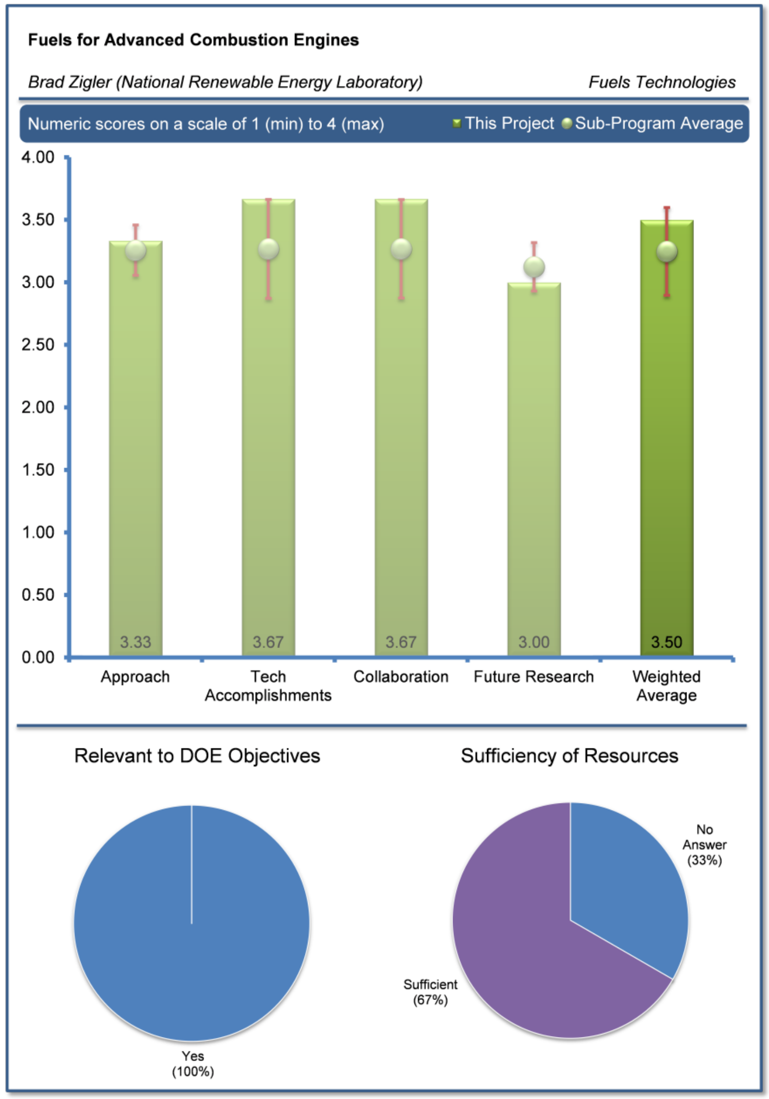
5. Fuels and Lubricants Technologies

The Fuels Technology subprogram supports fuels and lubricants R&D to provide vehicle users with cost-competitive options that enable high fuel economy with low emissions, and contribute to petroleum displacement. Transportation fuels are anticipated to be produced from future refinery feedstocks that may increasingly be from non-conventional sources including, but not limited to, heavy crude, oil sands, shale oil, and coal, as well as renewable resources such as biomass, vegetable oils, and waste animal fats. The impact of changes in refinery feedstocks on finished fuels is an area of relatively new concern to engine manufacturers, regulators and users. Advanced engine technologies are more sensitive to variations in fuel composition than were earlier engines, in addition to facing tightening emissions standards. This subprogram consists of two activities: Advanced Petroleum-Based Fuels (APBF); and Non-Petroleum-Based Fuels and Lubricants (NPBFL). The goals are: (1) to enable post-2010 advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and, (2) to reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. These activities are undertaken to determine the impacts of fuel and lubricant properties on the efficiency, performance, and emissions of current engines as well as to enable emerging advanced internal combustion engines. These advanced engines operate in low-temperature combustion regimes that are expected to become more prevalent in the marketplace because of their higher efficiency and continually improving emissions performance. These activities are coordinated with and supportive of EPA's fuels and emissions-related activities, as mentioned in their strategic plan.

During this merit review, each reviewer was asked to answer a series of questions using multiple-choice responses (and with explanatory comments when requested), as well as using numeric scores *(on a scale of 1 to 4)*. In the following pages, reviewer responses to each question for each project are summarized, the multiple choice and numeric score questions are presented in graph form, and the explanatory text responses are summarized for each question. The summary table below lists the average numeric score for each question and for each of the projects.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Fuels for Advanced Combustion Engines	Brad Zigler (National Renewable Energy Laboratory)	5-2	3.33	3.67	3.67	3.00	3.50
Quality, Performance, and Emission Impacts of Biofuels and Biofuel Blends	Bob McCormick (National Renewable Energy Laboratory)	5-4	3.33	3.33	3.33	3.00	3.29
Optical-Engine and Surrogate-Fuels Research for an Improved Understanding of Fuel Effects on Advanced-Combustion Strategies	Chuck Mueller (Sandia National Laboratories)	5-6	3.50	3.75	3.75	3.25	3.63
Advanced Lean-Burn DI Spark Ignition Fuels Research	Magnus Sjoberg (Sandia National Laboratories)	5-8	3.00	3.50	3.50	3.00	3.31
Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies	Scott Sluder (Oak Ridge National Laboratory)	5-10	3.00	3.00	3.00	3.00	3.00
Gasoline-like fuel effects on advanced combustion regimes	James Szybist (Oak Ridge National Laboratory)	5-11	3.50	2.50	2.50	3.50	2.88
Chemical Kinetic Modeling of Non-Petroleum Based Fuels	Bill Pitz (Lawrence Livermore National Laboratory)	5-13	3.20	3.40	3.40	3.00	3.30
Lubricants Activities	George Fenske (Argonne National Laboratory)	5-16	3.20	3.00	3.00	3.25	3.08
Overall Average			3.26	3.27	3.27	3.13	3.25

Fuels for Advanced Combustion Engines: Brad Zigler (National Renewable Energy Laboratory) – ft002



Reviewer Sample Size

This project was reviewed by three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

All reviewer feedback was positive. One reviewer stated that there was an extensive matrix of research fuels to be blended, characterized and made available to the research community. Another evaluator said that research characterized a set of surrogate reference fuels to be used as tools for advanced combustion modeling and research. A separate reviewer commented that this is an important collaboration between the Department of Energy (DOE), original equipment manufacturers (OEM) and energy companies, and that developing research fuel sets for advanced combustion processes can result in engine efficiencies.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

