted to gallon equivalent on a 1-1 British thermal unit basis, but noted that really depends on the generation mix. As done, it assumes all renewable electricity.

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 the project has sufficient resources to finish in a timely manner.

Reviewer 2:
The reviewer commented that though there were some delays in the development of some of the trucks, the project has shown good progress with the available funding. As indicated previously, cost analysis for technologies, petroleum displacement projections and emissions benefits are needed to ensure understanding the complete picture this technology might represent.

Reviewer 3:
The reviewer stated the project is on plan.

Reviewer 4:
The reviewer remarked doing stuff the first few times is expensive.

Presentation Number: gi116
Presentation Title: Hydrogen Fuel-Cell Electric Hybrid Truck and Zero Emission Delivery Vehicle Deployment
Principal Investigator: Andrew DeCandis (Houston-Galveston Area Council)

Presenter
Andrew DeCandis, Houston-Galveston Area Council

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 approach to this project is reasonable and it represents a relatively conventional development and deployment activity for advanced vehicle technologies. The project team is seeking to develop and deploy highly-advanced electric drive technology in applications for which the technology should be suited. The reviewer observed that because of the advanced nature of the technologies the team is working with smaller technology providers and this offers both challenges and benefits.

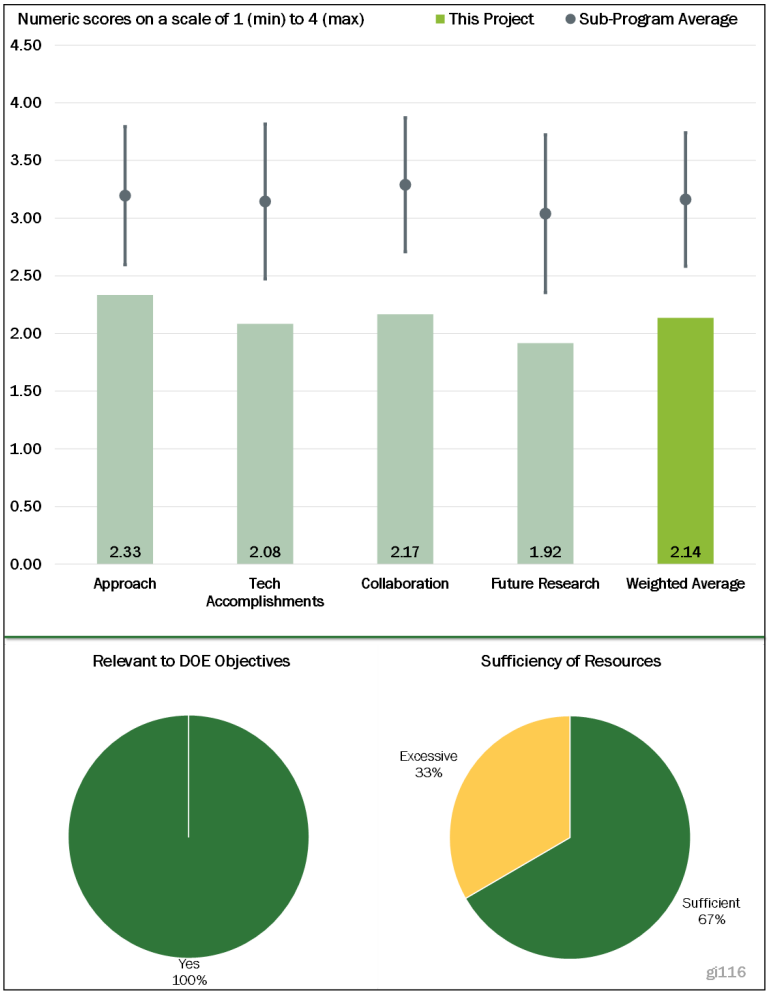

Figure 6-7 - Presentation Number: gi116 Presentation Title: Hydrogen Fuel-Cell Electric Hybrid Truck and Zero Emission Delivery Vehicle Deployment Principal Investigator: Andrew DeCandis (Houston-Galveston Area Council)

Reviewer 2:
The reviewer noted that for the fuel cell hybrid truck project, the initial approach made sense, but apparently funding issues and requirements resulted in departure of the demonstration fleet partner. It may have made sense to have included in the original approach a way of addressing this potential issue, which was not necessarily a surprise for this type of project. No such process was identified in the presentation as being part of the original approach.

The reviewer remarked that for the Zero Emission Delivery Vehicle Deployment, the approach included a solid demonstration partner in United Parcel Service (UPS).

Reviewer 3:
The reviewer commented the approach has some flaws given that it could not meet the original schedule and scope. It seems that the PI's organization did not have full understanding of fleet operator's decision-making criteria, appetite for new technologies, and how they are incentivized. The reviewer suggested that in future similar projects could adjust how they incentivize fleet operators to enter into a partnership.

Reviewer 4:
The reviewer stated the approach for this "demonstration" type project is fairly straight forward and has been used in other programs. However, this project has demonstrated what can go wrong with non-committing partners and technical issues beyond the skill set of the project managers at the Houston-Galveston Area Council.

Reviewer 5:
The reviewer commented it is difficult to give ratings for these two projects together as they are both substantially funded with varied success. The reviewer indicated the Hydrogen Fuel Cell Class 8 is a mess and that the project should not be extended. The reviewer said the project was flawed from on-set. It is understandable that partners leave projects and that makes them difficult to complete, but the lack of hydrogen infrastructure in the area is a pretty big oversight. Cost of trucks should have been projected better. The reviewer added that there should be a review of projected success prior to large spends in FY 2017. Electric Delivery trucks have had better success and data is available, but noted only 18 of the original 30 planned trucks to be built, due to re-scope. The reviewer suggested data collection could be extended to meet the 24-month initial project goal and an initial review of this project data vs other EV and HEV drayage truck projects should be performed to determine if both are required.

Reviewer 6:
The reviewer noted the approach for the Hydrogen Fuel-Cell Electric Hybrid Truck Project is completely unsatisfactory. The project has failed to secure a demonstration partner, which is the focus of the entire project. A more robust approach was needed from the start of the project to ensure a demonstration partner would be secured and follow through. Additionally, no plan for hydrogen fueling infrastructure has been set forth, which is critical to the success of a demonstration and the project.

The reviewer observed the approach to the Zero Emission Delivery Vehicle Deployment is fair to satisfactory. Vehicles were produced, put into service, and data is being successfully collected. However, the approach should include a data analysis plan that dictates what the data will be used for. Metrics should be defined that will allow comparison of operation of the Zero Emission Vehicles to their conventional internal combustion engine (ICE)-powered counterparts. The reviewer said the PI referred to reliability as a key concern, but no plan was described to measure and assess 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 towards DOE goals.

Reviewer 1:
The reviewer indicated the collection of the data on the UPS trucks is great progress. It would have been good to have a slide on the data analysis done so far with respect to utilization of the trucks. Lots of information was conveyed but it was all verbal.

Reviewer 2:
The reviewer reported the delivery project the team has already completed the deployment of an 18-truck fleet and is collecting data on them. The trucks were delivered over a reasonable schedule. The team has re-scoped the project to 18 trucks to ensure sufficient data collection time, which is a good decision. The team should consider working with NREL through the Fleet DNA project to contribute data to this VTO-funded project. The utilization rates for the vehicles appear to be reasonable but there is opportunity to use the vehicles more. It seems as though some of the challenges the team faced (chargers and DC/DC converter failures) could have been easier to resolve as these components are not necessarily cutting edge. The reviewer noted it took a long time to get everything started but progress seems to be speeding up and the demonstrations will still be over 2 years long. The team did a good job in addressing the reviewer comments, especially the truck specifications (especially now that vehicles are out in service).

The reviewer said the drayage truck project also seems to be moving slowly but progress is accelerating. The team has done a good job of addressing the challenge of project partner turnover and not allowing the setback to derail the project. The trucks have now been procured and the zero emission drayage truck demonstration (ZECT) drivetrains are being installed so the project is now back on track.

Reviewer 3:

The reviewer noted both projects are seeking extensions to complete demonstration elements. For the Fuel Cell project, a fleet partner has not been identified at this time, after departure of the original fleet partner. The PI indicated that the project team identified several other fleet partners along the way, only to have each of those back out. Obviously, efforts to obtain a fleet partner have been a significant focus of project efforts, there just has not been success yet. The project would possibly have benefited from including either a fully solid fleet partner (like UPS under the Zero Emission Delivery portion), or perhaps a clearer process for selecting a partner if the original one dropped out (or, a point at which the project would be revised if no partner had been obtained).

The reviewer remarked the Zero Emission Delivery project appears to be ready to go for demonstration using what is now a commercially-available product. Data is beginning to be generated now. The project team is also finding out some limitations of the technologies which is critical information before larger deployment. However, the project is still seeking additional fleets.

For both projects, however, the original timelines appear too long for at least the call for projects and partner selection process (2 years or more for each). Particularly when compared with the admittedly highly-accelerated timelines for the American Recovery and Reinvestment projects, this appeared overly long to get things moving (at least as far as the project call and selection processes). It is possible as far as the Fuel Cell project, this may have simply been the wrong location. Houston may simply not have a sufficient interest level for this type of project (hydrogen), particularly when compared to California. It may make sense to try to restructure things to focus more on the Zero Emission Delivery portion of the overall project, which seems to largely be moving ahead as planned.

Reviewer 4:

The reviewer remarked to expand on a prior comment, the performance at 5 years into the project is poor. Largely due to non-committing partners and technical issues, this project not only is suffering delays but a vehicle accident which may have ties to the program, and accumulating delays with issues in the chargers, converters, and battery management system (BMS) cell balance. The reviewer stated it may be preferable, sometimes, to end the project if funds are recoverable; if non-recoverable, DOE may have a great burden to micro-manage progression.

Reviewer 5:

The reviewer stated again that two projects are being reviewed, and suggested the hydrogen project would be less than one. The reviewer indicated that the Zero Emissions Delivery Vehicles have strong partners, but observed technical challenges with trucks in operation. The presenter noted that 80% of UPS routes are less than 100 miles, but these trucks only have 80-90 miles of range. The reviewer reported very large motor specifications for trucks that are usually cubed out versus maximum weight, in the flat area of the gulf coast. This reviewer described the drivetrain architecture selection as interesting. Additionally, only 7 of 18 vehicles have greater than 50% utilization, which does not support continuation of the project.

Reviewer 6:

The reviewer indicated accomplishments of the Hydrogen Fuel-Cell Electric Hybrid Truck Project are completely unsatisfactory. The project has failed to secure a demonstration partner, which is the focus of the entire project. Three trucks have been procured, but the conversion to fuel cell-electric hybrid drive has not been completed 5 years into the project. No plan for hydrogen fueling infrastructure has been set forth, which is critical to the success of a demonstration and the project.

The reviewer said the approach to the Zero Emission Delivery Vehicle Deployment is satisfactory. Eighteen vehicles were produced, put into service, and data is being successfully collected. However, this falls short of the project goal of 30 vehicles. Over a year of data was collected from the 18 trucks, but no report on vehicle utilization, efficiency, reliability, or any other quantitative summarization of vehicle operation has been created. The reviewer noted only a list of summary metrics for each vehicle was presented, which is inadequate for drawing any conclusions or comparisons to conventional vehicle use in the same application.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said the collaboration on the UPS EVs seems to be working, although the truck OEM does not seem to be incentivized to keep the EVs operational. Perhaps consider that as a financial milestone if you were to do a similar project in the future.

The reviewer suggested that not having a fleet partner on the hydrogen truck seems to be a large detriment. Perhaps taking a step back and understanding what part of the project is unfavorable to fleets and adjusting the scope makes sense. While it is clear that this is an unknown fuel, there are hydrogen producers in the area so educating fleet owners is a hurdle that could be overcome. Consider the incentives and how business decisions are made at the Fleet Partner level and adjust the project to align better with that.

Reviewer 2:
The reviewer noted that U.S. Hybrid is a partner in both this project and the ZECT project in California. It is good to leverage the work in these California projects that are further along and help speed this one to completion. The drayage project has an interesting mix of vehicle up fitters, researchers, and a non-governmental organization. Overall the partner list is reasonable and the team is working on a new local fleet which will be important. The delivery project has both a vehicle OEM and a major fleet partner. These are important components for success in a project like this.

Reviewer 3:
The reviewer reported for both projects, partners for hardware (OEMs) and analysis seemed appropriate. For the Zero Emission Delivery project, the fleet partner selected is a very solid partner, who has participated in a number of demonstration and deployment projects, and who is also anticipated to be an ultimate user of the technology (UPS). The project is still seeking additional fleets. However, for the Fuel Cell project, the original fleet partner was apparently not as solid, and no process appeared to be identified in the original plans to address the departure of the fleet partner. It is simply tough to obtain a fleet for this application in a geographic area where fuel cells are not being promoted. There will need to be a balance between getting a fleet partner soon and getting a good partner, or else perhaps resources should be moved from the Fuel Cell side to the Zero Emission Delivery side of the project.

Reviewer 4:
The reviewer reported that again two projects are being reviewed.

The reviewer said the hydrogen project only has a partner to deliver on trucks, Gas Technology Institute (GTI) and a university. The reviewer noted this would be great experience for students, but at what cost. The reviewer commented it is surprising that GTI cannot help with hydrogen infrastructure.

The reviewer stated Zero Emissions Delivery Vehicles have strong partners, as noted earlier but are still missing a critical partner with EV fleet knowledge that can keep things up and running.

Reviewer 5:
The reviewer said that the Houston-Galveston Area Council has been subjected to poor collaboration and commitment with its partners. The hydrogen portion appears worse than the electrification project.

Reviewer 6:
The reviewer stated collaboration in the Hydrogen Fuel-Cell Electric Hybrid Truck Project is completely unsatisfactory. The project has failed to secure a demonstration partner, which is the focus of the entire project.

The reviewer commented the approach to the Zero Emission Delivery Vehicle Deployment is satisfactory.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 the future plans to complete the drayage truck construction and delivery truck demonstration are reasonable and straightforward. The project team is addressing the previous issues with finding more fleets and getting more demonstration miles on these vehicles. The reviewer noted the team is focusing correctly on getting the vehicles in service and collecting as much operational data as possible.

Reviewer 2:
The reviewer observed the data collection process is good. It would be better if they could make all 18 vehicles available more often so the utilization increases. It was not clear if all the utilization drop was based on technical problems or whether there were also driver preferences that play into that utilization number. Perhaps start collecting data on the reasons the EV is not available so one can see what percentage of the time it is due to chargers versus battery energy management system versus something else.

It is not clear that a fleet partner will ever be found under current project structure for the hydrogen vehicles. The reviewer suggested to consider redirection of efforts.

Reviewer 3:
The reviewer remarked the most critical activity will be to find a fleet partner, or else move the resources from the Fuel Cell effort to the Zero Emission Delivery activity. If a fleet partner can be obtained for the Fuel Cell project, there will clearly need to be an extension to allow for data collection and analysis. The reviewer note that seems to be a long-shot at this point.

Reviewer 4:
The reviewer warned that time has expired on this project, there is little guarantee for future success with a time extension.

Reviewer 5:
The reviewer warned the plan for no cost extension of the Fuel Cell effort should be reviewed with great scrutiny. The plan is not sufficient to enable good ROI for continued investment. The reviewer questions if trucks are placed into service will they really have any relevancy. The reviewer asked if they operate as true examples, what burn-in time will be required to determine that the recently completed trucks will have a shot at producing useful data. The reviewer suggested the project should not be continued without significant re-scoping of the project again.

