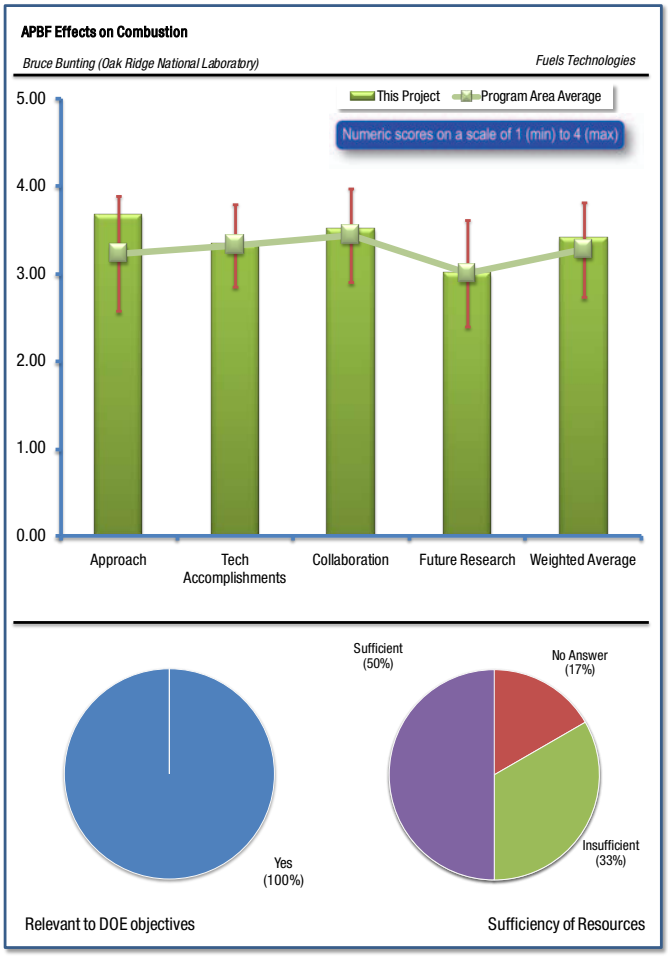
5. FUELS & LUBRICANTS TECHNOLOGIES

The Fuels & Lubricants Technologies 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. 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.

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 to 4)*. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
APBF Effects on Combustion	Bruce Bunting (Oak Ridge National Laboratory)	5-2	3.67	3.33	3.50	3.00	3.40
Fuels for Advanced Combustion Engines	Bradley Zigler (National Renewable Energy Laboratory)	5-4	3.33	3.50	3.80	3.00	3.43
Quality, Performance, and Emission Impacts of Biofuels and Biofuel Blends	Robert McCormick (National Renewable Energy Laboratory)	5-6	3.17	3.50	3.50	3.00	3.35
Fuel Effects on Advanced Combustion: Optical Heavy-Duty Engine Research	Charles Mueller (Sandia National Laboratories)	5-8	3.00	3.40	3.60	3.00	3.28
Mid-Level Ethanol Blends Test Program	Brian West (Oak Ridge National Laboratory)	5-10	2.83	3.33	3.33	2.83	3.15
Advanced Lean-Burn DI Spark Ignition Fuels Research	Magnus Sjoberg (Sandia National Laboratories)	5-12	3.20	3.00	3.00	3.00	3.05
Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies	Scott Sluder (Oak Ridge National Laboratory)	5-14	3.17	3.33	3.33	2.83	3.23
Non-Petroleum-Based Fuel Effects on Advanced Combustion	James Szybist (Oak Ridge National Laboratory)	5-16	3.60	3.20	3.33	3.33	3.33
Advanced Petroleum-Based Fuels Research at NREL	Bradley Zigler (National Renewable Energy Laboratory)	5-18	3.00	3.17	3.50	3.00	3.15
Chemical Kinetic Modeling of Fuels	William Pitz (Lawrence Livermore National Laboratory)	5-20	3.33	3.40	3.50	3.00	3.35
OVERALL AVERAGE			**3.23**	**3.32**	**3.44**	**3.00**	**3.27**

APBF Effects on Combustion: Bruce Bunting (Oak Ridge National Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The first reviewer felt the project was relevant as it could potentially lead to introduction of new fuels or more efficient combustion. Another said the research to improve engine efficiency and alternative fuels research will result in petroleum displacement. A third reviewer said the project was focused on determining fuel characteristics that enable high efficiency, emission compliant engines, and that success would lead to lower consumption of petroleum based fuel. The final reviewer said that this project is investigating the fundamentals of combustion and engine operation. This has a direct bearing on efficient use of fuels, both petroleum and non-petroleum based.