All reviewer feedback was positive. A reviewer said that the diesel fuels matrix is quite advanced and the gasoline fuels matrix is in progress. A separate evaluator noted that there is such a wide range of possible fuels to consider; a condensed and focused table is needed to help minimize the costs associated with supply of these fuels. One expert commented that improving the fuel economy of light-duty (LD) and heavy-duty (HD) engines is addressed and the project brings together the stakeholders in designing a set of research fuels.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Comments were generally positive. One expert said that there had been good progress and that Chevron and Conoco Philips made outstanding contributions in the gasoline fuels analysis. The reviewer added that there were only five fuels commercially available. A separate commenter stated that the creation of the Fuels for Advanced Combustion Engines (FACE) coalition was a major breakthrough in order to get the right level of buy-in. The reviewer added that 5 out of 10 gasoline range fuels are complete in their characterization and that the balance will be studied and reviewed in Fiscal Year (FY) 2012. Then the goal would be to correlate the engine based data against these models. Additionally, the reviewer remarked that the project had reduced the possible number of fuels from 58 to 10 that could provide high value of data to researchers. The final reviewer noted that the FACE activities are progressing well and in a timely fashion, and that the diesel FACE fuel matrix was fully blended and available. The reviewer added that the analytical characterization of diesel fuels has been accomplished, and some studies using the FACE fuel set have started. The same evaluator stated that the gasoline FACE fuels matrix is underway, and AVFL-18 and AVFL-19 are started. The reviewer did caution that the cost of research fuels is high, and researchers must come up with ways to reduce the cost. The reviewer added that there is a risk that many would not buy the fuels.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers all had positive responses to this question. One reviewer mentioned an impressive collaborative work between DOE labs, Canadian labs, and the Coordinating Research Council (CRC). A separate reviewer also noted that there was excellent collaboration with CRC. The third reviewer stated that there was a strong group of both industry as well as academia involved in the support of the project.

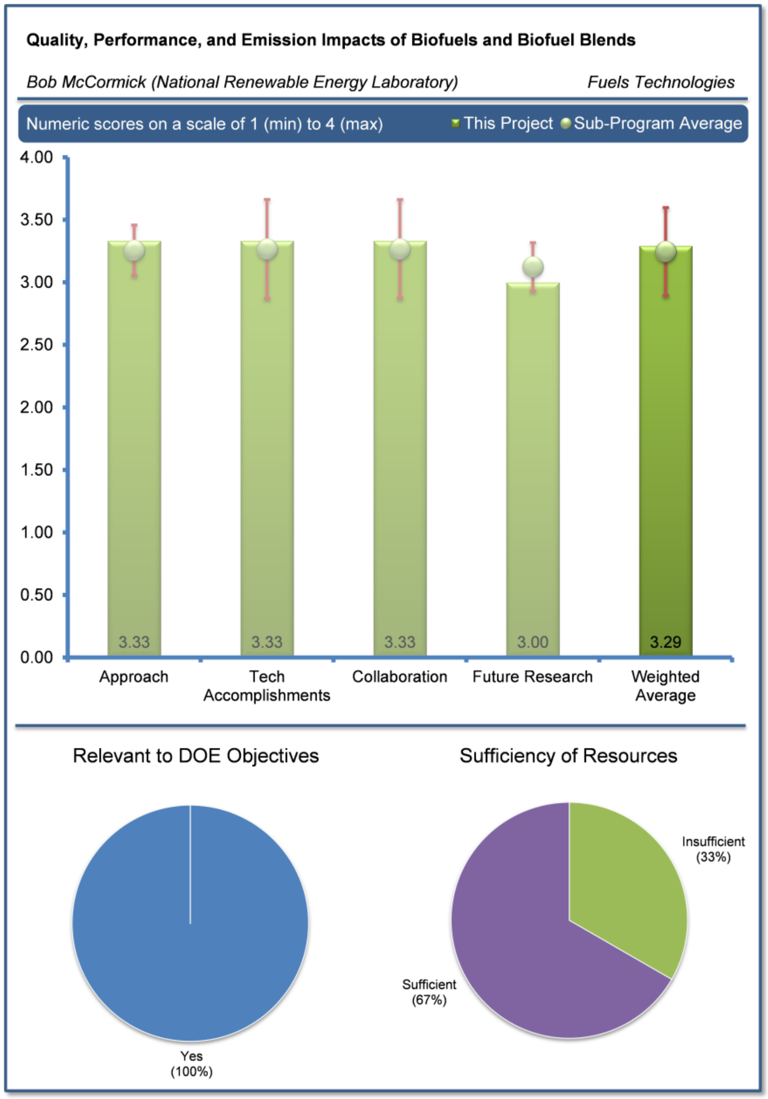
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer suggested that more emphasis on alternative fuels is needed. A separate evaluator suggested that the project should perform additional characterization of other fuel blends and includes the AVFL-19 fuel in the project. That reviewer also suggested the project focus on ways to reduce the cost of fuel on a barrel or gallon basis. Another reviewer noted that the timeline on delivering specific goals, such as engine-based data correlation to specific physical/chemical properties of fuels, was not well defined. The evaluator wondered if we are talking two years or five years. One commenter suggested performing a detailed fuel characterization and encouraging the use of FACE research fuels in the future.

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

Sufficient resources were observed by two respondents, of which one reviewer stated that the DOE annual operating plans seem to be sufficient. The third reviewer expressed a deep concern about insufficient resources and funding to complete planned activities.

Quality, Performance, and Emission Impacts of Biofuels and Biofuel Blends: Bob McCormick (National Renewable Energy Laboratory) – ft003



Reviewer Sample Size

This project was reviewed by three reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer stated that the goals and objectives of current and future work were clearly defined and focused. A separate reviewer said that the project supports the baseline requirements for development of drop-in fuels, and supports the United States' ability towards offsetting foreign oil supply for transportation. The reviewer also noted that the presenter was able to strongly articulate how the research connects to practical applications such as diesel fuel replacement with B20 in transit bus applications. A separate reviewer said that the research was necessary to achieve DOE's petroleum displacement goals.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One evaluation noted a very-disciplined approach with highlighted milestones, timing, and go/no-go decision points. A second reviewer said there is a good tie to the current research and the further unknowns that are a result of the current research. One reviewer mentioned the project had covered a broad scope of biofuels. The reviewer added that fuel quality, performance properties, and compatibility with engines have been addressed. The evaluator believed there still are some barriers that prevent the wide use of biofuels, which include cold temperature operability, oxidation stability and other impurities, which must be addressed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that the project had clearly listed the technical accomplishments, such as having good data on fuels storage/handling, and ADT durability with B20/metallic contaminants. The reviewer also noted that, among other things, there had been a B100 quality survey. Another evaluator commented that the work on catalyst stability, and determining the effects of biofuels in long term aging, was well presented and the results show promise. The reviewer added that the results indicated no long-term issues associated with the use of B20 in light-duty diesel applications. The reviewer continued by saying that the work on transit bus B20 applications proved that there were little to no effects of biodiesel in newer technology engines that use SCR. The reviewer thought findings on long-term storage of biodiesel were interesting; additionally, how much biodiesel oxidizes demonstrates that the fuel refiner and the type and blend of feedstocks will be critical to the overall performance with respect to emissions performance. This evaluator also noted that the project team was able to show that the oxidation of these fuels was reversible and that the properties of the fuel were not changed; these highly oxidized fuels can be rescued. One expert found the project accomplishments to be good. The reviewer stated that the characterization of acids in hydrotreated pyrolysis products, mixed alcohols from biomass-derived syngas, and biodiesel catalyst durability study addressed the negative impact of sodium, potassium and calcium. The E85 survey and specification changes were interesting. This reviewer also thought the project needs more focus on addressing quality, performance and specification issues.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated the team of partners in these projects was extensive and some aspects of the work were strongly tied to more real world demonstration tests. A reviewer commented that the project was still missing collaboration with universities, such as Pennsylvania State University or University of Michigan. Another reviewer suggested that it would be nice to have the OEM and the energy companies in the list.