The reviewer stated the Zero Emissions Delivery Vehicles has a chance to produce useable data, still prior to providing extension. Current data needs to be reviewed along similar data to see if continuation is a value add for the program. The reviewer asked what new will be learned here if there is an extension. Since UPS has tested other EV fleets, the reviewer wonders if the architecture is correctly sized for mission and is there weather or other unique characteristics to this program which make the continuation beneficial.

Reviewer 6:
The reviewer observed a number of actions were proposed, but recommended that the Hydrogen Fuel-Cell Electric Hybrid Truck Project be cancelled immediately due to failure to perform.

The reviewer noted the proposed future actions for the Zero Emission Delivery Vehicle Deployment are fair, but again, a plan for data analysis to make meaningful conclusions from the project must be made. Otherwise, the demonstration will not produce any meaningful results.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer said the project is relevant as it addresses a long-term research opportunity for electric drayage trucks and delivery vans to reduce petroleum consumption. The demonstration aspect of the project addresses the issue of acceptance since if fleets do not accept technology the petroleum displacement cannot occur.

Reviewer 2:
The reviewer indicated yes, deployment of alternative fuel vehicles lowers petroleum use during the project and hopefully educates stakeholders so that the displacement continues after the project end date.

Reviewer 3:
The reviewer commented the project is focused on reducing barriers to introduction of high efficiency and low emissions technologies for particularly high fuel-use emissions applications.

Reviewer 4:
The reviewer observed petroleum reduction would occur if it were successful. This project was developed and executed with best intension to demonstrate and quantify the benefits of alternative energy storage.

Reviewer 5:
The reviewer remarked electrification of medium-duty delivery trucks and heavy-duty (HD) drayage trucks has the potential to significantly displace U.S. petroleum consumption. There are a number of barriers to electrification of these vehicles. This project has the goal of addressing some of those barriers.

Reviewer 6:
This reviewer expressed dislike for this question and opined that it should not be a yes or no question. The reviewer stated there would have been a petroleum displacement impact if this project had been a success; there is minimal impact given the limited progress or differentiators from other EV delivery 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 observed resources appear to be sufficient to achieve the stated goals and deploy the stated number of trucks.

Reviewer 2:
The reviewer commented funds appear sufficient, at least for now, but it is certainly unclear going forward. If no fleet partner is found soon for the Fuel Cell project, it may make sense to redirect resources toward the Zero Emission Delivery effort.

Reviewer 3:
The reviewer remarked though it is apparent that this project has faltered, it is not due to resources provided by DOE.

Reviewer 4:
The reviewer stated based on original milestones, funding was appropriate, to maybe insufficient. The reviewer noted given re-scope, and value of information obtained, project was overfunded.

Reviewer 5:
The reviewer commented resources are judged to be sufficient for completion of the projects. However, the reviewer suggested the Hydrogen Fuel-Cell Electric Hybrid Truck Project be discontinued and remaining funding be redirected.

Reviewer 6:
Given that the hydrogen trucks are not deployed and that there are only a portion of the 30 EVs originally envisioned, the reviewer suggested this is more funding that is needed for the scope currently underway. The reviewer noted that the PI's organization is missing a network connection / industry knowledge to address the missing fleet partner for the hydrogen vehicles in its project.

Presentation Number: gi157
Presentation Title: UTEMPRA—Unitary Thermal Energy Management for Propulsion Range Augmentation
Principal Investigator: Sourav Chowdhury (Mahle Behr USA, Inc.)

Presenter
Sourav Chowdhury, Mahle Behr USA, Inc.

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 reported this project follows a well-established approach of identifying vehicle and technology requirements, advancing technology through identification of component and system specifications and subsequent development, conducting system integration and testing, and ultimately vehicle demonstration.

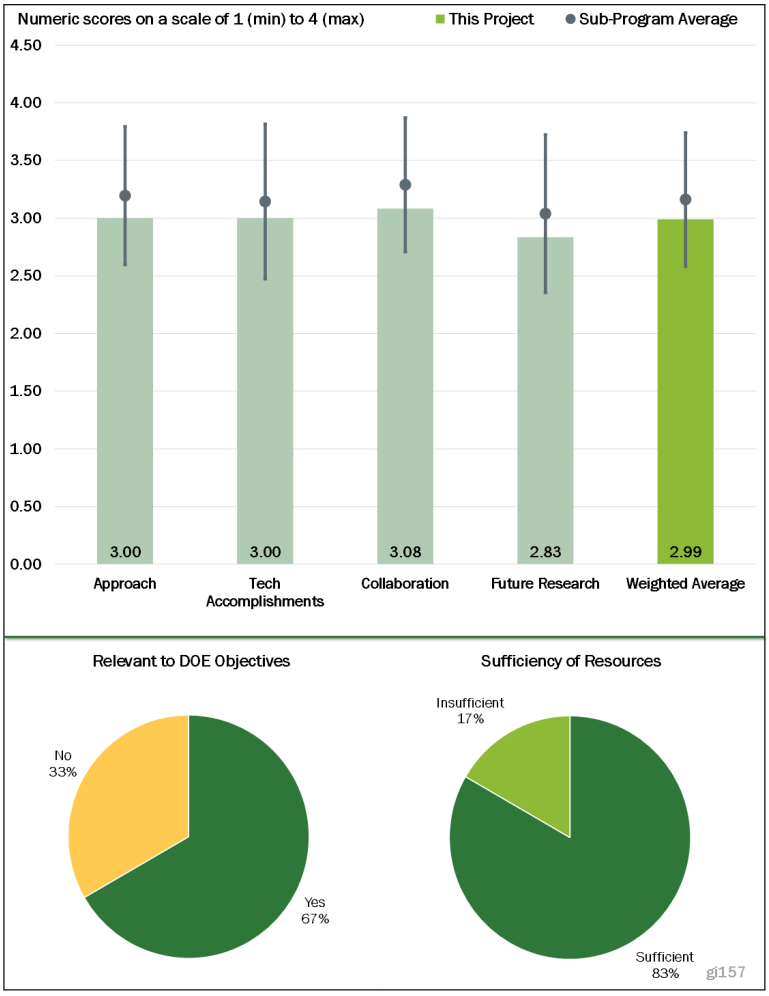

Figure 6-8 - Presentation Number: gi157 Presentation Title: UTEMPRA—Unitary Thermal Energy Management for Propulsion Range Augmentation Principal Investigator: Sourav Chowdhury (Mahle Behr USA, Inc.)

The reviewer said the focus is to develop a coolant-based heat pump system (which provides heating and cooling) to reduce the energy impact of climate control on EVs especially at low temperatures, thereby increasing range. The reviewer noted heat scavenging from the battery and power electronics is employed.

The reviewer observed the principal technical challenges are development of the multi-mode fluid controller (MMFC) with minimal leakage, flux free brazing, and as always cost effectiveness. The valve system is the heart of the project, with hardware and control being key issues driving cost and commercialization potential. These areas are being focused upon. The reviewer noted there is no direct mention of the project's specific integration with other efforts.

Reviewer 2:
The reviewer noted the project has comprehensive approach with a production oriented design that has shown solid performance.

Reviewer 3:
The reviewer said this is a well-focused project

Reviewer 4:
The reviewer noted HVAC draw in extreme temperatures is a large concern for EVs, and this project seeks to address the low extreme with a new system design. The system development and vehicle build and development phases appear to be sound and well designed. A successful project could significantly in reducing the impact of extreme temperatures on EV range.

The reviewer noted the vehicle baseline testing is lacking in drive cycle selection and temperature. The presenter indicated that more drive cycles will be used in the future, and these should include those from the 5-cycle methodology. The temperature testing occurred only at -6º C, and had to be extrapolated. Testing to the full limit should be conducted. The presenter indicated that -10 º C covers 98% of the continental U.S., but this reviewer is skeptical of this number. A reference should be provided to corroborate the rationale for not establishing a lower goal temperature for the unitary thermal energy management for propulsion range augmentation (UTEMPRA) system.

Reviewer 5:
The reviewer stated this is a rather expensive DOE project. It seems as if scope or budget was inadequate with a budget overrun which was picked up by supplier partner.

Reviewer 6:
The reviewer said it is tough to justify business case to proceed to a conclusion.

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

Reviewer 1:
The reviewer noted the project has achieved a number of technical accomplishments including the following. Testing has confirmed that the second generation MMFC has fully addressed leakage issues through design improvements and new materials at a modest cost penalty. Successful flux free brazing with excellent control has been demonstrated and validated in components including chillers which have surpassed burst requirements. The reviewer noted that Mahle believes the flux-free technology will be independently applicable to components in any vehicle.

Numerous components have been successfully designed and built including chillers, compressors, pumps, and heat exchangers. Bench testing has confirmed successful valve operation and the absence of leakage. Through simulation, a baseline range improvement of 15.5% at -10^0 C has been projected through reductions in energy requirements for cabin warm-up and driving cycle steady state operation. However, it is not clear what the projected quantified range improvement is over the entire driving cycle under more typical operating temperatures. Although, the presentation does indicate that energy reductions and subsequent range improvements will be had throughout the span of cold weather operation, with a modest penalty incurring at warm temperatures.

Reviewer 2:
The reviewer commented accomplishments and progress seem satisfactory but it is tough to justify business case to proceed to a conclusion.

Reviewer 3:
The reviewer said good results based on hardware iteration.

Reviewer 4:
The reviewer remarked that when this project was presented, it was a bit confusing as to whether the flux free product would be put in production, or whether the plastic part would move to production. The reviewer noted

that there was little data provided to address questions about through put or quality of the manufacturing process. The reviewer questioned if this was well thought out because data does not exist.

Reviewer 5:
The reviewer remarked coolant distribution network is the novel part of project. The reviewer noted a heat pump with low level of working fluid it intelligently channels fluids to individual elements.

The reviewer stated the project had leakage of fluids between loops. This problem was solved and the reviewer suggested it is patentable. The reviewer suggested a need to develop flux free brazing method. The project has demonstrated significant energy use reduction.

Reviewer 6:
The reviewer noted the project is behind schedule for reasons that were not fully explained by the presenter. The reviewer suggested mitigation plans for how to re-establish a feasible schedule should be developed. This plan should include additional baseline testing as mentioned in the approach review section.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed this project has a strong and well-balanced team including Mahle, Norgren, Fiat Chrysler Automobiles (FCA), and NREL. All the principal areas are represented including system developer and integrator, valve manufacturer, OEM, and independent testing and verification entity. This reviewer reported that the PI conducts regular communications and coordination with project partners through bi-weekly WebEx meetings and frequent site visits. The reviewer said Mahle indicated it has been in discussions with other OEMs with regards to this technology, but it would be good to incorporate additional OEMs more formally if viable at this stage of the project.

Reviewer 2:
The reviewer said there was collaboration with Mahle, Norgren, FCA and NREL.

Reviewer 3:
The reviewer reported there is good collaborations in line with a production oriented product development. An OEM will test the system now that it is designed.

Reviewer 4:
The reviewer commented there is a good balanced collaborative team. Hopefully this will result in an implementation with FCA

Reviewer 5:
The reviewer reported the collaborations are good, but a battery OEM would be a useful partner in developing a system that will impact EV range. A battery OEM partner should be sought for insight and advice into thermal management of batteries.

Reviewer 6:
The reviewer cannot recall substantive partner 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 reported this effort has for the most part stayed on schedule and proposes a straight-forward approach for future research and completion of the project. Key remaining elements are targeted in budget period three including completion of the commercially viable, plastic MMFC; development of vehicle controls; durability validation of components; manufacturing plan and cost estimates; and vehicle testing, build, and final analysis and delivery to DOE.

The reviewer observed that Mahle mentions that in budget period three, there is going to be focus on project cost and timing. This is good, but an additional suggestion as part of this effort is to not only focus on the directly quantifiable cost elements of bringing the technology to commercialization, but also approaches to overcome the associated intangibles. For example, this may include the reluctance of an OEM HVAC or other engineers to adopt the new technology given inherent risk aversion and the constraints of the vehicle design and technology integration cycles, or possibly consumer acceptance.

The reviewer remarked there is a lack of complete clarity on the ultimate energy savings of this proposed technology over realistic drive cycles across typical ambient temperatures. It is shown there is a range penalty at warm temperatures. The reviewer noted that a question arises as to the strategy to sell a UTEMPRA equipped EV in warm climates. The reviewer questions how this would be handled from an OEM marketing standpoint and wonders if the UTEMPRA system would be offered as an option only in relatively cold climates. In addition, the reviewer questions if this is viable from an OEM manufacturing and integration standpoint.

Reviewer 2:
The reviewer suggested there is still much to accomplish for this project. A plan to accelerate progress that does not depend necessarily on the no-cost extension by the DOE should be developed.

Reviewer 3:
The reviewer noted this was a rather lengthy project with a large amount of DOE money. Financial overruns on the project were handled by Mahle. The reviewer has a concern as to why DOE was paying for a process improvement process in moving to flux free, which seems like it would be more of a benefit to Mahle besides cooling for electronic components. However, not much was presented on how this was progressing, how the manufacturing was progressing, or if there was improved quality and lower cost. There also was not a comparison of flux free, versus plastic, versus machined aluminum.

Reviewer 4:
The reviewer remarked it was the project's intention is to complete the design, pre-validate through OEM testing, and continue with a low-cost production design scheme.

Reviewer 5:
The reviewer commented that it is recommended that the vehicle test be performed by an independent party.

Reviewer 6:
The reviewer said improvement versus status quo future is not great.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

The reviewer stated electric vehicles have the potential to significantly reduce the transportation sector's reliance upon petroleum. However, they currently face challenges including range limitations due to battery capacity and the high energy use for climate control especially at low operating temperatures. The development of a commercially viable, high efficiency heat pump system to reduce energy requirements for climate control will help mitigate the range penalty for EVs and increase commercial viability. Additionally, some of the technologies developed under this project, such as flux free brazing, are potentially applicable to a broad range of other vehicles and components both electric drive and conventional.

Reviewer 1:
The reviewer observed lower energy use in EVs allows for longer range and potential increased adoption of petroleum displacing EVs.

Reviewer 2:
The reviewer remarked, this addresses the significant auxiliary power usages of climate control which impacts range and thus consumer acceptance.

Reviewer 3:
The reviewer said EV range is negatively and significantly impacted by extreme temperatures. A novel thermal management system (TMS) certainly aligns with DOE goals of extending the range of EVs with the goal of reducing petroleum consumption.

Reviewer 4:
The reviewer commented that the project somewhat supports the overall DOE objectives

Reviewer 5:
The reviewer noted petroleum displacement prospects seemed 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 observed as indicated by Mahle within the presentation, financial resources to successfully complete this project are sufficient. Despite exhaustion of resources for budget periods one and two, no significant resource issues have been highlighted. Current projections indicate that financial resources required to finish budget period three will be underspent by about five per cent, therefore, funding is sufficient. The reviewer said sufficient human resources for engineering are available with Mahle having brought on board a control engineer and FCA assigning a test engineer.

The team has the full span of equipment and facilities necessary to successfully complete the project.

Reviewer 2:
The reviewer noted the resources appear to be sufficient for this project.

Reviewer 3:
The reviewer said resources seem good.

Reviewer 4:
The reviewer said the project is staffed in accordance with a production oriented development program.

Reviewer 5:
The reviewer opined that funding seemed to exceed value proposition and that achieving milestones in a timely basis was secondary.