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?

Reviewers felt there was a good combination of engine studies and modeling, and good investigations of the fundamentals of combustion technical barriers. A third review comment was that the project had an excellent approach of evaluating a range of fuel types and different engine platforms. This reviewer approved of the inclusion of petroleum based fuels, biofuels, and alternative fuels (oil sands & oil shale) to help establish fundamental understanding of relationship between fuel properties and compositions vs. performance. The final commenter noted that this project has used the FACE fuels from the CRC research and appears to be well designed.

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

A reviewer stated generally that there was good progress on many fronts on HCCI, PCCI and conventional combustion. Also stated was that the work on FACE fuels and HCCI exhaust chemistry has progressed well in the past year. The team has initiated a CRADA program on ionic liquids with GM, and determined that these lubricants have some benefits relative to conventional lubes (better thermal stability, better lubricity). A reviewer strongly supported addition of gasoline research engine due to potential for efficiency improvements and increasing supply of gasoline/ethanol in the U.S. pool: this reviewer also felt it was important to continue to improve the kinetic model. PCCI fuel effects were well studied, in this reviewer's opinion.

Reviewers noted several specific technical accomplishments of the project: the investigators have tested the CRC FACE diesel fuels in HCCI and PCCI advanced combustion modes, have identified the fuel properties/compositions preferred by each of these engines, and are also using these fuels as basis for a kinetic modeling mechanism reduction with the University of Wisconsin. Other accomplishments that were highlighted by reviewers included that the team has determined the detailed exhaust chemistry for the HCCI engine, and determined that 90% of HC emissions come from unburnt fuel. The team has also found that PM is from volatile condensation products, not traditional diesel soot. This reviewer pointed out that the team has built on experimental work by using CFD modeling.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Opinions on collaborations were generally positive. Among the comments were that the research team is working effectively with a wide range of groups, and that the collaboration with CRC, GM and others appears to be well directed. A reviewer said that the team has established collaborations with OEMs/engine manufacturers, several energy companies, and universities. The final reviewer said the collaboration was good, but that the team needs to mention details of the contributions of partners.