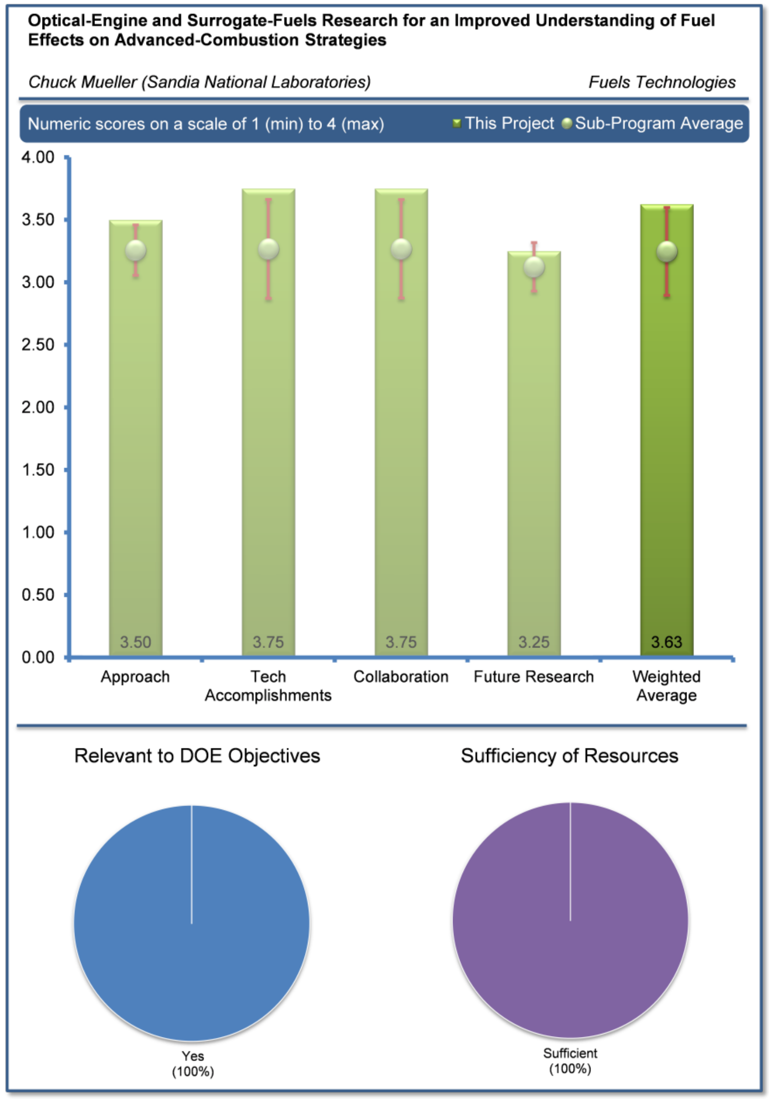
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer believes that B20’s impact on oil dilution needs to be continued, adding that European data shows examples of high fuel in oil dilution levels, which can impact hardware life. A separate commenter stated that there was a good plan for future work, adding that future work must focus on issues that are preventing the commercialization and use of biofuels. An evaluator saw the work about determining what parameters and requirements are critical for defining this equivalent drop-in fuel will be needed to be able to support the work of biofuel refineries as well as proper feedstock preparation. The reviewer added that this downstream to upstream approach needs to be further leveraged so that we can understand how to better provide a less broad range of fuel from these different biorefiners.

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

Sufficient resources were observed by two respondents, of which one specifically commented that the resources appeared to be sufficient. One reviewer noted insufficient resources.

Optical-Engine and Surrogate-Fuels Research for an Improved Understanding of Fuel Effects on Advanced-Combustion Strategies: Chuck Mueller (Sandia National Laboratories) – ft004



Reviewer Sample Size

This project was reviewed by four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

A reviewer said that the project would develop science-based approaches for high energy clean combustion (HECC) engines using fuels that can improve U.S. energy security. A commenter was of the view that the project was developing the science to enable high efficiency engines using fuels that improve U.S. energy security. The reviewer added that the project also advances the state of the art of diesel surrogate fuels. An evaluator asserted that by advancing knowledge of leaner lifted flame combustion, the project could ultimately enable sootless compression ignition combustion, avoiding the need for aftertreatment while reducing weight and otherwise increasing fuel efficiency. One evaluator stated that this project is very relevant to the objective of petroleum displacement. The reviewer added that the development of new and surrogate fuels will help in the development of engine optimization in new engines. In addition the reviewer mentioned that the work on reducing soot formation will be extremely valuable to the development of future engines that will produce fewer exhaust emissions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer saw the primary approach of the project as being on biodiesel surrogate fuels, quantifying soot formation and developing a series of screening techniques to understand the effects of changing fuel qualities. Another commenter was of the opinion that the diagnostic capabilities and collaborations are excellent and that the methods for solving the barriers being addressed in the project were good. A separate reviewer noted the unique and comprehensive diagnostic capabilities and good collaboration. One reviewer felt the approach is to develop general knowledge of fuel parameter effects through diesel surrogate fuels so as to provide a screening technique to characterize current and future fuels. The reviewer believes that this raises the chicken-and-egg question of to what extent will such future fuels be subject to screening based on this technique. In many cases, the reviewer continued, fuel properties will be determined by feedstocks and limitations of process technologies. The reviewer added that defining fuel component effects might or might not be valuable in development of such process technologies for future fuels. The commenter stated that the research in this project might be more useful defined or at least described this way, presuming that it successfully proceeds to the point where it can be used in this way, rather than just as a screening technique. The reviewer also said that the other side of the research—to enable computational engine optimization—may be more important as the ability to engineer the fuels to optimum properties may be limited.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt the project had identified a series of key characteristics for diesel fuels, such as volatility, carbon type and ignition quality. The reviewer also commented that the project has developed and validated the best injector design to limit the soot formation during combustion (no smoke). The same reviewer added that 2 holes provided a longer flame line and introduced the least jetting effects as with injectors with 5 and 10 holes. This reviewer also felt the project was able to determine the list of critical independent variables that need to be controlled and that more understanding of the second order level variable and interdependencies will be investigated in future years. Another evaluator noted that progress on technical accomplishments has been very good and thought it will be interesting to see the engine test of the surrogate fuels in the future. An expert commented that two surrogate fuels were created and that the project had used detailed target-fuel characterization data. The reviewer felt that a good matching of property targets was achieved. One respondent stated that diesel surrogate fuels had been identified by various properties and replicated with mixtures from various component groups. The reviewer saw this as the first step to analyzing fuel effects on and through various diagnostics. The reviewer added that it does not assure that the diagnostics will adequately define the effects on optimizing leaner lifted-flame combustion (LLFC) and the presentation is not clear to what extent progress on the latter is being made. Moreover, the presentation does not make clear to what extent existing literature on LLFC and/or other combustion regimes is being reviewed and applied along with the diagnostics from the optical engine research.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers noted that there is strong collaboration. A reviewer opined that there was a good mix of collaborating institutions with range of perspectives and experience relevant to the research. One respondent felt there was a great collaboration with universities and private sector. A third reviewer noted that the project has had a long list of collaborators for many years. The final reviewer stated that collaboration with CRC is always excellent, and also noted collaboration with the Advanced Engine Combustion (AEC) MOU Working Group and Caterpillar.