Reviewer 6:
The reviewer commented obviously, resources are insufficient. There was a cost overrun.

Presentation Number: gi158
Presentation Title: Zero Emission Cargo Transport II: San Pedro Bay Ports Hybrid and Fuel Cell Electric Vehicle Project
Principal Investigator: Joseph Impullitti (SCAQMD)

Presenter
Joseph Impullitti, SCAQMD

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 this project involves the demonstration of a wide variety of advanced vehicle powertrains in several types of applications. These types of deployment projects align well with DOE goals of petroleum displacement because of the real-world data on usage and performance. This project is well designed and involves industry consortia with that require relevant expertise.

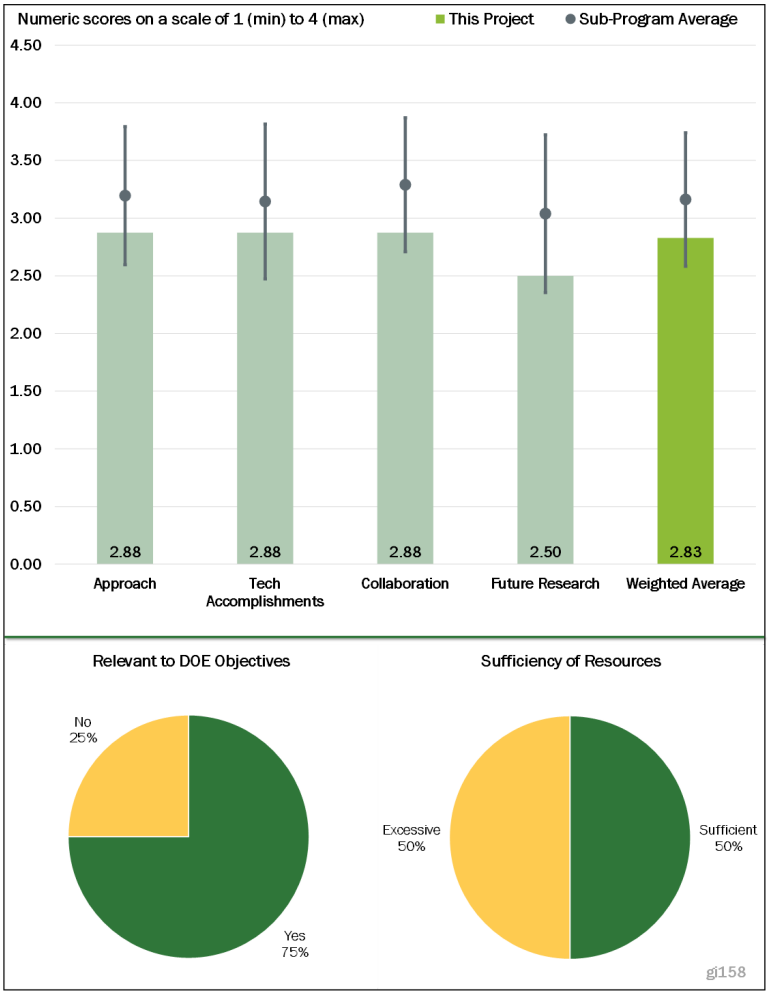

Figure 6-9 - Presentation Number: gi158 Presentation Title: Zero Emission Cargo Transport II: San Pedro Bay Ports Hybrid and Fuel Cell Electric Vehicle Project Principal Investigator: Joseph Impullitti (SCAQMD)

The reviewer suggested the project could include an analysis of the potential for fuel cell technology in these applications, including a cost analysis and H_2 production and infrastructure analysis. The project could also include an investigation of other H_2 storage technologies besides compressed H_2.

The reviewer also suggested a battery OEM partner would be a useful addition to the project group.

The reviewer commented RDE testing with PEMS units would be useful with the hybrid vehicles in order to be able to quantify the emissions advantages of the fuel cell-based vehicles.

Reviewer 2:
The reviewer stated the approach being used of all existing fuel cell companies is good, but should be more clearly identified as part of the objective. There are not many opportunities for these kinds of comparisons between companies in this high technology space.

Reviewer 3:
The reviewer questions how DOE's goals are severed with OEM's and contractors deploying already existing technology. In addition, the reviewer questions if this advances research.

Reviewer 4:
The reviewer observed this project has big bucks, but the approach seems to be to just try this and that and one of those, because it will probably work. There does not seem to be any background plan of what types of features might be most useful for different vocations, with an attempt to design vehicle characteristics to match needs. The reviewer remarked each design is well thought through and technically sound, but the project team should figure out which make sense and focus on those. The reviewer suggested the different types of trucks need to be compared to each other and to conventional alternatives.

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

Reviewer 1:
The reviewer noted all the pieces are being addressed in a timely manner.

Reviewer 2:
The reviewer stated technical progress seems alright on vehicles (although difficult to gauge with so many combinations and approaches). There is little mention of progress on fueling infrastructure, which is identified as a significant barrier on this project.

Reviewer 3:
The reviewer said the vehicle build and deployment appear to be on schedule. The establishment of the temporary H_2 refueling should provide sufficient capability for the deployment. The project was able to successfully replace industry partners, which is a testament to the mitigation plan and/or abilities of the PI to manage unforeseen circumstances.

Reviewer 4:
The reviewer remarked the progress seems slow considering that the project is in its fourth year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer affirmed collaborations with industry are the strength of this project. The various industry partners are highly representative of the significant and active participants in the advanced powertrain HD industry. The reviewer suggested a battery OEM partner would be a welcome addition in these projects instead of simply integrating cells and modules by the overall integrator. Additionally, an academic collaborator would help deepen the analysis, including both the performance against other powertrain technologies but also on the commercialization side.

Reviewer 2:
The reviewer observed there are lots of industry partners, all working away, but did not see anybody doing any analysis of performance or potential benefits, not to mention costs.

Reviewer 3:
The reviewer remarked there are lots of partners on this project, which is a benefit. However, actual collaboration seems lacking between the different contractors and some of the historical Drayage vehicle projects from the past.

Reviewer 4:
The reviewer mentioned although there was no specific slide on collaborators it seems like there are a number of contractors 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 acknowledged the proposed work to complete the deployment and testing appears to be feasible and on schedule. Development of the test plan for the vehicles is not explicitly shown, and considerable thought should be put into how these vehicles will be monitored and what will constitute a success in the deployment phase.

Reviewer 2:
The reviewer noted the proposed future research is a continuation of what the project team has been doing, which is lots of different trucks being developed and tried. The reviewer suggested some project integration and analysis and comparison of technologies.

Reviewer 3:
The reviewer commented fuel cells is future enough. There was little said in the presentation about future work, but fuel cell applications are likely to be in the future for some time.

Reviewer 4:
Although, FY 2019 is referenced as the end of project, this reviewer pointed out that no future work was mentioned.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer observed this project supports the overall DOE objective of petroleum displacement by advancing the art in advanced powertrains in HD vehicles. HD vehicles have significant potential for fuel economy improvements, and this deployment project provides considerable learning opportunities for government, industry, and the general public.

Reviewer 2:
The reviewer said any one of the technologies under development would use less diesel than conventional trucks.

Reviewer 3:
The reviewer noted fuel cells provide 100% reduction in petroleum use.

Reviewer 4:
The reviewer commented that no mentioned of actual petroleum savings was made.

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 the cost share of 50% means that industry is providing a significant amount of funding, which is advantageous leveraging of industry resources. The overall funding amount is large, but deployment projects that involve significant design work require this funding level.

Reviewer 2:
The reviewer commented the project has big bucks, but it is developing and demonstrating a whole set of different technologies. The reviewer noted f everybody's budgets are slashed, one could consider funding only those shown to be most practical, but then somebody would need to do analysis to see which.

Reviewer 3:
The reviewer commented that $20 million seems a lot of resource for demonstration of four different vehicles that do the same thing. The funding also does not address one of the primary barriers to adoption which is infrastructure. The reviewer suggested there seems like there would be a better way to spend this much money to promote hydrogen fuel for this application and considers it to be a good application for the technology.

Reviewer 4:
The reviewer noted the funding level seem high compared to the accomplishments.

Presentation Number: gi161
Presentation Title: Multi-Speed Transmission for Commercial Delivery Medium-Duty Plug-In Electric Drive Vehicles
Principal Investigator: Bulent Chavdar (Eaton)

Presenter
Bulent Chavdar, Eaton

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 the approach seems fine, but hardware in-the-loop (HIL) in-vehicle testing timeline is not well-presented. Vehicle demonstration is due to be complete in October, which seems fast, but this is the part of the project where ORNL and Proterra start doing their testing. The reviewer remarked that it seems like scheduling and coordination will more difficult and/or complicated than presented here.

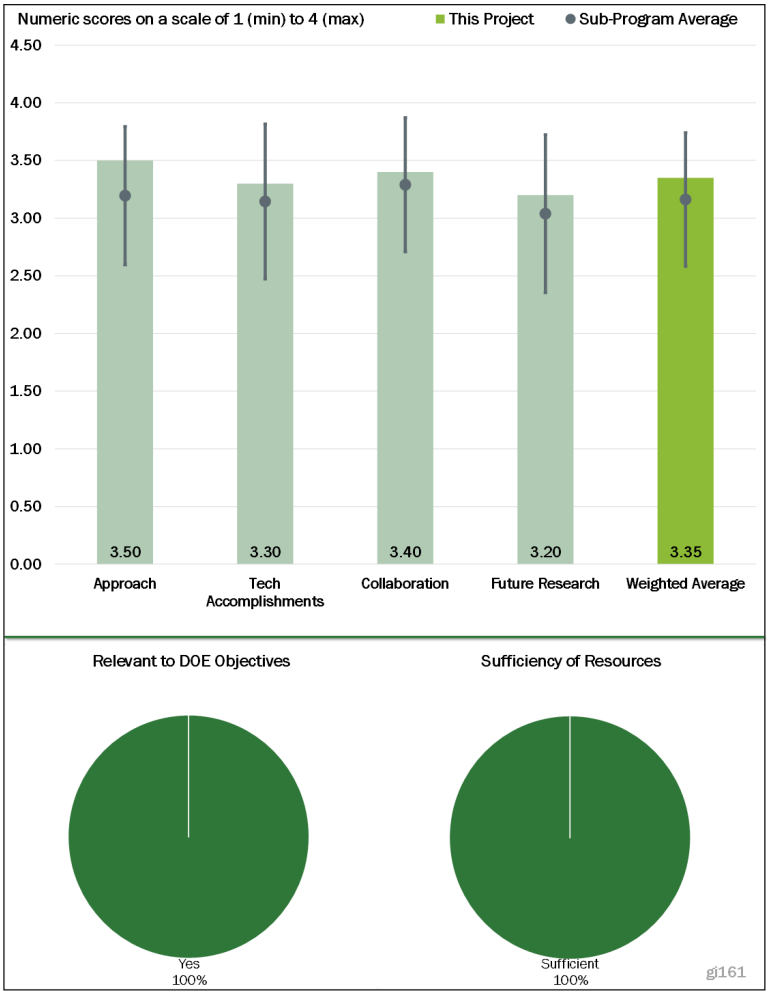

Figure 6-10 - Presentation Number: gi161 Presentation Title: Multi-Speed Transmission for Commercial Delivery Medium-Duty Plug-In Electric Drive Vehicles Principal Investigator: Bulent Chavdar (Eaton)

Reviewer 2:
The reviewer stated this was a good idea, and it looks like technical details have been addressed carefully.

Reviewer 3:
The reviewer observed the weight reduction is a significant achievement in addition to the other performance achievements. The details of how this was achieved should be explained in more detail as this would add more value to the overall project.

Reviewer 4:
The reviewer noted the class of vehicle range for this transmission is not feasible. There are many technical barriers between class seven bus duty cycles and a class three van duty cycle. The reviewer suggested this should be focused on class one or two 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 towards DOE goals.

Reviewer 1:
Regarding the improvements on Slide 3 showing Urban Dynamometer Driving Schedule efficiency and acceleration, the reviewer questioned what the contribution ratio for the improvement consists of between weight reduction, design/control improvements or something else.

Reviewer 2:
The reviewer observed the modeling results look good and are to be validated against in-vehicle performance.

Reviewer 3:
The reviewer noted the project appears to be on target and the results look very promising.

Reviewer 4:
The reviewer reported performance goals for class seven appears to be feasible.

Reviewer 5:
The reviewer said there is a solid team assembled on this project.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed a good team with DOE and other industry partners and stated that the upcoming four months is the part where the collaborators get to play their role. The reviewer commented that the project has a very compact schedule and that coordination is required to realize value from the collaborations.

Reviewer 2:
The reviewer said a small solid team promotes this.

Reviewer 3:
The reviewer suggested the project team should have some end user participation to obtain some real-world usage by class.

Reviewer 4:
The reviewer suggested actually getting a vehicle partner to enable much improved project integration and coherence.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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, as previously indicated, was unsure that the future work planning is presented with enough detail and was not convinced that HIL/in-vehicle testing can be done in the timeline presented.

Reviewer 2:
The reviewer remarked again, the project team needs end user participation.

Reviewer 3:
The reviewer noted how the equipped buses actually perform will be the interesting part. It would also be interesting to install the system in other vehicles. The reviewer indicated one question not addressed is how much improved performance will enable the more rapid penetration of electric vehicles.

Reviewer 4:
The reviewer indicated there is not much research left to do.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer indicated the project supports the DOE objectives through the development and vehicle integration of an efficient and low weight transmission.

Reviewer 2:
The reviewer stated yes, the work supports the DOE objectives.

Reviewer 3:
The reviewer state yes, performance on class seven buses show improvement.

Reviewer 4:
The reviewer said having EVs that actually perform well is a prerequisite for actual market penetration. If the bus takes a week to get up the hill, you cannot use it in San Francisco.

Reviewer 5:
The reviewer indicated not being convinced this is the best way to reduce petroleum usage compared to other projects but it has value.

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 the resources seem fine.

Reviewer 2:
The reviewer suggested the project team could use an end user in this project.

Reviewer 3:
The reviewer noted the project team did lots of work.

Presentation Number: gi165
Presentation Title: Design and Implementation of a Thermal Load Reduction System in a Hyundai PHEV
Principal Investigator: Cory Kreutzer (National Renewable Energy Laboratory)

Presenter
Cory Kreutzer, National Renewable Energy Laboratory

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 the approach is to segment the individual parasitic load elements and to address each of them with individual technology improvements. In addition, it increases range with a low climate system energy load using solar control glass and reflective paint as well as a pre-loaded heating system. The reviewer said this is an excellent approach.