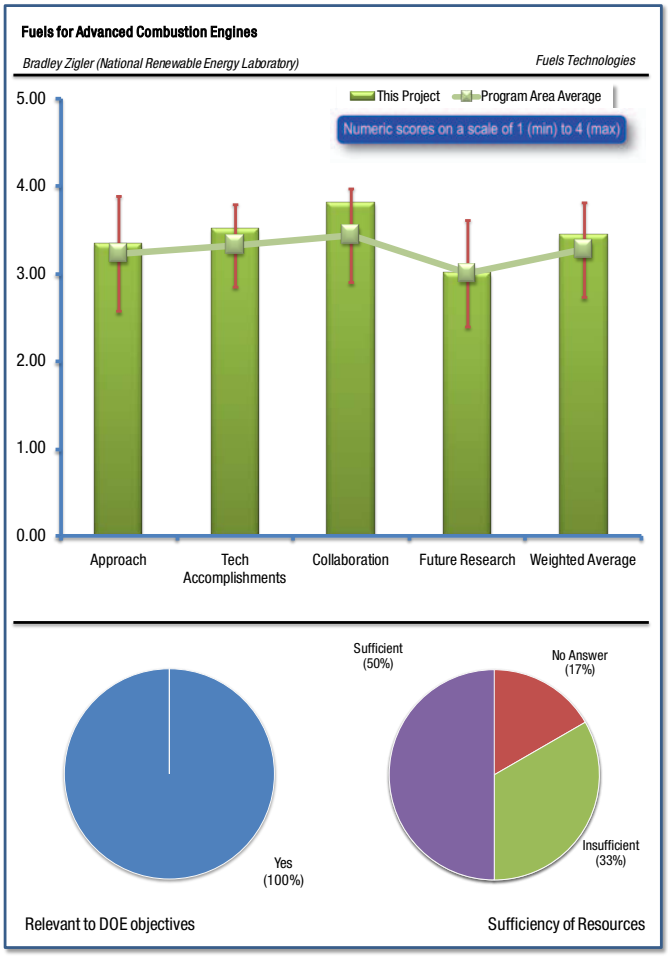
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The first reviewer recommended the highest priority be placed on gasoline/ethanol work. Another suggested that cuts in budgets must be planned for, and the research team needs to rethink priorities to accommodate these potential cuts. A reviewer pointed out the FACE diesel work in the future research, and offered that ionic liquids represent a new class of lubricants. Plans of continuing experiments and statistical analyses and modeling to evaluate petroleum and biofuels in advanced combustion engine regimes are very good, according to another reviewer (although this reviewer had concerns about funding). This reviewer emphasized that more progress will be made on ionic lubes. The final reviewer stated that the PI didn't spend too much time on future work because he ran out of time.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The first reviewer thought the project team made good use of resources. The other reviewers had some reservations about resources for this project: one was concerned that the reduction in APBF funding will have a great impact and will reduce the effectiveness of this program. This reviewer said it was important to continue to include petroleum based fuels as baseline and blend components. A third reviewer stated that the future of APBF research is unknown, as the budget is zeroed out for 2011. Some fuels are not available now, according to this reviewer, who suggested that the team emphasize renewable fuels instead of petroleum-based fuels.

Fuels for Advanced Combustion Engines: Bradley Zigler (National Renewable Energy Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The first reviewer stated that the FACE type programs are a necessary first step in making a wide-range of improvements in fuel economy and to use as baselines for the next generation of fuels. Another said this project improves understanding of fuel effects on efficiency and properties of new fuels. Further, this project is developing the most characterized fuels for fundamental R&D on both fuels and engines, which will lead to better understanding for alternative fuels use in engines. A reviewer said that the team is focused on enabling advanced combustion engines having improved fuel economy by understanding fundamental relationship between fuel properties and performance. The final commenter observed that the goals are to improve efficiency by 25% for gasoline and 40% for LD vehicles by 2015, to understand the fuel property impacts on advanced combustion processes, and to develop a characterization of advanced research fuels. This reviewer said the research team needs to include ethanol in the matrix because a large quantity of ethanol is entering the gasoline pool.

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 observed that the approach contains a number of important aspects: development of standard sets of diesel and gasoline fuels that are available to all researchers (enables comparison of results across different research labs and engine platforms; extensive characterization of the physical and chemical properties of the fuels to enable correlation of fuel properties to engine performance to an extent not done previously. Another said that characterization of diesel provides very useful information: this reviewer would like to see this work extended to some commercial diesel fuels for comparison. Since a lot of the tie-in to addressing the technical barriers is dependent upon how the FACE fuels are used, according to a third reviewer, this is largely a function of how/if researchers use these fuels. It seems like the fuels are being made readily available. A reviewer highlighted the great collaborative approach to developing a fundamental set of diesel and gasoline fuels as well as low temperature combustion regimes. The final commenter mentioned the project's coalition of auto and oil companies, fuel blenders, and encouraged R&D activities.

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

Positive comments included that there were great accomplishments to date, and well characterized fuels. A reviewer thought that progress on characterization is excellent but could be faster. A reviewer said that progress on the gasoline fuel set has been slow (the only non-positive comment received). A third reviewer noted that the diesel fuels set has been developed and is available for purchase through a commercial fuels blender. This reviewer also stated that diesel fuels have been extensively characterized through the CRC FACE Working Group, and that development of the gasoline fuel set is in progress.