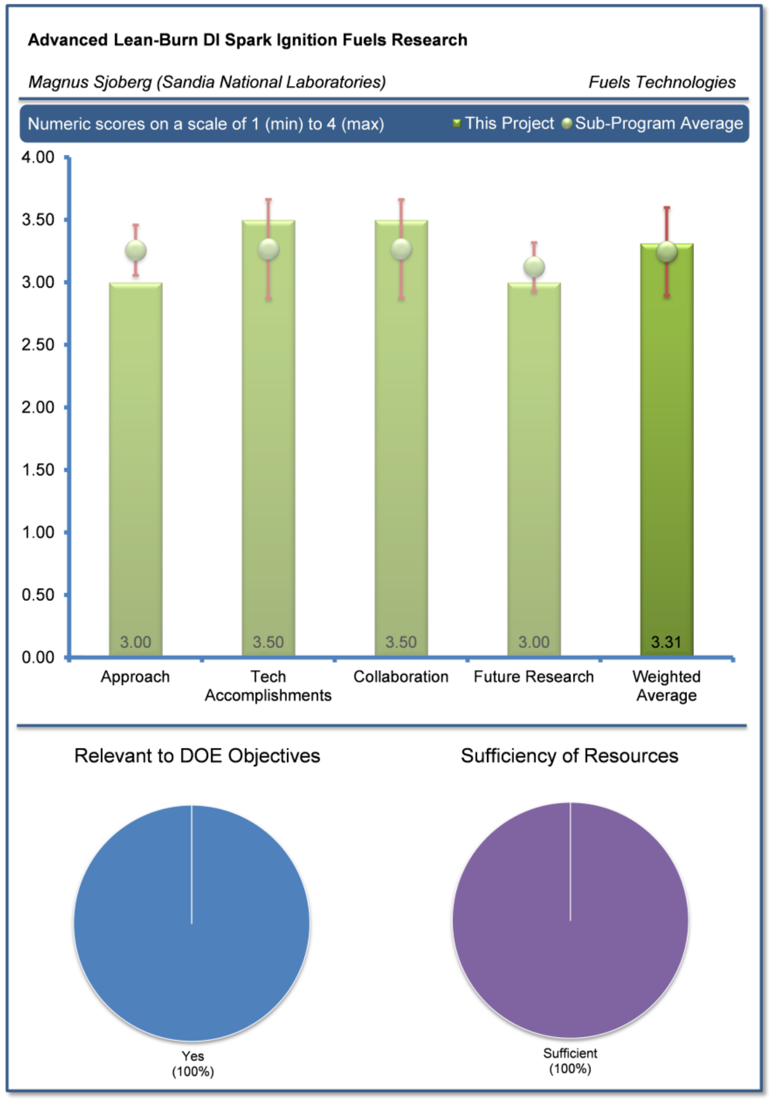
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer suggested that the project apply these robust screening techniques to quantify mixing controls. The reviewer also encouraged engine testing of the surrogate fuel sets and blends and felt that further testing on fuels will be required to overcome barriers to LLFC. A commenter was of the opinion that the planned engine testing will provide very good data in the future and that the results of the surrogate fuel testing will be very valuable. One evaluator said that the characterization of fuel effects through diagnostics to be performed both on subset of LLFC surrogate fuels (generic), and on some real world fuels –esters and other oxygenates – should give better sense of the utility of the research. A reviewer suggested the researchers apply the engine-based screening technique for quantifying fuel effects, adding that the engine testing of fuels is critical.

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

All of the responding reviewers said the resources were sufficient. One reviewer stated that the resources appear sufficient for the work that is planned. Another said that the resources appear to be sufficient. One reviewer noted that there was no indication from presentation or presenter that resources were major constraint and an $800,000 level seems appropriate, in conjunction with use of an optical engine already existing at a contractor facility.

Advanced Lean-Burn DI Spark Ignition Fuels Research: Magnus Sjoberg (Sandia National Laboratories) – ft006



Reviewer Sample Size

This project was reviewed by four reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

Reviewers generally found that the project supports DOE's objectives. A commenter responded yes this project supports the goal of displacing petroleum by helping to maximize efficiency. Another reviewer said that high pressure spray guided direct injection engine technology has great potential to reduce petroleum demand and enable further expansion of petroleum displacement through renewable fuels. An evaluator noted that the focus of the research is how future fuels will impact the combustion systems of new light duty engines, adding that there the focus is also on E85 gasoline and that these support the overall DOE objectives. One reviewer said that apparently the research would contribute to petroleum displacement due to highly efficient direct injection spark ignited (DISI) light-duty engines, although the basis for that efficiency, or even the concept of stratified ignition, is never really explained. The reviewer also felt that the presentation had not explained why the focus is on reducing nitrogen oxides (NO_x) and soot formation because those two pollutants are not normally of major concern with light-duty engines, spark ignition or gasoline/E85 fuels. The reviewer stated that presumably the two are associated with stratified charge ignition but that is never stated or explained. The reviewer elaborated that while the research would apparently support the goal of petroleum displacement, there is some leap of faith in that regard based on the presentation. The reviewer concluded that if this factor had numerical ratings like the others, it would have been downgraded for this but given the choice between yes or no, the answer appears to be yes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One evaluator said that the approach of using optical and metal engines with associated modeling technique is excellent. Another reviewer said that the researchers were applying a combination of metal engine and optical engine research to understand barriers and the fundamentals to overcome those barriers. The reviewer went on to note that the experimental studies are supporting numerical studies of these processes, to further the understanding of fundamental aspects of barriers to these combustion processes. An evaluator stated that the general approach as stated – performance testing, testing with optical and conventional diagnostics, and supporting modeling– makes sense, but that beyond that, it is hard to tell to what extent the approach is focusing on the most important technical barriers for the reasons stated above and because the presentation is at a high level of technicality, difficult to understand, includes many slides (images) that do not tell anything to reviewers who are not highly specialized, and uses many unexplained technical terms--including many acronyms that are never spelled out.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Most reviewers saw that the project has made good progress. One reviewer commented that there was extensive work accomplished on gasoline and E85 fuels, and noted that the researchers had accomplished high speed imaging of the stratified combustion process and planar laser induced fluorescence (PLIF) of the spray process. The reviewer continued that the project had identified operational challenges with controlled NO_x and particulate matter (PM) while improving efficiency. The reviewer also stated that the injection timing control allows for in-cylinder NO_x and PM control, as expected, but E85 allows greater reductions of PM and NO_x into a combined low-emission operating condition, and with unusual spark timing high combustion stability can be achieved as well. The reviewer concluded that clearly, this is very innovative and creative work. A separate reviewer noted the researchers had performed a comparative study and high speed imaging study, and that good progress toward the objectives has been made. One evaluator opined that the progress in this project and accomplishments have been very good, especially the work showing E85 can reach inside the U.S. 2010 NO_X/PM box. A reviewer was not clear on why the engine is only tested with very high compression ratio (12), which is near optimum for E85 but higher than optimum for gasoline. The reviewer wondered if the project is geared only toward E85 use or toward increased efficiency with various fuels, including those likely to be most in use.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the project has a very good list of collaborators. Another reviewer noted that GM and University of Michigan were involved in the program, with new collaboration with the University of Southern California, and the project is also working with other national labs and groups. Another commenter also mentioned the collaboration with GM and AEC MOU, and concluded that it was a good team. One evaluator stated that is was apparently a good collaboration, with other laboratories identified and an industry consortium of ten engine maker partners and five energy companies, though these members are not identified.