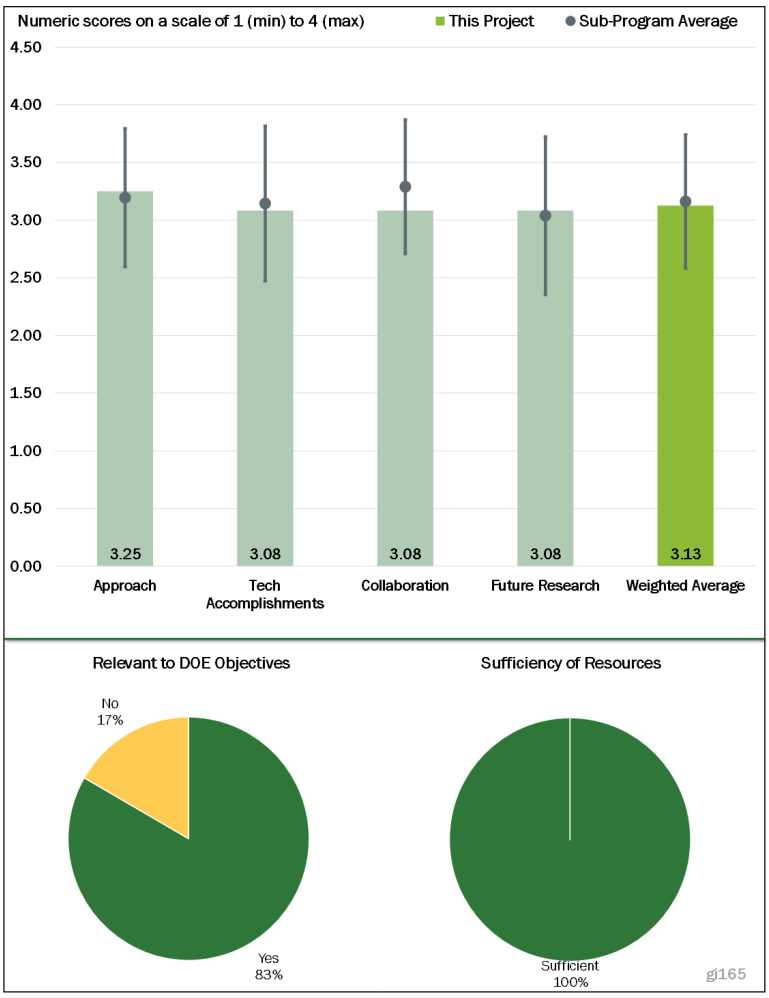

Figure 6-11 - Presentation Number: gi165 Presentation Title: Design and Implementation of a Thermal Load Reduction System in a Hyundai PHEV Principal Investigator: Cory Kreutzer (National Renewable Energy Laboratory)

Reviewer 2:
The reviewer described this as an excellent approach to overall project with good consideration of resources required and solid partnerships established for effort. Additionally, this reviewer observed good recognition of areas that would impact comfort of passengers and understanding of need for various performance measures including windshield clearing. The reviewer noted it is difficult to solve cost barrier without better partner supplied data, to understand ROI. The grid connected vehicles can provide much of transient power without impact to all electric range (AER).

Reviewer 3:
The reviewer remarked this project incorporates a two-phase process. First the design and development including evaluation and analysis, and second integration and validation including full system impact on range, national impacts, and occupant comfort.

The reviewer stated the project is fundamentally well-designed and feasible from a technical standpoint, with a goal to increase grid-connected electric drive vehicle (EDV) range by 20% during operation of the climate control system over a standard baseline.

The energy savings potential during transient and steady state operation of five technology areas are addressed for climate control including: solar control glass/heated windshields, solar reflective paint, heated surfaces, climate control seating, and door glass defrost/defogger.

The reviewer commented it is not clear how well the project is integrated with other efforts.

Understanding the proprietary challenges, there is little discussion or analysis with regards to technology costs and the potential impact upon commercialization.

Reviewer 4:

The reviewer reported that it is clear the testing that was done relative to occupant comfort is one of the most subjective aspects of the project. The researchers should provide more detailed information on the approach used to conduct these tests to that the validity of the results can be better supported.

The reviewer noted Slide 12 presents numbers on the efficacy of solar reflective paint to a very high degree of precision. Given the part-to-part variability perhaps the results should be rounded off to fewer significant digits, to prevent creating a false impression of accuracy.

Reviewer 5:

The reviewer acknowledged that this was not a favorite paper to evaluate. The reviewer remarked that this looked like suppliers looking for reasons to incorporate their technology onto vehicles. There was not an overall system approach to a vehicle, which would also incorporate electrical loads on the vehicle, wiring, and costs.

Reviewer 6:

The reviewer noted the business case is better than others reviewed.

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

Reviewer 1:

The reviewer commented that many areas for energy use reduction were evaluated. Some were experimental level with base data fed to analysis of cabin thermal loads and how they affect EV range; numerous glass technologies were evaluated at 23%-43% reduction of load. The reviewer also reported the following: solar reflective paint was different; used ventilated and cooled seats; used heated surfaces like arm rests coupled with improved heated seats are more important in steady state; no transient improvement and heated windshield and door defogger. This broad range of items establishes excellent technical progress.

Reviewer 2:

The reviewer stated the project has made good progress to timeline and milestones. The reviewer commented that highlighting the large transient loads needed to establish comfort prior to stabilization is important for many projects, and allowed good use of prior work regarding simulation tools. The reviewer noted the project seems on track to complete on time, though still question whether or not impact to AER will calm OEM apprehension about investing in new technology or change perceptions for potential vehicle buyers.

Reviewer 3:

The reviewer observed the project completed Phase one, candidate technology evaluation, and downselection for Phase two, system level integration and evaluation. The project has demonstrated a number of technical accomplishments with regards to quantifying the energy savings potential of the downselected technologies in five technology areas under summer cooling and winter heating scenarios.

Summer cooling conditions accomplishments include glass package: 42.5% transient and 12.8% steady state energy savings, solar reflective paint: 5.3% transient and 16.1% steady state savings, ventilation / cooled seat: 25%-45% transient and 10%-17% steady state savings and heated surfaces: 1%-2% transient and 29%-59% steady state savings. Under winter heating conditions 19.5% reduction in time to clear windshield and 24.5%-67.8% reduction in power demand and the project has developed a national level analysis process for range estimates under varying U.S. environmental conditions.

Reviewer 4:
The reviewer noted accomplishments and progress were in line with goals.

Reviewer 5:
The reviewer observed progress is being made toward the goal, but in the end, the proof is in the pudding. Once the national level analysis has been completed, it will give a better idea of the petroleum displacement potential. The national level analysis will presumably consider several different scenarios and evaluate a range of possible outcomes.

Reviewer 6:
The reviewer noted accomplishments are good, not great. The reviewer did not want to rate the project lower than good. The reviewer indicated some of this technology is old news in the industry. Costs are especially important on this, not just engineering data. The reviewer suggested what has to be looked at are various OEM standards for heating and cooling of occupants.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented there is a very comprehensive group of collaborators representing the individual technology expertise for each energy saving areas listed.

Reviewer 2:
The reviewer noted there is a good set of collaborators, though seems a little bit like a hard sell from suppliers to leverage government funds for R&D.

Reviewer 3:
The reviewer remarked the NREL project team incorporates all the requisite partners including technology developers in each technology area and a major automotive OEM supplier for overall integration and assessment.

The reviewer said there is little mention of discussions with other automotive OEM suppliers or OEMs to potentially broaden out the market base for the respective technology options.

Reviewer 4:
The reviewer stated collaboration with others was demonstrated and good.

Reviewer 5:
The reviewer noted several industry partners are included, but it does not seem to be including other national laboratories. Given the funding atmosphere, perhaps more involvement of other laboratories should be sought.

Reviewer 6:
The reviewer suggested this project really needs someone to look at the costs, system integration and manufacturing complexity of these ideas. This is not done here.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 future research prospects look good.

Reviewer 2:
The reviewer is looking forward to results of the national level analysis.

Reviewer 3:
The reviewer reported the project is completed in FY 2017 when the validation testing at Death Valley and in the cold chamber at Hyundai American Technical Center, Inc. This will establish a path to commercialization and will complete a research project that evaluates elements of new technology that when grouped together will meet the 20% reduction goal.

Reviewer 4:
The reviewer suggested there is a need to continue to report out on possible solution set to the items that reduce range for EVs.

The reviewer remarked future work may need to include some sort of human factors standard set of comfort but not to develop it, just to do research to see what exists with industry experts. This would eliminate some of the perceived variability in participant response to tests with same parameters.

Also, the project may look to EV use in colder climates to see what percentage of operators complain about windshield clearing performance, or if they even understand the range impact.

Reviewer 5:
The reviewer reported future proposed research as part of Phase two includes cold and warm temperature evaluation in an environmental chamber and hot weather field evaluation for baseline and thermal load reduction system vehicles plus refinement and validation of models and performance of national level energy savings analyses.

The reviewer suggested to the extent feasible, future proposed research would benefit from a greater emphasis upon cost analysis and development of technology packaging approaches to best present the technologies' energy savings potentials to automotive suppliers and OEMs. For example, as proposed, all downselected Phase two technologies will be integrated into a vehicle for cold and hot weather performance evaluation. But, the reviewer questions if this approach will provide the disaggregated data necessary to encourage one or a suite of these technologies to be adopted by the OEMs. The reviewer asked if there is a clear understanding of the optimal pathway and thereby the appropriate Phase two testing, analysis, and information dissemination strategy to encourage adoption of these technologies singly or as a group.

Reviewer 6:
The reviewer suggested to not continue this path.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer indicated this project will create a path to commercialize energy efficiencies in EVs and hybrid electric vehicles making them more desirable to consumers. The reviewer noted more EVs means more petroleum displacement.

Reviewer 2:
The reviewer noted obviously, increased market penetration for EVs would aid the DOE objective of petroleum displacement. Performance of HVAC and passenger comfort for EV has great potential to reduce customer apprehension, and counteract reduced range fears. Still, there is a great need to understand the cost of these solutions.

Reviewer 3:
The reviewer commented this project is relevant as the range of EVs is severely limited in extreme weather conditions, especially cold temperatures. The goal of this project is to extend grid connected EDV range by 20% through thermal load reductions which will significantly improve mainstream commercial viability leading to greater petroleum displacement.

Reviewer 4:
The reviewer stated energy reduction met objectives.

Reviewer 5:
The reviewer said it is weak.

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 based on task progression, being 80% complete, and projected remaining work, funding resources appear to be adequate. The equipment and personnel are available to conduct the remaining elements of the project.

Reviewer 2:
The reviewer noted a very wide range of expertise in individual technologies as well as a good integration partner in Hyundai. Resources are sufficient because the project is on a path to achieve its objectives in the timeframe originally proposed the reviewer reported.

Reviewer 3:
The reviewer stated resources are alright.

Reviewer 4:
The reviewer said the project should finalize in a timely fashion.

Reviewer 5:
The reviewer remarked it appears that a good part of the work remaining is the responsibility of the other industry partners.

Reviewer 6:
The reviewer commented that while resources are bordering on excessive, in terms of reduced petroleum per dollar of R&D, this project helps to validate a number of tools and concepts which should be able to be projected thru use of tools in the future.

As stated previously, transitional thermal loads for Grid connected vehicles should be moved to vehicle preconditioning. The steady state load understanding is a greater area of importance in my view, and critical to understand the impact of AER and cost to adopt these technologies. In truth, some of cooling techniques are applicable to standard ICE vehicles, which could reduce their air-conditioning use, thus bringing technology costs down thru economies of scale. The project just has to get someone to identify that this is a critical customer demand.

Presentation Number: gi187
Presentation Title: Comprehensive Assessment of On- and Off-Board Vehicle-to-Grid Technology Performance and Impacts on Battery and the Grid
Principal Investigator: Sunil Chhaya (EPRI)

Presenter
Sunil Chhaya, EPRI

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 all the technical pieces are going to be addressed in this new project, and does not see any insurmountable technical barriers. The only minor misgivings the reviewer has to do with the human factors and the actual benefits to be accrued. The reviewer inquired about the potential and whether any car-owner wants to have a car on the grid while at work. The reviewer noticed that the battery life study will show that battery life will be reduced, so it may be a commercial non-starter.

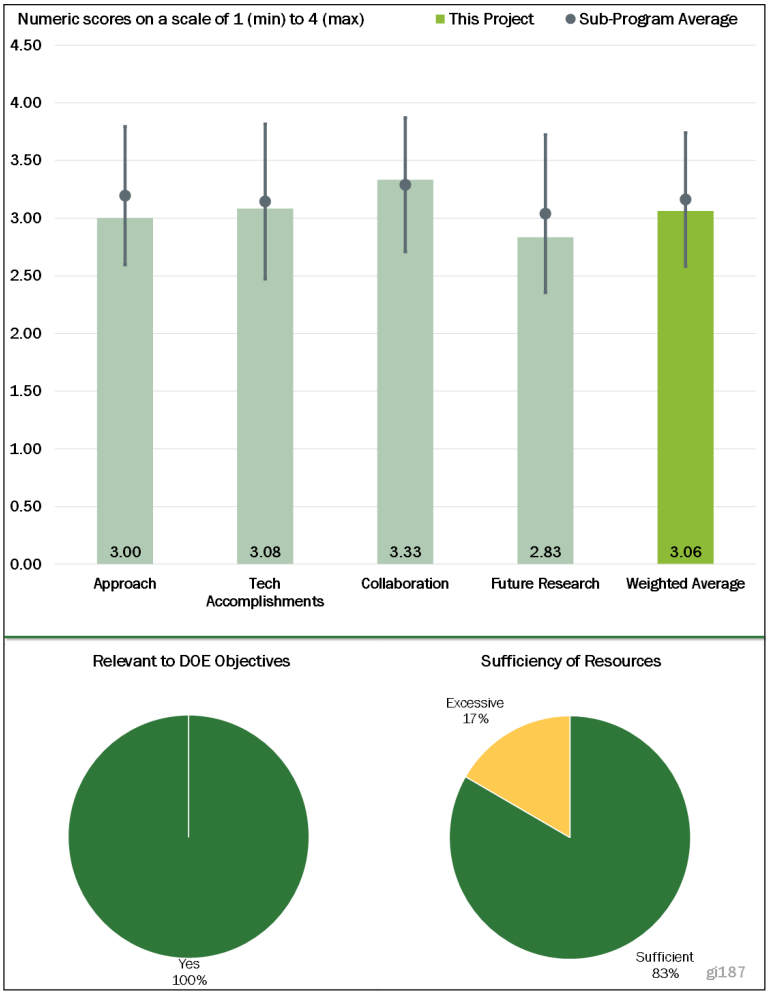

Figure 6-12 – Presentation Number: gi187 Presentation Title: Comprehensive Assessment of On- and Off-Board Vehicle-to-Grid Technology Performance and Impacts on Battery and the Grid Principal Investigator: Sunil Chhaya (EPRI)

Reviewer 2:
The reviewer remarked the project seems to include a very ambitious set of activities, covering a broad range of efforts with a large number of milestones scheduled over a relatively short period of time. Some activities are clearly parallel paths, but some are inter-related. The hope is that all will occur as planned, or else there may be concerns on multiple activities backing up.

The reviewer observed the overall structure appears to be trying to answer a lot of questions with this one project and these are important questions to answer. Time will tell exactly how well the approach has been structured since the project only began in November 2016.

Reviewer 3:
The reviewer likes the approach to the work.

Reviewer 4:
The reviewer reported this project is very diffuse. This reviewer opined that it is a bit difficult to get a grip on all of the pieces because there are really two separate systems being developed: one is for the DOE, off-vehicle; and one is for the California Energy Commission (CEC), on-vehicle. The reviewer observed this project seeks to develop a suite of controls and power electronic systems that can enable V2G, but there are many aspects that are not clear.

Reviewer 5:
The reviewer commented that the technological approach is pre-mature. Just like all information technology enterprise systems, the business requirements must be worked out and articulated with each business owner associated with a requirement before taking a technological approach. The reviewer noted here the business requirements were never worked out or articulated. It is not even clear that there is a business case for this study. Neither a test cycle nor a business model has been worked out yet.