A reviewer noted several aspects of the research, including that the diesel fuel matrix is fully blended and characterization of diesel fuels is completed. The research team has also encouraged R&D activities to use the FACE matrix, and has conducted an in-depth analysis of fuels. The work has enabled the AVFL-18 project and a multi-component diesel surrogate with supporting kinetic model. This reviewer suggested that some of these characterization techniques should be applied to advanced and alternate fuels.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Collaboration was generally judged to be good: comments included that collaboration in FACE has been excellent and that there was good collaboration with many outside partners and recognition of same. A reviewer highlighted the collaboration with industrial partners, along with the DOE and Canadian National Lab participation. A reviewer said that working with CRC and academic institutions is crucial for this project to develop research fuels and this program does an excellent job of making the information available and hopefully people will use these fuels. The reviewer further noted that the team is working with industry to do a lot of the gasoline characterization. The final commenter said that this has been an excellent collaboration between the national labs and industry that has been facilitated through CRC - perhaps the best example of national lab-industry collaboration. This reviewer did note that the proposed reduction in APBF will potentially erode this collaboration.

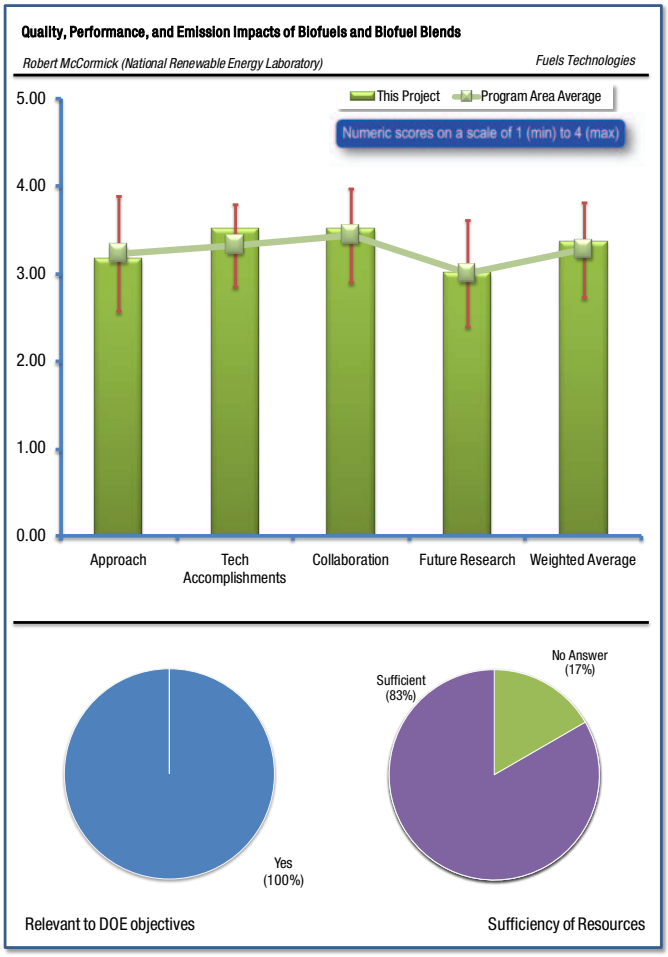
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

A reviewer said that the future work looking at how engine-based data compares with FACE data is very interesting. It might also be interesting comparing to the work EPA is doing on the new complex model (at least with the gasoline FACE fuels). This reviewer said the researchers should put ethanol in the fuel because it is going to be a reality of the fuel system. Many refiners design their fuels based on ethanol being added to a blendstock (not necessarily blended into a finished fuel). Gasoline without ethanol is an endangered species, so it should be considered for inclusion in the gasoline matrix, according to this reviewer. Another reviewer had comments in a similar track, stating that ethanol should be integrated into gasoline fuels. This reviewer also said that a simpler gasoline matrix focusing on octane+ethanol would be more cost-effective. Future plans are to finalize and enable a fuel blender to manufacture and sell the FACE gasoline matrix, noted a commenter. A reviewer said that plans to obtain and characterize alternative and renewable fuels (similar to what was done with the FACE diesel fuels via CRC working group) are valuable: ultimately the scope and plans will depend on 2011 budget. Similarly, the last reviewer said that there had been good planning for future work but plans may be shifted with funding cuts.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Allocation of resources was judged to be good, but there were concerns about the uncertainty of future funding. A reviewer noted that the cutback in APBF funding has already led to some of the national lab participants to disengage from some of the collaborative programs with industry via CRC. Continued/further cutbacks will likely further erode this collaboration, which at least in the past was a key objective of the DOE programs.