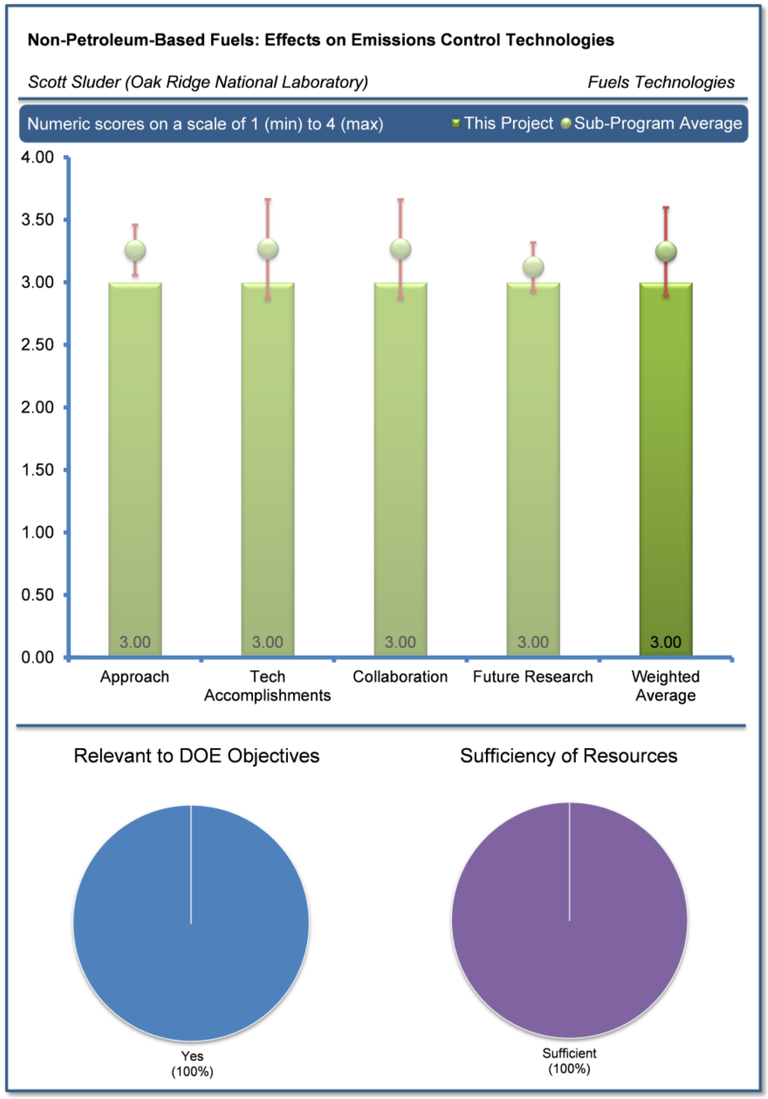
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer remarked that the present work has raised a number of interesting and valuable questions that the proposed future work will explore. The reviewer concluded that the project should yield additional highly interesting results. One reviewer felt that future work on this project will continue to provide valuable information regarding advanced fuels research. One evaluator mentioned that the effects of temperature on low-NO_x soot operation are addressed, and felt there was a good plan for future research. The final commentator remarked that the technical terminology makes some of the proposed future work difficult to understand. Additionally, it is not clear why intake temperature would be studied. The reviewer was uncertain if the spark ignition direct injection (SIDI) engines would be deployed only in certain climatic regions. The reviewer noted that other parts of the future work, such as park timing, and fuel vaporization/thermal efficiency, all appear to have merit.

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

All of the reviewers selected sufficient. A reviewer commented that the project was reasonably well funded, and that the funding level appears stable. The reviewer added that funding for out-years should be maintained or expanded to keep the momentum that this project has built up. One reviewer noted that the resources appear to be sufficient. A separate reviewer stated that there was no basis for concluding that the resources are either excessive or insufficient.

Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies: Scott Sluder (Oak Ridge National Laboratory) – ft007



Reviewer Sample Size

This project was reviewed by one reviewer.

Question 1: Does this project support the overall DOE objectives? Why or why not?

The reviewer stated that understanding of the fuel-property impacts on combustion and emissions control systems is important and supports the overall DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The evaluator stated that the research brings together targeted engine-based micro reactor and bench reactor studies with characterization of PM, hydrocarbons (HC) and the emissions control systems (ECS).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The commenter stated the researchers had identified a pathway for the use of ethanol in gasoline, determined Na effects on ECS and soot oxidation kinetics.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer noted that there was a good collaboration, including OEMs and others.