Reviewer 6:
The reviewer remarked V2G is a promising technological application, but the business case still needs to be made. If it can be implemented, it supports the DOE petroleum displacement goals. However, while V2G demonstrations are useful, the satisfaction of the various stakeholders in V2G deployment (e.g., the vehicle OEMs, ESS OEMs, utilities, vehicle owners, and building owners) must be ensured. The reviewer suggested a comprehensive analysis of the V2G business case is thus warranted.

The reviewer said the still-developing standards for V2G make this project challenging in that it is less than ideal to be testing communications protocols that may be changed in the future. Every effort should be made to support the standards development and acceptance by the V2G community and industry to ensure the relevance of this project.

The reviewer acknowledged the on- and off-vehicle parallel paths are useful in showing which path has the most promise for V2G 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 towards DOE goals.

Reviewer 1:
The reviewer said the progress on both paths appears to be on schedule from a technology standpoint, albeit with protocols that have not yet been finalized within a standards framework. The use cases must be addressed in a comprehensive manner. This complements the business case mentioned in the Approach section.

Reviewer 2:
The reviewer remarked the project began only last November, so it is early. The reviewer noted the milestones for early 2017 have been accomplished, though not that much of the funding has yet been spent (5% according to the presentation, at least at the time the presentation was prepared). No other milestones are scheduled until October 2017. The reviewer said accomplishments are in line with the project's plan, however, at this time it is hard to tell if the planned schedule will be sufficient to complete planned activities on time.

Reviewer 3:
The reviewer noted this is a new project.

Reviewer 4:
The reviewer stated it is so early in the project that this question regarding accomplishments is actually somewhat meaningless. The researchers are focused on the technical details, which is both the strength and the weakness of the project.

Reviewer 5:
The reviewer noted the progress to DOE goals needs to be more explicitly stated in a front slide. However, it is understood that V2G is important, along with standards to meet this goal. The project is just getting started.

Reviewer 6:
The reviewer indicated the goals are not well-defined instead, they just seem to be fuzzy, motherhood, apple-pie concepts. The goals do not seem to be quantifiable at this point in time.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said the project is coordinating among the utility industry (through Electric Power Research Institute (EPRI), the Principal Investigator organization), hardware manufacturers, a vehicle manufacturer, and several national laboratories. These appear to be the critical participants necessary. The reviewer noted the project is also focused on particular requirements for California, coordinated through the CEC.

Reviewer 2:
The reviewer reported it seems like a good team with utilities, DOE and other industry partners.

Reviewer 3:
The reviewer praised the collaboration with Government and Industry, and that the project team used multiple vehicles.

Reviewer 4:
The reviewer commented the team looks good, and the division of tasks seems appropriate.

Reviewer 5:
The reviewer remarked an electric power utility supplier or distributor was not included in this project unless it has been made clear that EPRI considers itself as taking on that role.

Reviewer 6:
The reviewer suggested more engagement with industry partners (specifically, more vehicle and ESS OEMs) as well as academic partners might improve the project results. The collaborations that already exist appear to be working well with strong coordination.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 many of the upcoming activities are identified, although the PI acknowledges a few will develop over time which is likely the appropriate approach. The planned future activities appear to answer many of the remaining questions for this project, but, due to the broad scope of this project, it is a bit early to tell if these are exactly the correct activities needed. The PI stated that they are still looking for participants for future efforts. The PI did indicate that EPRI has already been awarded a follow-on project by the CEC.

Reviewer 2:
The reviewer stated since this project is quite new, most of the work remains in the future. The proposed future research work appears to be part of a feasible and logical schedule and implementation plan.

Reviewer 3:
The reviewer commented the project plans to address all of the technical aspects thoroughly and would like to see some analysis of the detailed logistics and the human factors. The reviewer question if a car is plugged in at work, will there be enough charge left to get the person home. Also, the reviewer wonders if the user will need to charge more often, will they be compensated and what would happen if the user needs to leave for an emergency will they be able to get there.

Reviewer 4:
The reviewer noted as this project is just in start-up mode, there is not much mentioned about future work. However, the reviewer would like to see a more phased approach on the work, assuming that the project team is successful in this approach.

Reviewer 5:
The reviewer commented regarding the "off-vehicle" system, this project proposes the equivalent of a smart inverter. These smart inverters are commercial products and, (in general) the EVSE is mostly an alternating current cord and ground fault circuit interrupter, so it is unclear what is particularly novel about this SPIN inverter. The reviewer questions why this is a single box, as opposed to a distributed system and wonders if it should be able to use off-the-shelf EVSE and be able to communicate with the TMC.

The reviewer has many questions about the business case that will be developed. The speaker said that they were aiming to do more than just frequency regulation, but some of the information on the slides suggests that frequency regulation is under consideration. For example, Slide 7, Slide 12 suggests A/S and International Standards Organization integration. The reviewer suggested that maybe it is just that this business case development process needs to be clarified. The reviewer questions what the metrics of economic viability would be for this technology.

For the battery testing task, the reviewer is a bit concerned that this project will only be able to do a couple of designed experiments to look at battery degradation due to V2G cycles. The planning for these experiments should be based on the economically viable V2G use cases.

Reviewer 6:
The reviewer noted the business requirements have not been worked out yet. In addition, there is no duty cycle defined and no business model postulated. All that exists are concepts.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer observed the project is highly relevant in obtaining critical answers necessary for plug-in electric vehicles to succeed. As such, this clearly supports DOE objectives and petroleum displacement.

Reviewer 2:
The reviewer noted V2G may become a major component of demand response activities. This may not support petroleum displacement directly in that petroleum is not used in a large percentage of U.S. electricity production; however, V2G may improve the cost of EV ownership, and this certainly helps displace petroleum. Thus, this V2G project does support DOE goals.

Reviewer 3:
The reviewer noted V2G is an incentive to electrify transportation.

Reviewer 4:
The reviewer stated yes, the project supports the DOE objectives but, would like the PI to please state it more explicitly. We all understand that electric vehicles are important for petroleum displacement.

Reviewer 5:
The reviewer stated that clearly making the grid more robust enables more EVs. The reviewer suggested providing some quantitative benefits estimate in terms of reduced costs to utility from unneeded peakers or unpurchased storage.

Reviewer 6:
The reviewer remarked the principal investigator should have elucidated (instead of assuming that the reader knew) that this project would help with peak loading or peak shaving by balancing peak electric power demands with surplus electric power stored in electric vehicles and allowing electric vehicles to be re-charged during non-peak periods. No study was cited or referenced to show that this is feasible.

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 the resources appear to be sufficient for this project that includes a large technology development and deployment portion.

Reviewer 2:
The reviewer indicated if funded as proposed, funding appears sufficient. In addition, EPRI has received a follow-on project from California.

Reviewer 3:
The reviewer said resources seems fine.

Reviewer 4:
The reviewer remarked since there are lots of technical details to be addressed, and that is expensive, there is not too much money. The reviewer still wonders whether the whole concept makes sense. It is certainly possible, but asks if is worth it. The reviewer questions if the concept could it actually fly commercially and what its potential mat be.

Reviewer 5:
The reviewer noted that funding for this project is excessive when it is primarily a paper study.

Reviewer 6:
The reviewer commented the project has just begun and will have more information available to be reviewed in a year’s time.

Presentation Number: gi188
Presentation Title: Bi-Directional Wireless Power Flow for Medium-Duty Vehicle-Grid Connectivity
Principal Investigator: Mike Ippoliti (CALSTART)

Presenter
Mike Ippoliti, CALSTART

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 the risk aversion and cost barriers are well addressed since ORNL has previously demonstrated a 20 kW WPT mono directional system integrated into a Toyota Prius. The constantly changing technology barrier is also addressed by the head start that ORNL has using a previously demonstrated design. The computational model barrier is also likely well addressed since ORNL can leverage its existing models to include the secondary to primary power flow model.

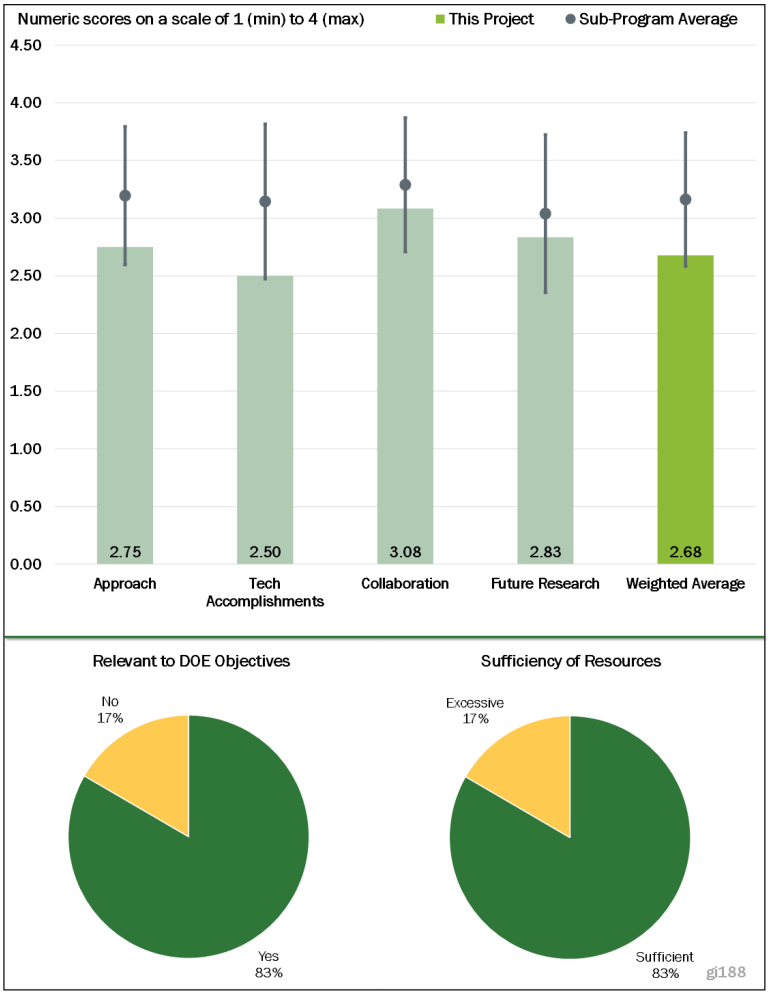

Figure 6-13 - Presentation Number: gi188 Presentation Title: Bi-Directional Wireless Power Flow for Medium-Duty Vehicle-Grid Connectivity Principal Investigator: Mike Ippoliti (CALSTART)

Reviewer 2:
The reviewer stated the approach seems logical but it is still early in the project.

Reviewer 3:
The reviewer understands the difficulty of identifying the best partners for application and demonstration projects, as such the reviewer is reluctant to see the perfect fit in this case study. As UPS has been an excellent partner in many demonstrations, the limitations of their vehicles and lack of optimization of the wireless technology makes a fit seem impractical. The reviewer clarifies as follows. The UPS vehicles have fairly set routes and therefore the battery is sized to optimize for their application. They do not carry excess capacity so when the project expects to exercise “reverse flow” to grid, the fleet operator will be reluctant to allow reduction of the range of their vehicle. In addition, the 11-inch air gap to coils is not insignificant with magnetic resonance charging technology but acceptance appears to have made it into the project.

Reviewer 4:
The presenter implied that there is not much to review with the audience, but the reviewer disagrees and finds the beginning of a project to be the most appropriate time to discuss technical challenges and barriers that will be encountered. It is difficult to understand technical barriers that were not well-communicated, performance

metrics that the project will measure success of the developed power transfer system, and performance targets that the team will be trying to achieve.

Reviewer 5:
The reviewer noted this project is so new that it is difficult at this stage to rate the approach. The preliminary approach does seem logical and feasible. The business case for V2G in medium-duty vehicles (MDVs) should be made that clarifies how each of the stakeholders (i.e., vehicle OEMs, ESS OEMs, utilities, vehicle owners, and building owners) stand to benefit from this technology paradigm. The reviewer remarked the presenter did not mention which standard is to be followed. It is crucial that this project align with a wireless charging standard such as SAE J2954 to maintain the relevance of the developed technology.

Reviewer 6:
The reviewer stated the feasibility is subject to question.

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

Reviewer 1:
The reviewer observed the project team has made good progress in the short time that the project has been running. The project team has established coordination meetings with the partners and ORNL has begun design activities as outlined by the project plan.

Reviewer 2:
The reviewer noted the project is still young, but acceptance of limitations such as the wireless air gaps are not being challenged.

Reviewer 3:
The reviewer indicated it is difficult to determine the degree by which the group has prepared themselves for this project since there is little justification presented for the technical designs and strategies used. The impression was given that the project's performance and system requirements was primarily motivated by UPS's needs in a bidirectional WPT system. It would be helpful if the PI and team included more information about what analysis was performed to determine the architecture for the system they will be developing and demonstrating. The reviewer noted the collaboration with UPS to be very important, the design of the charging system demonstrated should be informed by a comprehensive benchmarking of the industry's charging technologies, as well as analysis to identify what power levels, gap distances, and power electronics architecture would be most relevant to current charger development within the industry.

Reviewer 4:
The reviewer suggested this project is too new to assess the technical accomplishments.

Reviewer 5:
The reviewer stated the project was only recently started.

Reviewer 6:
The reviewer commented that it seems like this project is so new that it should not have been reviewed this year.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer is impressed to see the level of enthusiasm and collaboration developed among the involved partners and contributors.

Reviewer 2:
The reviewer indicated it looks like a good list of collaborators.

Reviewer 3:
The reviewer acknowledged UPS and Workhorse are good and competent partners, but as prior note, perhaps not the best choice.

Reviewer 4:
The project plan concentrates most of the early activities at ORNL and has assigned the other project partners well defined roles with appropriate workloads. The degree of collaboration and coordination will not drain all the project resources.

Reviewer 5:
The reviewer noted the collaboration could be improved by including academic institutions as partners to broaden and deepen the analysis.

Reviewer 6:
The reviewer suggested collaboration and coordination with end customers (users) needs to be 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 observed the future work outlined by the presentation is a logical progression of next steps for the project to pursue. The future work outlined allows for the possibility of significant design modifications to mitigate any unexpected issues.

Reviewer 2:
The reviewer remarked the proposed future research, which is essentially the entire project, appears to be sound and feasible. The project results could be quite useful in advanced the art of V2G for MDVs.

Reviewer 3:
The reviewer indicated the future work is described in the project work plan, as it should be for a young program. The project would score better with expressing for site beyond the tasks of the present program.

Reviewer 4:
The reviewer commented considering the early stages of the project the future work could have been more detailed.

Reviewer 5:
The reviewer said future research results seem dubious but satisfactory to date.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The project supports the objective of petroleum displacement by developing a WPT system for a MD electric vehicle. This type of WPT technology will increase the convenience of charging the MD EV and will add some vehicle to microgrid features that has potential to make the EV more marketable. MDVs have lower fuel efficiency than LDs and therefore the electrification of MD vehicles will displace significant amounts of petroleum from the U.S. transportation sector.

Reviewer 2:
The reviewer observed all projects which develop and assess EV technology (as this project does) also support the primary objective of the DOE by reducing dependence on petroleum fuel.

Reviewer 3:
The reviewer stated wireless power flow is a relevant topic in DOE's framework.

Reviewer 4:
The reviewer observed V2G does not necessarily produce petroleum displacement since petroleum is not used in a significant amount of electricity production. However, if V2G improves the total cost of ownership (TCO) of EVs and induces more EV adoption, V2G could become an important factor in petroleum displacement and therefore align with DOE objectives.

Reviewer 5:
The reviewer noted petroleum displacement value needs to be proven.