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



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviews are generally favorable for this aspect of the research. A reviewer noted that Bob McCormick and colleagues have been the key source of making biodiesel a viable alternative fuel to the U.S. market: without the work of Bob and his partners, biodiesel would still never be used because the problems and shortcomings of the fuel would never be understood. Another comment was that the biodiesel emissions work is very important, especially as some entities push for higher concentrations of biodiesel blended into diesel. The biodiesel surveys are useful given the variability in biodiesel quality. Other comments were that the project focus is on biofuels and biofuels blends which would directly displace petroleum, and that renewables meet the overall DOE objectives of petroleum displacement (however, the quantities of biodiesel entering the pool are small). The final commenter said that it was important to understand the best use of biofuels and to remove barriers to use: this reviewer also noted that overall supply potential is limited.

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 observed the excellent approach of focusing on aspects to understand and improve acceptability of biofuels such as: assessing quality of biofuels in the marketplace; development of new biofuels test methods; and biodiesel compatibility/impact on lube oil. Another comment stated that the team has made fundamental improvements to the viability of biodiesel fuel and resulted in improvements at ASTM for the blend and neat biodiesel fuel. A reviewer highlighted the performance testing, chemical analysis, engine and dynamometer testing: the key technical barrier is the biofuel quality.

On the other hand, a reviewer said that oil dilution conditions studied may not be relevant. A final commenter stated that this work is not tied together well to how it promotes the displacement of petroleum. The projects are well-designed and feasible, but need to focus more on the next generation of biofuels (renewable diesels and higher level alcohols).

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

Positive comments included that there was good progress in understanding cold soak filtration, and that great technical accomplishments have been made today that led to better understanding of biodiesel. Progress was made in a number of different areas, according to another reviewer: conducted study evaluating biodiesel impacts on lube for passenger vehicles equipped with DPF/SCR and DPF/NAC systems; evaluated effects in DPF-equipped medium duty engines; looked at impact of alkali levels in biodiesel on DPF ash loading; examined biodiesel impact on Fe-zeolite SCR hydrocarbon storage; performed biodiesel exhaust HC emission speciation; developed new methods for analysis of biodiesel; conducted a survey of biodiesel blends being sold in marketplace; and identified causes of poor biodiesel performance at low temperatures. A final commenter had similar observations on

several aspects: biodiesel lube oil effect studies were completed; biodiesel emissions in DPF equipped engines were studied; DPF ash loading study and exhaust hydrocarbon emission characterization was completed, and a biodiesel blend survey was done.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Collaborations were generally felt to be good, with one reviewer observing that there had been good collaboration with OEMs and the National Biodiesel Board. Similar comments focused on the team's good work with engaging NBB, MECA, EMA, etc. and working directly with industry partners (Ford for the Fe-Zeolite SCR work), their good collaboration with co-researchers and acknowledgement of their input, and the way the team collaborates well with wide range of groups. The final comment noted that the Ford collaboration for Fe-zeolite study is good: the reviewer also pointed out the CRC collaborative study on low temperature operability validation for biodiesel blends.