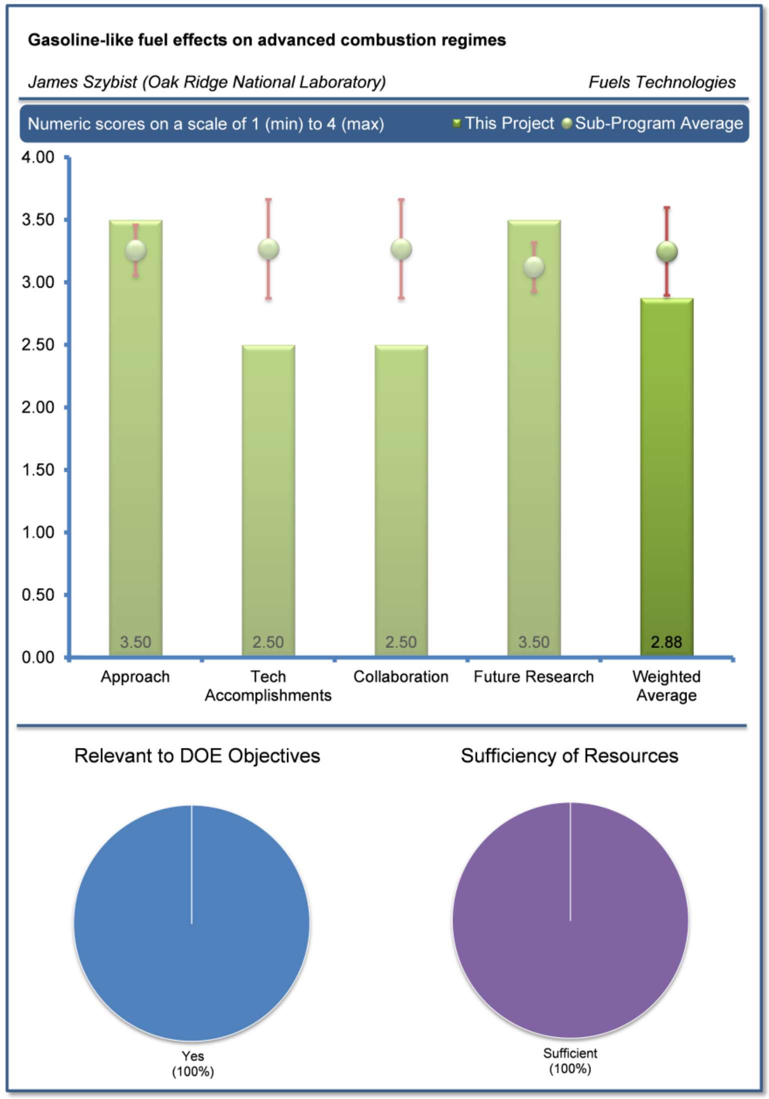
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer suggested a need to study the fuel effects on exhaust gas recirculation (EGR) cooler fouling, adding that exploiting alcohols in gasoline to enable lean-NO_X is a good idea.

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

The reviewer commented that resources appear sufficient.

Gasoline-like fuel effects on advanced combustion regimes: James Szybist (Oak Ridge National Laboratory) – ft008



Reviewer Sample Size

This project had a total of two reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

A reviewer noted that the project contained advanced research on how to improve combustion of conventional fuels by blending with ethanol and using advanced combustion techniques. One reviewer stated that the research was to determine the effects of fuel properties and chemistries on combustion performance and emissions for advanced combustion regimes, and worked towards direct petroleum displacement with alternate fuels. The reviewer concluded that the work could enable direct petroleum displacement, improved engine efficiency, and reduced emissions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer commented that there was a strong focus on developing a stable test engine platform with enough flexibility and control to effectively mix the high and low reactivity fuels. The reviewer added that there was an interesting blend of using the OEM equipment as well as a custom applied fuel injection system. Approach to multi-cylinder reactivity controlled compression ignition (RCCI) is good. The experimental approach to determine optimization potential for high ethanol content fuels with low octane number hydrocarbons is a sound approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer believed that a high-level DOE milestone has been completed, and that the three projects are progressing well. One reviewer noted questions regarding the fuels selected for this study, and their relevancy in the industry. The reviewer added that, although the fuel met the needs of the experiment, there was confusion in the technical community as to the relevancy and usability of the research.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer noted there were good corporate and university partnerships. A second reviewer also said there was good collaboration.

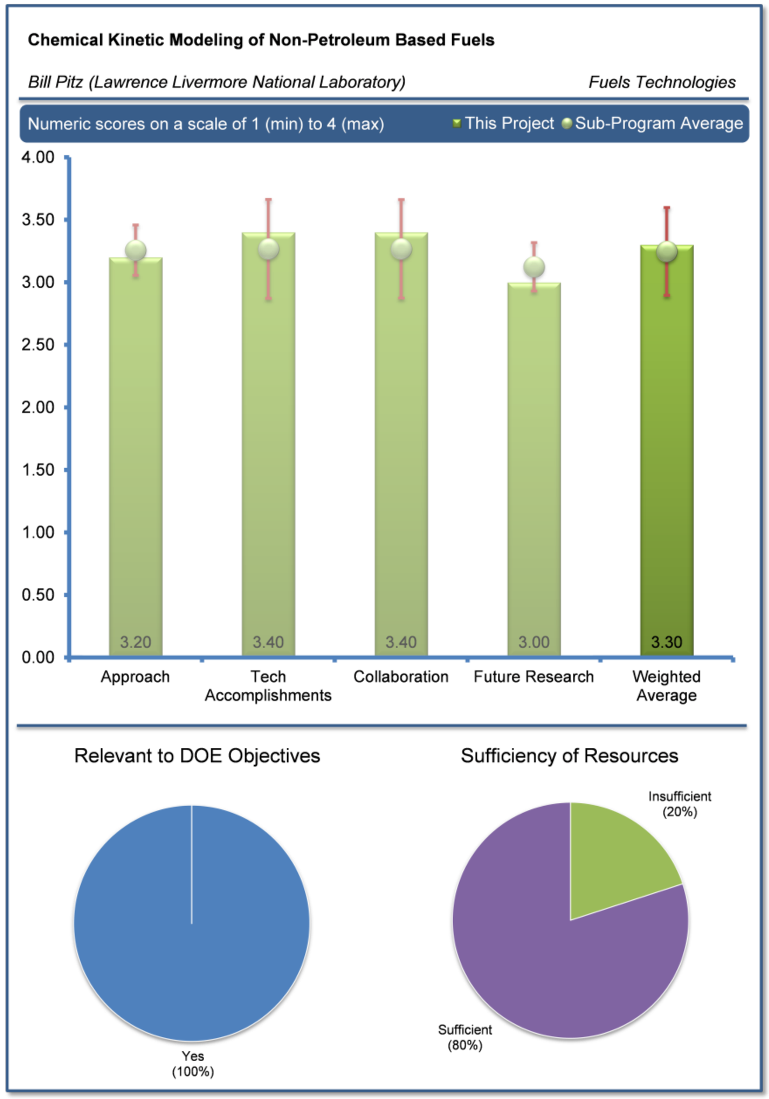
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer suggested that future work could include research on further blending ratios, compression regimes, and spark curves. An evaluator noted that numerous activities investigating the effects of gasoline-like fuels on high efficiency operating regimes are going on.

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

All reviewers selected sufficient. One reviewer noted strong lab capabilities, and a second reviewer said that the resources appear to be sufficient.