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 describes reasonable funding levels for the program described.

Reviewer 2:
The reviewer reported the budget seems in line for the project scope.

Reviewer 3:
The reviewer indicated the resources appear to be adequate for this project.

Reviewer 4:
The reviewer affirmed the resources are likely sufficient to meet the basic milestones of the project. One area that may require additional resources may be the evaluation of battery degradation due to V2G operations. To be statistically significant this evaluation may require a lot of test cycles and possibly multiple battery packs.

Reviewer 5:
The reviewer stated resources are not the question the results are!

Reviewer 6:
The reviewer suggested that given the benefit and vested interest that UPS is receiving from this collaboration and cost-sharing, they should increase their contribution amount.

Presentation Number: gi189
Presentation Title: Electric Truck with Range-Extending Engine (ETREE)
Principal Investigator: John Kresse (Cummins)

Presenter
John Kresse, Cummins

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 reported the approach of this project is logical and sound, with appropriate go/no-go milestones. Medium -duty vehicles have large potential for fuel economy improvement, and the range extender approach could be commercially viable while also aligning with DOE petroleum displacement goals.

The reviewer noted there are three "competing" simulation efforts, but there is no mechanism or process in place to evaluate and compare and contrast the results. There should be extensive effort in developing such a process.

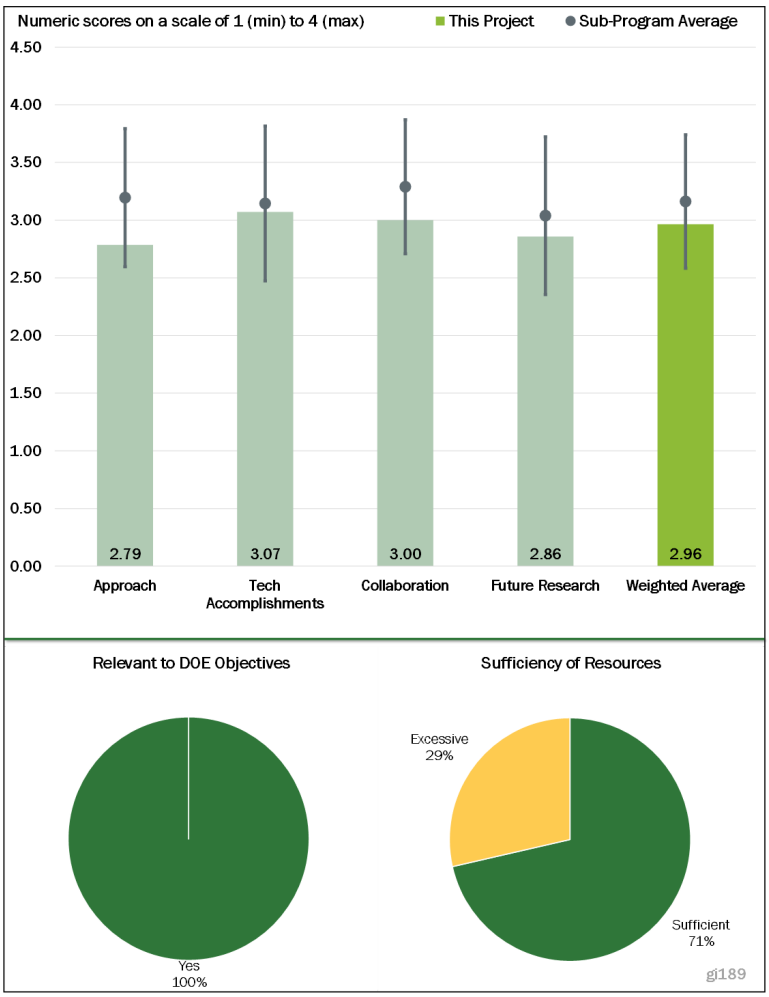

Figure 6-14 – Presentation Number: gi189 Presentation Title: Electric Truck with Range-Extending Engine (ETREE) Principal Investigator: John Kresse (Cummins)

The reviewer remarked the ESS TMS is passive air cooling. However, this was not justified explicitly by the presenter. The reviewer asked if the use cases corroborate this design decision In addition, the reviewer asked if a liquid-cooled TMS considered and if so a justification is required.

The reviewer indicated it was not explicitly mentioned whether DC fast charging was or is being considered. This could further enhance the lower operating costs of these vehicles while also increasing utility.

Reviewer 2:
The reviewer said the approach is logical and well presented.

Reviewer 3:
The reviewer observed the PI indicated that the project is a little less than one year into a total three-year level of effort. Planned system development activities in the first year include establishing the powertrain requirements, selecting components, designing the control and mechanical systems, and performing evaluations through simulation and component testing. After clearing the 12-month go/no-go decision gate

(based on demonstrating 50% fuel consumption reduction of the prototype powertrain system operating in a test cell), a few of the system development activities will continue, but overall efforts in year two will shift largely to vehicle integration. The 24-month go/no-go decision gate involves successful SAE J1321 Type II demonstration of the first test vehicle, which is to be followed in the final year by targeted testing of the second demonstration vehicle and field demonstration of both vehicles in a participating partner fleet.

The reviewer commented overall, the approach seems fairly sound, though the PI referred to a potentially excessive grade-ability requirement that may drive some components to larger and more costly levels than would otherwise be the case. It may be worth discussing this trade-off with the fleet that set the grade requirement to see how firm it actually is. It looks as though the requirement is at least relaxed in the vehicle's charge sustaining mode, so that could be a good test case during the demonstration phase to determine whether or not reduced grade-ability ever becomes an issue once the battery depletes, and/or to forecast if it ever would have been an issue prior to the battery having depleted were the components to have been sized differently. The reviewer suggested that another potential approach improvement would be to incorporate best-available battery life modeling capabilities into the design and analysis stage, though it is understood that life data specific to the batteries being considered is difficult to come by. It is possible that these two issues related to potential battery over-sizing on the one hand and potential underappreciation of life/degradation in the intended application on the other hand may offset to some degree. The final critical comment on the approach is that the plan is unclear as to the relative roles and overall benefit from the "competitive/cooperative" simulations being conducted by three different members of the project team.

Reviewer 4:

The reviewer reported the goal of this project is to meet at least a 50% energy efficiency improvement over a wide range of driving cycles for Class 6 Package and Delivery Trucks. This vehicle will have to work over a variety of missions and environmental conditions and be manufacture red, serviced, certified, and delivered using standard commercial processes. The vehicle will be a prototype and is to deliver comparable performance and range as a conventional Class 6 truck.

The reviewer noted the focus is to solve barriers to electrification of Class 6 trucks including cost and range while minimizing fleet operator risk.

The reviewer observed the approach is to utilize a PHEV with a low-cost range extender in the near- to mid-term. Based upon the Kenworth K270/Peterbilt 220 platforms, the project follows a well-founded and structured approach including system development (simulation, component selection and design, control design, and testing); vehicle integration (thermal systems, mechanical design, and accessory selection); and vehicle demonstration.

The reviewer warned the one notable weakness in the project approach is the under emphasis upon cost analysis early in the project. An extensive cost analysis should be conducted (in concert with fleet partners) early to determine and frame the commercial viability of the overall concept from the customers' standpoint.

The reviewer indicated milestones are well identified and structured with the exception that it would have been preferable that consideration be given that the first go/no-go milestone be based on a detailed cost and market feasibility study.

In addition, there is no mention of project integration with other efforts.

Reviewer 5:

The reviewer stated the design cycle is alright as an overview. However, technical barriers were not identified or addressed. It is feasible, but does not appear to leave any room for troubleshooting/ addressing issues. The project is not directly tied to other efforts. The technical approach appears to be to design, test, then define the goals or eventually ask for relief as stated in the reviewer slides. The reviewer noted this is not well designed, as the goals should be defined up front, then try and achieve them.

Reviewer 6:
The reviewer reported the specifics on the approach could be more clearly stated in the presentation of the project.

Reviewer 7:
The reviewer indicated the approach is very disjointed. The reviewer pointed out that adding 3,000 pounds of weight, using an oversized diesel engine with an after-treatment system and designing it for a 200 plus mile range while testing for an 80-mile route does not make sense.

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

Reviewer 1:
The reviewer remarked this project is on schedule and has achieved numerous technical successes in its first year.

These technical successes include identification and amalgam of appropriate representative duty cycles upon which to base testing and analysis (NREL 80 and NREL 100 composite cycles) and establishing predicted fuel consumption for the target NREL 80 cycle exceeding 60% fuel efficiency improvement.

In addition, simulation-focused component selection including simulation-driven architecture identification downselecting to a hybrid architecture with 112 kWh energy storage was achieved.

In the first year, the project also identified predicted performance on level ground at minimum state of charge (SOC) is still marginally acceptable due to generator size (130kW), and progress was achieved in optimizing SOC trajectory. Finally, advancements in vehicle design and integration, J1772 level two EVSE support, electronic braking system, electrified accessories, TMS, and passively cooled battery were made.

Reviewer 2:
The reviewer reported the project appears to be on schedule and is meeting its targets. The simulations appear to validate the design decisions and warrant physical prototype development and testing. The NREL drive cycle development is a useful contribution on its own and is a laudable technical achievement. This could be further developed and validated to make it a true contribution.

Reviewer 3:
The reviewer said the DOE objectives for fuel economy improvement is clearly identified and progress toward this is apparent from information presented.

Reviewer 4:
The reviewer noted good progress has been shown all the way up to hard implementation.

Reviewer 5:
The reviewer commented the technical progress on the project has included analysis of relevant duty cycles for the targeted application and creation of a representative cycle for testing (and against which to evaluate whether or not the project achieves the targeted 50% reduction in fuel consumption). However, one of the slides indicates that the NREL 80 cycle is both 80 miles long and "represents 80th percentile of required energy of representative drive cycles." It would be helpful to clarify whether the 80th percentile criteria were applied to cycle energy intensity, driving distance, or both, and whether or not it is simply a coincidence that 80 miles aligns with the 80th percentile daily driving distance if that is indeed the case. Due to the PHEV approach, it is particularly relevant to select a daily driving distance that accurately represents typical in-use driving distances.

The reviewer indicated reported technical progress included selecting the powertrain architecture and component sizes based on the established requirements, and demonstrating through simulation that the selected design should achieve the 50% fuel savings goal. Progress was also reported on establishing SOC trajectory optimization (though the team should be sure to err on the side of using up the stored battery energy early as opposed to leaving some energy un-used by the time the vehicle ends up recharging), design of a system to blend regenerative and mechanical braking when drivers attempt to brake. It is good that the project team is simultaneously considering driver acceptance while trying to maximize efficiency benefits from the electrified components and setting up the powertrain in the test cell. This is a prudent step ahead of vehicle integration. Lastly, the project plan indicated that the fleet to be used for system demonstration in the third year would be selected by the end of the first year, but progress toward that fleet selection objective was not mentioned in the presentation.

Reviewer 6:

The reviewer indicated the project presented a graph showing in simulations the design would exceed a 50% fuel reduction target. The project did not address if it would meet the 50% utilization of grid power goal. It did estimate a 40 mile all electric range, and the drive cycle being used is an 80-mile drive cycle, so it is possible the project is close to or meets the goal. The reviewer suggested this should be directly addressed in the future. The goal of having a commercially viable vehicle was not addressed and should be. The reviewer observed the project is on track with the project plan and currently laboratory testing components.

The reviewer remarked that in the reviewer backup slides, the project implied there were requirements that would not be met when talking about commercial viability. These should be called out up front.

Reviewer 7:

Although the reviewer does not believe this is a solid project it has fairly well accomplished its goals.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer said there is a good partner team.

Reviewer 2:

The reviewer reported this project has a lot of large partners and seems to have coordinated fairly well.

Reviewer 3:

The reviewer stated the Cummins team is strong and diverse with heavy weights in a position to address all of the technical challenges of the project. The reviewer identified a notable omission is the lack of fleet partners as part of the formal team. While dialogue is undoubtedly underway and will intensify in the future, it would have been greatly preferable to have several fleet partners on the team from the outset. This would have been especially beneficial to early on best identify and refine approaches to potential cost and operational challenges from the fleet perspective.

Reviewer 4:

The reviewer acknowledged the current collaborations appear useful and constructive. An ESS OEM is a missing collaboration that could really assist in this project. The TMS being air cooling is a concern and the input of an ESS OEM could increase the performance and commercialization potential for this design.

Reviewer 5:

The reviewer said collaboration with federally funded research and development centers is clearly identified, and their key collaborative role was presented as an important part of the project's progress.

Reviewer 6:
The reviewer observed contributions from a team of relevant experts seem to be benefitting the project, including system development, integration support, drive cycle analysis, fleet monitoring, simulation and controls. However, the relative value and integration of the three "cooperative/competitive" modeling efforts is unclear.

Reviewer 7:
The reviewer noted the project has an OEM and research laboratories. It would be a little stronger with a vehicle manufacturer as a direct team member.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 the proposed future research is fundamentally sound and logically presents an orderly course of action until project completion.

This includes vehicle integration and build including implementation of TMS in the prototype and cell testing. Reasonable future milestones (including go/no-go) are established.

The reviewer suggested the project should emphasize cost analyses and commercial viability moving forward.

Reviewer 2:
The reviewer commented the proposed future work appears to include everything needed to achieve the project objectives. One addition could be dynamometer testing that includes the NREL drive cycle to validate the simulation efforts.

Reviewer 3:
The reviewer articulated future work efforts are to complete the test cell testing, vehicle integration and build tasks (including implementing vehicle TMS), perform track and targeted environmental testing, and ultimately testing in a deployed fleet in the third year of the project. The reviewer agrees these are very appropriate areas of focus for future work. The reviewer suggested in the second and third years of the project the team should also increasingly focus on making sure the incremental system cost relative to a conventional vehicle can reasonably be offset by the expected fuel and operating cost savings.

Reviewer 4:
The reviewer remarked the future plans are logical, but the schedule seems a bit compressed. There should be a few more decision and design review points to make sure the different engineering disciplines are aligned and that the vehicle integration design is checked against test results. The reviewer noted the thermal management of the system (especially the air-cooled battery) when operating at heavy-duty cycle points (heavy acceleration/deceleration). The reviewer indicated the project did not list risks of barriers or have risk mitigation identified. It appears the project is assuming everything will work the first time, which puts it at risk for schedule slip especially since there are not any risks identified.

Reviewer 5:
The reviewer said future research identified, but activities not significantly into the future. The reviewer commented it might be a bit early in the project to identify need for future work and that next year's presentation should include more on this.

Reviewer 6:
The reviewer stated the vehicle results will be very interesting to see.

Reviewer 7:
The reviewer offered the current design of this project has little to no chance of being a viable solution for Class 6 trucks. There are too many other innovative ways to optimize powertrains today.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer observed the project aims to solve barriers to electrification of Class 6 package and delivery trucks including cost and range while minimizing fleet operator risk. In the near- to mid-term, the proposal is to use a PHEV with a low-cost range extender. The reviewer concluded if technically and commercially successful, this technology could replace many conventionally powered package and delivery trucks thereby leading to significantly greater energy efficiency and accompanying petroleum displacement benefits.

Reviewer 2:
The reviewer articulated that MDVs represent a significant opportunity for petroleum displacement through electrification and higher fuel economy. This project could result in a commercially viable design that will align with the DOE's objectives.

Reviewer 3:
The reviewer remarked reduced consumption of fuel is clearly a displacement of petroleum use and a 50% reduction in use is a significant achievement toward this objective.