Chemical Kinetic Modeling of Non-Petroleum Based Fuels: Bill Pitz, (Lawrence Livermore National Laboratory) – ft010



Reviewer Sample Size

This project was reviewed by five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

A reviewer commented that the development of kinetic models for combustion of hydrocarbon and alternative fuels is critically important for development of advanced combustion, advanced fuels and new engines. This reviewer added that this will lead to improved efficiency and reduced petroleum demand. One commenter said that it was critical to the development of higher efficiency low emission engine technologies in the future and would also prepare a percentage of petroleum displacement using these new fuel chemistries. Another evaluator stated that the research continues to be extremely relevant to the Vehicles Technologies Program (VTP), and that models being developed will be able to provide information to optimize fuel formulations and ultimately help meet the goal of reducing petroleum use. An expert noted that development of a chemical kinetic model could be useful for future engine/fuels research, use as a screening device, the matching of compatible fuels and components with engine types, etc. The final commentator mentioned the research provides fundamental research to support DOE/industry fuel technology projects, and would develop predictive chemical kinetic models. The reviewer added that it would develop chemical models for larger alkanes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One evaluator noted that the research was developing new kinetic models and performing validation with a variety of partners. The reviewer mentioned that new fuels being considered include pentanol, larger esters, cycloalkanes and other species. The reviewer also stated that the models are combined to provide the kinetics to describe combustion of surrogate fuels to represent practical and unconventional fuel combustion, and are also reducing mechanisms to enable detailed computational fluid dynamics (CFD) calculations of internal combustion engine combustion. One reviewer mentioned the developing of predictive chemical kinetic reactive models of alternative fuel blends of individual fuel components and that the approach included combining mechanisms to provide surrogate models of these new fuel blends. The reviewer stated that the surrogate models are published on the website for diesel and diesel blends as well as ethanol and ethanol/gasoline blends. Another reviewer said that the approach of looking at a variety of fuel mechanisms to obtain models to help determine future fuel formulations is an excellent approach. The reviewer added that the number of fuels being evaluated is very good. Another reviewer said that developing chemical kinetic reaction models for each fuel component for advanced non-petroleum based fuels may overcome some barriers. The final commenter stated that the use of a rapid compression machine (RCM) and shock tubes to simulate engine combustion is only partial surrogate for actual engine regimes. The reviewer noted that while various different fuel types are being tested to help build and validate the model, a number of those chosen seem to have ultimately no practical value, chosen perhaps because of connections/relationships to particular researchers, such as isomers of pentanols, individual methyl esters, and diethyl carbonate.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer said that the project had developed and validated kinetic models for methyl oleate, methyl palmitate and pentanol. One commenter also noted that the project developed methyl palmitate and methyl oleate models, and also were considering iso pentanol and also 1-pentanol. The reviewer noted that this was fully validated. One expert said that good progress has been made, noting that the research validated a chemical kinetic model for real biodiesel component methyl palmitate, methyl oleate. Another reviewer noted that experimental validation of these biodiesel fuels used many different combustion methods. The reviewer also stated that the project had collaborated with many universities, including Stanford and University of Michigan, as well as Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories (SNL). An evaluator said that the results presented of the validated biodiesel results and alcohols were very impressive will be extremely valuable information to help in optimizing fuels in the future. A final reviewer said that the experimental results conform closely to the predictions of the model, indicating that the model is fairly accurate as far as it goes with the two diagnostic variables. The reviewer added that there is no explanation of how these two variables translate into practical knowledge or how additional diagnostics will be determined by the model.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One commenter said that collaborations with university and national lab groups, including University of Michigan, Stanford University, Rensselaer Polytechnic Institute (RPI) and others, uses a variety of experimental techniques. The reviewer also noted the project is collaborating with several other national laboratories. Another reviewer said that the working collaboration included the University of Michigan, Stanford, RPI, University of Ireland, the nation of Columbia, the University of Connecticut and the FACE working collaboration. Another commenter said that there was a very impressive list of collaborators in this work. A reviewer said that there was good collaboration with academia and also mentioned AEC, CRC and FACE. One reviewer acknowledged the various linkages to other laboratories and research programs identified in a list, but felt that no real explanation of the relationships was indicated. The reviewer added that private sector interest or commitment was shown only through listing a consortium of engine and energy companies.

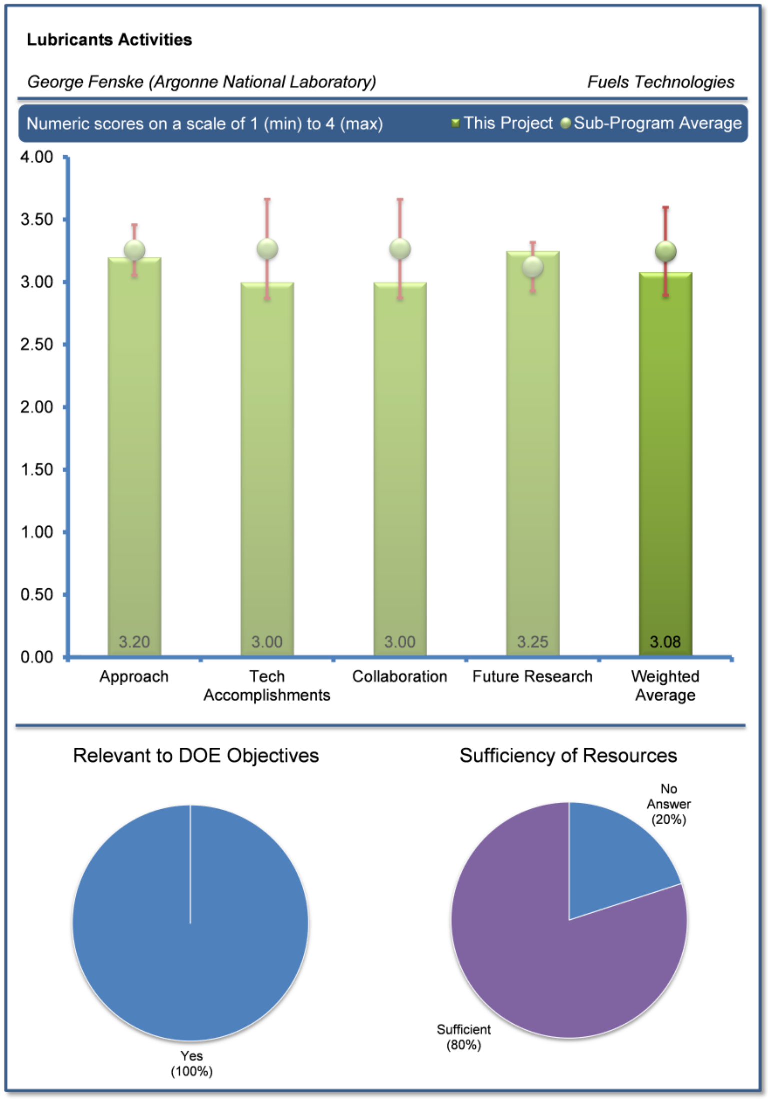
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One expert stated that all of the planned future work would provide needed additional results that will be extremely valuable to help optimize fuel formulations. A reviewer said that future work will continue validation of the large ester models and will consider additional cycloalkanes and gasoline –ethanol surrogate models. The reviewer said the future research would also consider the effect of double bonds on ignition behavior. The commenter concluded that this would continue to be highly valuable and high impact work. One evaluator remarked that future research would develop the surrogate models for Cyclohaexnae and Cyclohexane/diesel blends and develop and enhance the CFD models as they compare to empirical data. The reviewer also mentioned Methyl Linolenate and Mythey Stearate. One reviewer remarked that future research would continue the validation of larger ester models, validate gasoline-ethanol model and investigate the effect of double bond on ignition characteristics. The final reviewer felt that the project proposes extending the research to other fuels, not all of which are of particular interest, whereas the existing results for the two variables shown appears to already validate the model for those variables. The reviewer said there was no reference to expanding the model to other variables, and that the value of simply testing more fuels is not clear.