Reviewer 4:
The reviewer stated the design of an electrified delivery vehicle with the goal of reducing diesel consumption by 50% in the intended application is certainly relevant to DOE's objectives.

Reviewer 5:
The reviewer commented the intent of the project is to demonstrate a prototype commercially viable vehicle that utilizes 50% or more energy from the grid. Having a vehicle that uses grid energy instead of petroleum, and is commercially viable so it can be adopted, directly supports the DOE objective.

Reviewer 6:
The reviewer indicated the medium-duty world can really benefit from this technology.

Reviewer 7:
The reviewer warned this project can displace petroleum but there are much better ways to spend resources for displacing petroleum than the outdated concepts within 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 reported that minimal information was provided as to the expenditure of project funds to date and the project appears to be right on schedule. As such, it is assumed that funding resources are sufficient.

In addition, the reviewer noted the technical depth and diversity of the project team partners indicates there should be no challenges with regards to availability of equipment or facilities to conduct the required activities to successfully bring the project to fruition.

Reviewer 2:
The reviewer observed there was no shortfall noted in presentation, and project on schedule. Therefore, by deduction, the resources are sufficient.

Reviewer 3:
The reviewer stated the resources for the project appear to be sufficient.

Reviewer 4:
The reviewer said the project appears to have sufficient resources.

Reviewer 5:
The reviewer commented there is a good match between funding and project.

Reviewer 6:
The reviewer noted the DOE share of the overall project cost, which is nearly 67% is too high and more industry resources should have been leveraged for this project.

Presentation Number: gi190
Presentation Title: Medium-Duty Urban Range Extended Connected Powertrain (MURECP)
Principal Investigator: Alexander Freitag (Bosch)

Presenter
Matt Thorington, Bosch

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 observed the approach is clearly defined in project plan and schedule, which showed multiple parallel paths toward objectives.

Reviewer 2:
The reviewer said the approach had well defined goals and performance objectives as well as understanding of the target market. In addition, there is good use of available tools for architecture selection. The reviewer stated there is a solid partner and collaboration group, with experience and commitment to complete the milestones.

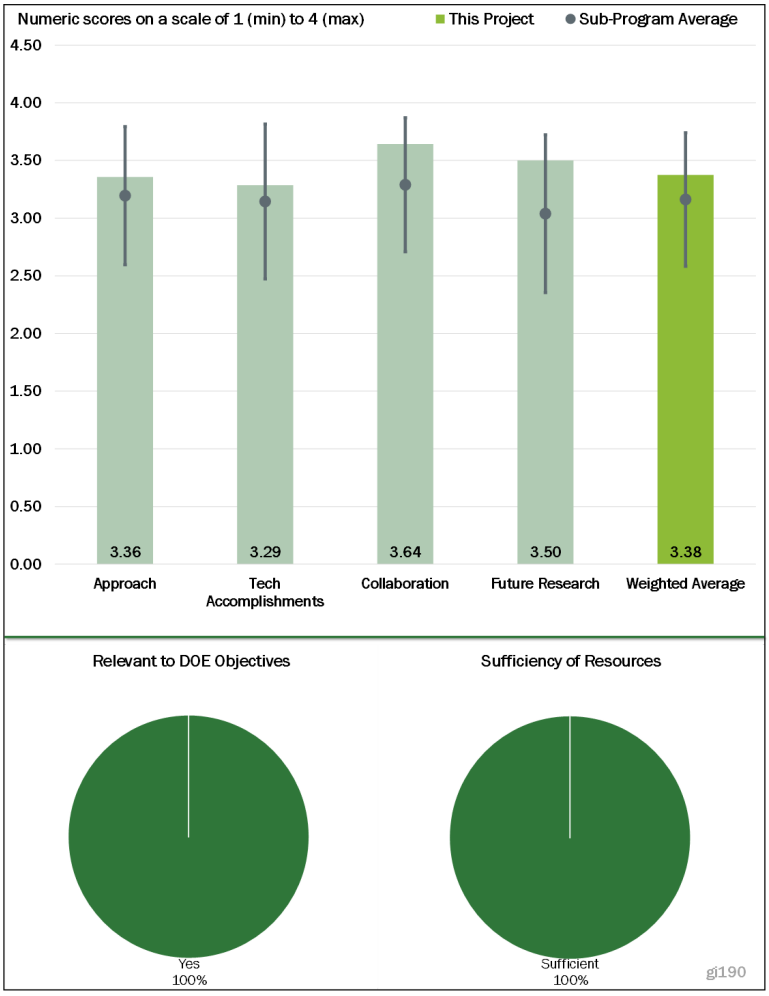

Figure 6-15 - Presentation Number: gi190 Presentation Title: Medium-Duty Urban Range Extended Connected Powertrain (MURECP) Principal Investigator: Alexander Freitag (Bosch)

The reviewer warned the cost target would seem to be the only concern area, though the selection of the commercial off the shelf motor and inverter/converter help. The reviewer indicated it would be great to see data prompting the 35-mile AER.

Reviewer 3:
The reviewer noted the approach is feasible and the three year payback make the project more attractive.

Reviewer 4:
The reviewer commented the cost target barrier is overlooked with the selection process of the transmission.

Reviewer 5:
The reviewer is interested in more information on how to downselect the powertrains. This seems like the primary output of the current phase of the project, but it is not clearly documented. The reviewer asked if cost, control-ability, performance, packaging, or grade-ability were considered.

The reviewer noted when one uses dynamic programming (DP), one has to think pretty hard about how the controls are influencing the FE outcomes. There is much opportunity for the development of difficult-to-implement controls. Generally, the reviewer commented, DP give FE benefits that are higher for systems that have greater complexity and have more degrees of freedom. Because this project is optimizing both powertrain architecture and controls, it may be particularly in danger of this problem.

Reviewer 6:
The reviewer remarked the base MPG is very low for a Class four delivery truck. It should be closer to 13 MPG.

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

Reviewer 1:
The reviewer observed as a new project, the technical accomplishments are in laying out approach and modelling. This project is clearly making progress toward its technical objectives.

Reviewer 2:
The reviewer said though early in the program, the detailed plan seems adequate and milestones are being met. Additionally, this reviewer noted integration of early commercial EV driveline components, ESS, and controls software will determine if the project is able to meet next milestones. The reviewer further remarked that integration of the dual planetary gear transmission will require additional controls tuning time in the second phase of project, after the first go/no-go milestone.

Reviewer 3:
The reviewer said the project is making progress against objectives.

Reviewer 4:
The reviewer noted there is missing selected system cost information to support presenting on the cost barrier (less than a three-year payback period).

Reviewer 5:
Progress is very aggressive for all the design work involved to meet the goals. Baseline MPG should be much higher.

Reviewer 6:
The reviewer remarked the baseline MPG does not seem appropriate for Class four trucks.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated this project partners involved are excellent and will all provide good value to the entire team.

Reviewer 2:
The reviewer commented the project has as great team.

Reviewer 3:
The reviewer stated the project has assembled a great team.

Reviewer 4:
The reviewer indicated collaboration was clearly identified in the project presentation. Roles for each collaborator were also identified, as well as overall Bosch objectives for the project.

Reviewer 5:
The reviewer observed a there is a good grouping of support for this project. Team members are reliable and capable. Full use of the team's areas of expertise should be exercised. The reviewer suggested more simulation by University of Michigan may show areas for future consideration of 2PG transmission, and additional data mining by NREL of Fleet DNA could result on other market information for comparison and field deployment selection.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 a good group should cover all of these bases.

Reviewer 2:
The reviewer suggested that the go/no-go decision on fuel efficiency simulation should use a rules-based controller even if its DP is derived.

Reviewer 3:
The reviewer noted it is early in the project, so ability to identify future research needs is difficult at this time. What was identified are clearly needed, but are part of this project already. The reviewer looks forward to the evaluation of this project next year.

Reviewer 4:
The reviewer stated since the project hinges on the 2PG, it will be interesting to watch that development. Other portions of the projection are challenging, but fully within the teams' capability.

The reviewer suggested as this project progresses some more outreach opportunities should be scheduled to show the capability of the 2PG technology.

In addition, fuel displacement projections could be done by University 0f Michigan or NREL to help show the potential of this technology

Reviewer 5:
The reviewer stated this project will need to evolve with current technology advancements before its end date. The reviewer did not see a viable future using a diesel-powered range extender requiring after treatment.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer remarked this project does support DOE objective by proposing to improve fuel consumption

Reviewer 2:
The reviewer said yes, the project supports the DOE objective of petroleum displacement.

Reviewer 3:
The reviewer commented yes, this project is very relevant to class four vehicle operations.

Reviewer 4:
The reviewer stated fuel economy improvement displaces petroleum needs. The objective of 50% reduction of fuel used is a significant effort to support this objective.

Reviewer 5:
The reviewer suggested there needs to be a quantitative number assigned to a successful deployment of this technology, but the potential is clear. As the delivery industry is headed for growth in the U.S. market, and will be a primary consumer of liquid fuels, this type of program blends technology development with deployment supported by the DOE to showcase technology benefits to first line consumers (Fleet owners). This project is very relevant to the DOE mission.

Reviewer 6:
The reviewer indicated this project has potential to do better at reducing petroleum usage and thinks the baseline MPG goal should be revisited.

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 resources seems fine.

Reviewer 2:
The reviewer commented this is good team.

Reviewer 3:
The reviewer noted it is early in the project and on schedule. The budget does not appear to be insufficient for the scope, but detail is insufficient to conclude that resources are excessive.

Reviewer 4:
The reviewer commented the only question about funding would be the number of trucks or transmissions that are planned.

The reviewer suggested for this large of an amount of DOE spending, the second transmission should be placed into service or have additional testing run with alternative engine sources for possible model calibration and verification.

Presentation Number: gi191
Presentation Title: Medium-Duty Vehicle Powertrain Electrification and Demonstration
Principal Investigator: Wiley McCoy (McLaren)

Presenter
Wiley McCoy, McLaren

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.

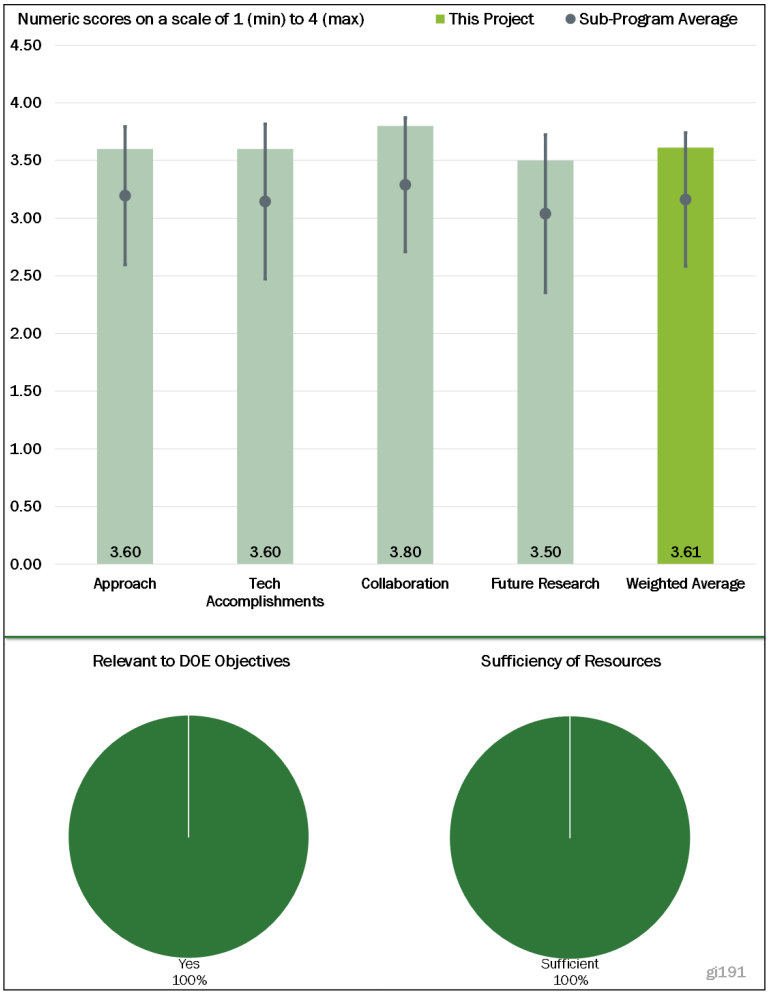

Figure 6-16 - Presentation Number: gi191 Presentation Title: Medium-Duty Vehicle Powertrain Electrification and Demonstration Principal Investigator: Wiley McCoy (McLaren)

Reviewer 1:
The reviewer noted the approach is outstanding with respect to the engineering design process and also in the practicality of the system goals and proposed design solution features. The practical nature of the goals and design solutions increase the likelihood of being able to deliver progress on the TCO barrier to adoption of MD EVs.

Reviewer 2:
The reviewer remarked the approach seems highly appropriate, aimed at ensuring success. A key element of this approach was clearly assembling the correct team, including a very solid demonstration partner. The reviewer observed that to bring costs down, the approach focused on using automotive products, and therefore included partners who provide those products. The approach also included working with UPS to develop the testing processes.

Reviewer 3:
The reviewer indicated the approach for the project includes designing and developing a PHEV powertrain, building four demonstration vehicles, and running a demonstration of cost and reliability for a full year. These efforts, and particularly the emphasis on commercialization potential at the end of the project, are appropriate areas of emphasis. It is also good that the project engages directly with a potential customer fleet to obtain input on requirements, included real-world operation expectations. The reviewer suggested it would be helpful to articulate a clearer path to overcoming the total cost of ownership barrier for successfully commercializing such a plug-in hybrid technology.

Reviewer 4:
The reviewer commends the PI for using a contemporary Define-Design-Verify approach to product development in this project. The use of real-world duty cycle data to define design requirements in excellent. The use of sophisticated simulation tools for powertrain sizing and driveline design is also admirable. The

reviewer recommends that cost targets be identified (or communicated, if already identified) early in the project to ensure that the project achieves its goal of producing a product with acceptable TCO for commercialization.

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

Reviewer 1:
The reviewer stated that based on the limited information provided the technical progress appears to be outstanding. The design process has spent significant effort in defining the requirements and modeling the proposed design features. The team has performed a significant amount of engineering to meet the overall project milestone delivery schedule.

Reviewer 2:
The reviewer reported the project appears to be accomplishing activities in accordance with an aggressive schedule. It has already accomplished a lot in less than a year, including many of the inputs necessary for making decisions concerning design choices. A particular highlight was the decision to instrument UPS in-use vehicles to establish a useful baseline. This data has impacted decisions already. The reviewer noted that so far, it appears all technical performance requirements are being met, at least when looking at predicted performance.

Reviewer 3:
The reviewer observed the project accomplishments included obtaining and integrating requirements from UPS, completing the initial conceptual design, and demonstrating through simulation that 100% fuel economy improvement is possible. Specific analysis accomplishments included modeling both the conventional baseline vehicle and the PHEV design in AVL Cruise. To do so the team used generic component maps available from the AVL Cruise library. The reviewer indicated it would have been nice at least for the baseline vehicle to have shown some validation of the model against the current UPS vehicle data.

The team did well to draw upon actual UPS vehicle operating data for evaluating the design, though the extent of the data used remained unclear. For instance, the reviewer asked how many vehicle-days of data went into the analysis, and what efforts were undertaken to ensure that the data captures both the breadth of likely operating conditions and in aggregate accurately represents average/typical operation that these vehicles would see in service.

The reviewer stated the simulated fuel economy table presented on Slide 14 indicates application of a "0.8 reduction factor" to simulate conventional and HEV operation "in order to be conservative." However, it is confusing that this factor is called out only on the lower set of tables and not on the higher set of tables, and use of the label "Hybrid" is also confusing. Typically, "hybrid" refers to a non-plug in vehicle that uses an energy storage system to capture regenerative braking and load-level the engine, but it appears as though the term here refers to both the charge-depleting and the charge-sustaining operation of the PHEV being designed for this project. This should be clarified. The reviewer also recommends showing the relative energy consumption comparisons without this 0.8 factor (in principle the real-world profiles should give an accurate comparison without this adjustment; if adjustments really are needed, such as for external environmental factors, it is quite likely that these factors would impact each powertrain differently—bringing into question the appropriateness of applying a fixed 0.8 factor to both powertrains). Finally, the reviewer takes issue with the use of "mpg equivalent" in the table. It would be better to stick with more physically meaningful measures, such as the total diesel, electricity and LPG use over a typical month or year for both the conventional and the PHEV (and the associated total operating costs and greenhouse gas emissions for each case).

Reviewer 4:
The reviewer noted the project is on schedule. Powertrain simulation results appear promising. The PI reported that additional analysis was done with partner Dana to ensure the addition of unsprung mass in the rear axle will not adversely impact driving dynamics. That analysis is important and should be included in future reports and presentations. Likewise, the rationale to use a series hybrid design (and pay the efficiency penalty over a parallel design with direct drive at high speeds) should be documented. The reviewer indicated the simulation results use an appropriately conservative derating factor. Simulation predicts that the target fuel efficiency will be achieved and other vehicle performance requirements will be met or exceeded. However, the proposed design must be evaluated for cost and design iterations should be performed, as necessary, to ensure the end result meets cost requirements for commercialization.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated the project has what appear to be exactly the correct types of partners, including an excellent fleet partner in UPS. In addition, the project has clearly shown that it knows how to work with these partners, taking advantage of the opportunities they present.

Reviewer 2:
The reviewer affirmed the collaboration in this project is stellar. The project team includes highly reputable companies including leaders in their respective fields with expertise in product development, manufacturing, and deployment. The reviewer remarked the PI is wise to include a partner that specializes in truck retrofitting, because retrofitting existing trucks is the commercialization goal of this project.

Reviewer 3:
The reviewer observed there appears to be effective collaboration and coordination amongst appropriate stakeholders for designing and building the desired vehicles. Again, it would be nice to have a better idea of the extent of the drive cycles provided by UPS that went into the analysis and how this compares with the total typical daily or monthly miles driven by all vehicles using the targeted depot.

Reviewer 4:
The reviewer stated the project team spans the range of expertise needed to address the project's issues. Having UPS as a demonstration partner is especially useful to validating the system requirements and providing a useful real-world test environment.

Question 4: Proposed future research—the degree to which the project has effectively planned its future work in a logical manner by incorporating 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 remaining steps appear to make sense, and are fully appropriate for this type of project. The project is now shifting toward a manufacturing process. The reviewer reported Phase three will not start until January 2018 due to small delays, and UPS does not want to interfere with the holiday delivery season. That stage will involve vehicle build, test, and demonstration. This will be followed by a commercialization plan.

Reviewer 2:
The reviewer noted the plan for future work is robust, adequately sophisticated, yet not overly ambitious.

Reviewer 3:
The reviewer said the future path of completing vehicle builds and testing and demonstrating the vehicles in service is appropriate, as is the stated emphasis in commercialization potential. The PI indicated that "costs are

still in development but preliminary results suggest the product can be successful." The reviewer suggested that at the next review it would be good to hear more specifics and more definitive language about what is needed for the vehicle to result in a competitive total cost of ownership for the fleet purchaser relative to conventional vehicle options.

Reviewer 4:
The reviewer observed this presentation does not contain much information on mitigation strategies but it does outline several significant technical challenges. The project team's near-term future work is appropriately focused on addressing the challenges outlined.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer mentioned the project is aimed at increasing electrification in a sector that tends to use a lot of fuel per vehicle. This also results in significant emissions reductions, largely in urban areas. The reviewer stated this project is fully in line with DOE's objectives in this area.

Reviewer 2:
The reviewer asserted the project seeks to commercialize a vehicle technology that can displace use of diesel fuel with a combination of electricity and LPG so is certainly relevant.

Reviewer 3:
The reviewer commented the project is relevant to petroleum production since MD vehicles typically have half the fuel efficiency of LD vehicles. The introduction of a cost-effective MD hybrid retrofit for delivery fleets that doubles the fuel efficiency over the conventional baseline vehicle would be a huge step in reducing the petroleum consumption of this portion of the U.S. transportation sector.

Reviewer 4:
The reviewer remarked electrification of medium-duty trucks has the potential to significantly reduce U.S. transportation petroleum consumption. This project addresses a significant barrier to electrification which is how to cost-effectively electrify existing trucks on the road.

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 the resources provided for the project should be sufficient to achieve the stated goal assuming that the team can address the outlined technical challenges within the project budget and schedule. The project team's reputation's and experience base give credibility to the expectation that they can perform within the budget and schedule constraints.

Reviewer 2:
The reviewer noted that so far, funding appears sufficient if it remains as originally proposed.

Reviewer 3:
The reviewer commented resources appear to be sufficient for the project.

Reviewer 4:
The reviewer indicated on first glance, $3.65 million seems excessive to produce a four-vehicle test fleet. However, the focus of this project in on product development, not deployment. Given the sophisticated approach being taken to product development and the significant challenge of cost-effectively electrifying

MDVs, the reviewer judges the financial resources of the project to be sufficient, but perhaps only just sufficient.

Presentation Number: gi192
Presentation Title: Hybridization of Class 8 Line Haul and Regional Refrigeration Trucks CRADA
Principal Investigator: Dean Deter (Oak Ridge National Laboratory)

Presenter
Dean Deter, Oak Ridge National Laboratory

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 the approach is based upon a three-phase structure including modeling and simulation, hardware in the loop and then vehicle testing and validation. These are the steps that appear correct for this type of project. The project is focused upon eliminating a relatively low-efficiency engine that runs constantly.

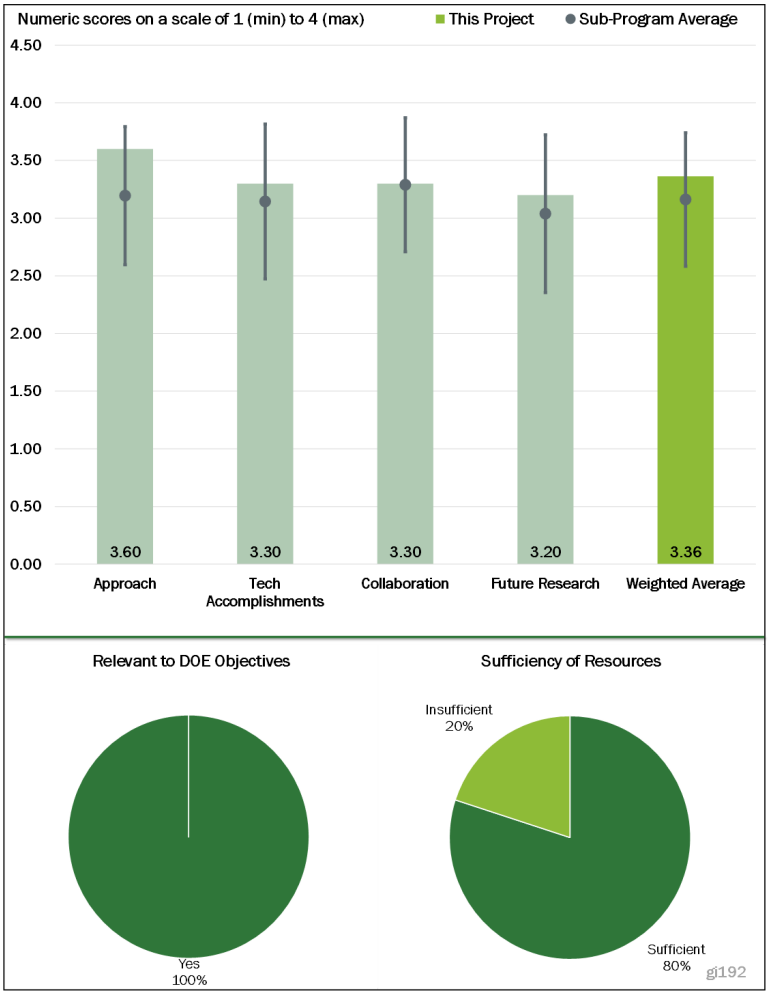

Figure 6-17 - Presentation Number: gi192 Presentation Title: Hybridization of Class 8 Line Haul and Regional Refrigeration Trucks CRADA Principal Investigator: Dean Deter (Oak Ridge National Laboratory)

The reviewer remarked that early in project, ORNL determined that an appropriate fleet partner was needed. They used a rational approach to select a partner, focused upon commonality of equipment throughout the fleet. Selecting this partner also allowed project to focus on the ultimate user's operational needs.

The project also worked with a refrigeration unit provider, Carrier, to help in determining technical needs.

Reviewer 2:
The reviewer commented this type of hybridization of the refrigeration container is an excellent example of "second/next level" hybridization of ancillary systems for energy savings.

Reviewer 3:
The reviewer remarked the approach appears to best address the risk aversion barrier since it will provide some HIL test data for the proposed system. The approach does not appear to address the cost barrier since there is no evidence of a cost analysis for the proposed system. It is difficult to forecast a long-term benefit from this activity without the cost analysis being included in the project scope.

Reviewer 4:
The reviewer said it is good to know that the developed system control strategies will be supported by experimental validation and verification of functionality and petroleum consumption reduction as a result of the proposed 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 towards DOE goals.

Reviewer 1:
The reviewer noted the technical progress is excellent considering the paltry budget for the project.

Reviewer 2:
The reviewer reported solid analytical methods are being or have been deployed to bind the engineering parameters of the problem. The development process appears to be well on track for successful demonstration.

Reviewer 3:
The reviewer commented the project finished data collection and validation of conventional models as baseline.

Reviewer 4:
The reviewer said the PI believes the project will stay on schedule, but there have been some smaller portions of the project that have had a few issues. The baseline system had been modeled, and then the new system identified and modeled. Initial simulation results were developed. Overall savings appear to range from 2 to 8.6% for the system.

The reviewer observed some of the delays were due to hardware development, which is not completely surprising, but the PI feels testing will still take place pretty much on time.

Reviewer 5:
Given actual drive profile can be obtained through the CTI telematics link, the reviewer suggested simulation and testing with actual drive profile rather than generic CMI cycle

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer observed initially, the project team was only Cummins and ORNL (after issues with keeping Carrier on team). The project added a fleet partner along the way (CTI), and obtained technical data from a refrigeration system manufacturer (Carrier). It also added TM4 for engineering support. The reviewer remarked the team is more robust now. The PI indicated that ORNL had access to trailers for the project, so that a trailer OEM was not needed. In addition, Cummins will serve as the route to deployment, potentially selling the product to truck OEMs.

Reviewer 2:
The reviewer affirmed ORNL, Cummins, and Carrier are excellent partners in this endeavor with TM4 as engineering support. It is recognized that a demonstration partner (CTI) will be difficult to work with due to the risk of failure is a high dollar value of cargo.

Reviewer 3:
The reviewer noted the project team is collaborating with OEMs and other industrial partners.

Reviewer 4:
It is difficult for the reviewer to assess the degree of collaboration with other organizations since there is no funding or resource breakdown for the team 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 the future of the project plan appears to be well described for successful completion through demonstration. The reviewer asked if there any possible follow-on efforts being explored in similar areas.

Reviewer 2:
The reviewer observed the future work planned will likely contribute to the technical knowledge base for using a hybrid system to power the trailer refrigeration unit. The presentation acknowledges the incompleteness of this effort to fully address the project challenges.

Reviewer 3:
The reviewer indicated the remaining efforts appear to be the correct ones and are laid out in a rational manner. If completed as planned, the project should result in finding the answers needed.

Reviewer 4:
The reviewer noted on road testing and fleet testing are included.

Reviewer 5:
The reviewer noted future challenges in hardware development is described generically. Specific future work in hardware development is not stated.

Question 5: Relevance—Does this project support the overall DOE objectives of petroleum displacement?

Reviewer 1:
The reviewer indicated the project can result in the elimination of the on-truck diesel engine used to power refrigeration units, which will result in significant petroleum reductions.

Reviewer 2:
The reviewer stated energy savings in this ancillary application is generally in alignment with DOE objectives to displace petroleum energy in transportation of goods.

Reviewer 3:
The reviewer noted hybridization of refrigeration trailers can provide significant reductions in fuel consumption, criteria pollutants, and greenhouse gas emissions.

Reviewer 4:
The reviewer commented the project provides a hybrid solution for trailer conditioning that is more fuel efficient in situations where electrical infrastructure does not exist to support pure electric conditioning

Reviewer 5:
The reviewer observed trailer refrigeration units are used throughout the United States and consume petroleum while awaiting pickup and in route to delivery of the load. This project has predicted that it would save between 1.8% and 8.0% of the petroleum consumed. The analysis does not include the petroleum consumed

idling while awaiting the pickup of the load so the petroleum savings from a hybrid technology is likely higher than the project estimates.

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 the resources are sufficient.

Reviewer 2:
The reviewer said no indication was made that funding as proposed is not sufficient.

Reviewer 3:
The reviewer remarked the funding for this project is generally in line with associated engineering costs.

Reviewer 4:
The reviewer stated the funding for this project appears to be insufficient for the stated project objectives.

Acronyms and Abbreviations

AER	All-electric range
ANL	Argonne National Laboratory
APRF	Advanced Powertrain Research Facility
BET	Battery electric truck
BMS	Battery management system
CAV	Connected and automated vehicle
CEC	California Energy Commission
DC	Direct current
DOE	U.S. Department of Energy
DP	Dynamic Programming
EDV	Electric drive vehicle
EPRI	Electric Power Research Institute
ESS	Energy storage system
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FCA	Fiat Chrysler Automobiles
FE	Fuel economy
FOA	Funding opportunity announcement
FY	Fiscal Year
GTI	Gas Technology Institute
HATCI	Hyundai American Technical Center, Inc.
HD	Heavy-duty
HET	Hybrid electric truck
HEV	Hybrid electric vehicle
HIL	Hardware-in-the-loop
HVAC	Heating, ventilating, and air conditioning
ICE	Internal combustion engine

INL	Idaho National Laboratory
kW	Kilo-Watt
LD	Light-duty
MDV	Medium-duty vehicle
MMFC	Multi-mode fluid controller
MPG	Miles per gallon
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PEMS	Portable emissions monitoring system
PHET	Plug-in hybrid electric truck
PI	Principal investigator
R&D	Research and development
RDE	Real-world driving emissions
ROI	Return on investment
SAE	Society of Automotive Engineers
SOC	State of charge
TCO	Total cost of ownership
TMS	Thermal management system
U.S. DRIVE	United States Driving Research and Innovation for Vehicle efficiency and Energy
UPS	United Parcel Service
UTEMPRA	Unitary thermal energy management for propulsion range augmentation
V2G	Vehicle to grid
VTO	Vehicle Technologies Office
WPT	Wireless power transfer
ZECT	Zero emission cargo truck

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