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

Four of the reviewers selected sufficient, and one reviewer selected insufficient. One reviewer commented that as important as this work is, the funding level should be increased, and adding that stability in the budget for this program would help maintain the momentum and continuity of this program and its many collaborative activities. One reviewer suggested that for the future work planned, the resources are adequate. Another reviewer also said that resources appear to be sufficient. One evaluator said that a low level of resources appears to be appropriate for the type of work being done and the utility of the results. The reviewer added that, if more resources were required to elaborate the model to provide more diagnostic data (going beyond shock tube and RCM) and meaningful results could realistically be expected, that greater resources might be justified.

Lubricants Activities: George Fenske (Argonne National Laboratory) – ft012



Reviewer Sample Size

This project was reviewed by five reviewers.

Question 1: Does this project support the overall DOE objectives? Why or why not?

One reviewer said that this research is very relevant to the goal of reducing petroleum use because by making advancements in lubricants, you can have a 1% or 2% improvement in fuel economy, and because there is a significant loss of fuel economy due to friction of up to 10%, improving lubricants will have an impact on petroleum displacement. A second reviewer noted that lubricants improve fuel efficiency of the vehicles, and can reduce parasitic losses in the engine by 10%. The reviewer added that low viscosity lubricants help a lot, and that up to 2% improvements in the fuel economy is expected. The reviewer concluded that these attributes support the DOE overall objectives. A third reviewer said that the results could increase fuel economy by 5%-7% in new vehicles and 1%-2% in legacy vehicles by reducing friction parasitic losses. A commenter said that the research was on lubricants and how they can affect vehicle performance and fuel economy. The final reviewer suggested that additional impact should be addressed by looking at interaction with aftertreatment systems.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer said that lubricants and tribology is a relatively neglected area of energy research to date. The reviewer continued that in recognition of that, this phase of the project proceeds from major consultation with stakeholder to identify pre-requisite needs for meaningful future research programs, test methods equipment, metrics, facilities, data needs, areas of initial focus, applications, etc. This will provide the basis of meaningful research for years to come in this promising but neglected field. The reviewer also mentioned a high level of sophistication in planning and coordination rather than jumping headlong into specific disjointed research projects. A reviewer said that good progress has been made in developing goals targets and barriers in support of the DOE multiyear program plan (MYPP) development, and that a comprehensive set of barriers has been developed. One evaluator said that the research had developed multiple pathways to address the barriers. A reviewer described a well focused approach to overcome barriers, adding that the barriers are inadequate data and predictive tools, limited base stocks and additive formulations and that validation is limited. Another commenter said that the approach was good and followed industry and academically approved methods. A final reviewer stated there was minimal focus on aged oil in old engines and there were no projects proposed for transmission fluids.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers generally observed good technical progress. A reviewer said that there had been good progress towards the characterization of the lubricants in order to screen these different constituents that can offer greater fuel economy and engine performance. One commenter stated that good progress has been made in the lab-engine validation project and the lubricant additive studies work. An evaluator noted that protocols and lab/engine validation methods were developed to screen candidate lubricants and friction modifiers without the need for expensive and time consuming engine testing of each candidate. The reviewer added that initial testing had been done on some sample lubricants and additives, and that methods for investigating mechanisms of friction and friction reduction, boundary films, etc. are set in motion. One expert stated that multiple goals are addressed, adding that issues are identified, such as fuel economy, emissions, alternate fuels and cost. The project identified multiple pathways and approaches to improve fuel economy. A reviewer said that a number of new projects have started this year but no data is available yet. The reviewer noted that it will be interesting to see the results next year.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

An evaluator cited collaboration, not only with the normal labs, universities and automakers, but also with key vehicle component makers, lubricant and additive makers, etc. all being brought into the process. Another reviewer mentioned there was good collaboration with university and oil company support. A third commenter mentioned the good collaborations with industry lab, academia and other institutions. A final commenter noted collaboration with the Massachusetts Institute of Technology, OEMs and lubricant and additives suppliers.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One evaluator stated that there was a well scoped plan for completing the process of putting the protocols and methodologies in place and getting wide input while transitioning to initial research on specific types of lubricants, films, etc. Another reviewer believed that future work would be to further develop the models that can help characterize the characteristics and correlate those to actual engine testing. Another commenter mentioned that several projects were established to address the development of advanced lubrication concepts. A final evaluator said that the proposed future activities are adequate.

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

All responding reviewers selected sufficient. One reviewer said that the resources appear sufficient for the work that is planned. Another evaluator commented that resource levels appear to be appropriate based on reported progress. A third reviewer noted a need for phasing, adding that there was a need and opportunity for substantial follow-on work, which was strongly suggested. The final commenter said that the resources appear to be sufficient.

Section Acronyms

The following list of Acronyms cited within this section is provided as a reference for readers.

Acronym	Definition
ADT	Accelerated Durability Test
AEC	Advanced Engine Combustion
AVFL	Advanced Vehicle/Fuel/Lubricant Committee
AVFL-19	Project 19 under Advanced Vehicle/Fuel/Lubricants of the Coordinating Research Council
B20	Biodiesel blend of 20% neat biodiesel
B100	Biodiesel blend of 100% neat biodiesel
CFD	Computational Fluid Dynamics
CRC	Coordinating Research Council
DISI	Direct Injection Spark Ignited
DOE	Department of Energy
E85	85 percent Ethanol blend with gasoline
ECS	Emission Control Systems
EGR	Exhaust Gas Recirculation
FACE	Fuels for Advanced Combustion Engines
FY	Fiscal Year
GM	General Motors Corporation
HC	Hydrocarbon
HD	Heavy-Duty
HECC	High Efficiency Clean Combustion
LD	Light-Duty
LLFC	Lean Lifted Flame Combustion
LLNL	Lawrence Livermore National Laboratory
MOU	Memorandum of Understanding
MYPP	Multiyear Program Plan
NOx	Oxides of Nitrogen
OEM	Original Equipment Manufacturer
PLIF	Planar Laser-Induced Fluorescence
PM	Particulate Matter
RCCI	Reactivity Controlled Compression Ignition
RCM	Rapid Compression Machine
RPI	Rensselaer Polytechnic Institute
SCR	Selective Catalytic Reduction
SIDI	Spark Ignition Direct Injection
SNL	Sandia National Laboratory
VTP	Vehicle Technologies Program