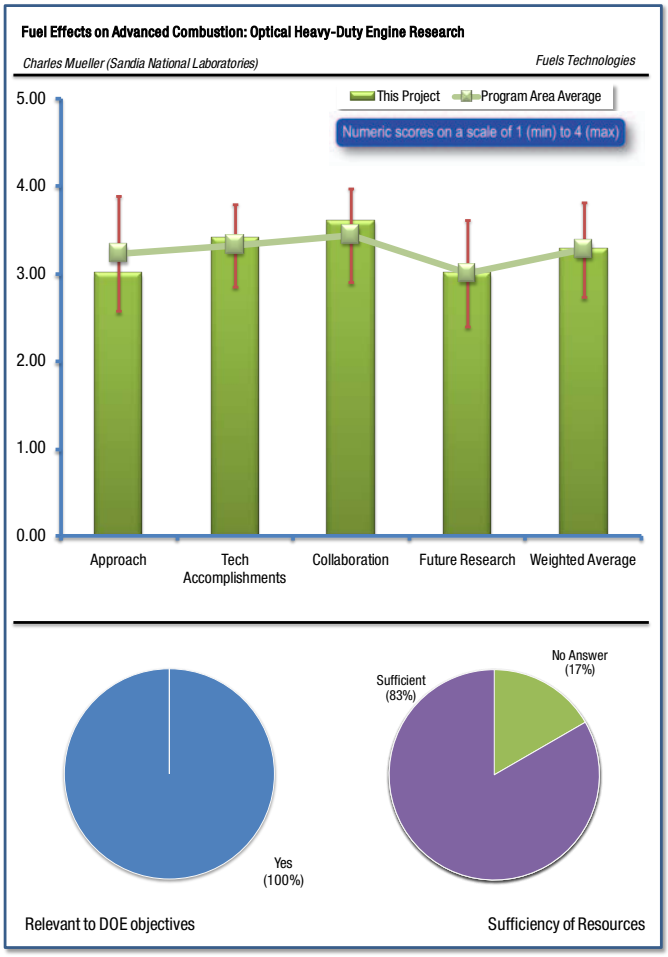
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

A reviewer felt there were good plans for moving onto ethanol/alcohols and gasoline for SI engines, and that understanding emission impacts is important. A reviewer suggested looking at severe conditions for oil dilution impacts. A reviewer said that plans to continue biodiesel-lube studies and to do work on next generation biodiesel seem very appropriate and worthwhile. This reviewer observed that mixed alcohol work seems incompatible with regulations in some states that only permit the addition of ethanol to gasoline, not other alcohols. Another reviewer said that next generation biofuels are to be studied (convert biomass to syngas and convert that to higher molecular weight alcohol). This reviewer would also include vegetable oil methyl esters like jatropha. The final reviewer wasn't quite sure what upcoming work was being proposed to complete this upcoming year.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The only comments were that no indication that resources are not sufficient, and that the project is funded at $1.8 million for 2010.

Fuel Effects on Advanced Combustion: Optical Heavy-Duty Engine Research: Charles Mueller (Sandia National Laboratories)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Among the comments received were that this program has fundamental work toward understanding combustion and behavior in current and future engines. There is a need to design new engines to use new fuels, and this work will help our understanding of combustion and the development of new technologies to utilize new fuels. A reviewer observed that the focus is on understanding how fuel properties and in-cylinder processes impact fuel efficiency and emissions: results from this work should help to improve fuel efficiency and reduce the amount of petroleum used. A reviewer noted that drop-in replacements need to have petroleum based fuels well characterized before we can understand how they work. Final comments involved noting that the project improves efficiency in HD engines, and that HECC engines using fuels improve U.S. energy security (this last reviewer would rank this a little lower in priority).

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 said that there was a very good approach of doing fundamental studies in pressure bombs and optical engines as well as incorporating actual OEM equipment such as Cummins high pressure common rail injection system. A reviewer said that the optical engine provides a unique tool to evaluate combustion and validate models. A reviewer observed that the project is to implement and test in optical engine and acquire liquid lengths for biofuels: the reviewer asked how single component fuel properties and unsteadiness affect the liquid length. The final reviewer said that the approach is good with some insights on behavior of biodiesel types: this reviewer was somewhat uncertain as to the benefits described for surrogate diesels.

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

Observations on the work included that the team has measured liquid length under unsteady in-cylinder conditions. A reviewer said that there was great use of the optical single cylinder engine and the use of biodiesel in this program. The principal investigator has excellent command of the objectives and principles behind this project. The final commenter noted that the team has extended the liquid length study to unsteady conditions for model compounds, a ULSD certification fuel, and biodiesels. Interesting results were found with the biodiesels vs. the ULSD and the model compounds provide some insights in how to potentially improve performance when using biodiesels.

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

Collaborations were judged to be excellent, both in terms of the good use of resources and in the interaction with research partners and recognition of their contributions. Other highlights were the good work with OEMs, academia, government and CRC. A reviewer

especially noted the CRC and Caterpillar, MOU collaborations. A final comment focused on the good indication of collaboration with Cummins, with OEM's and energy companies via the AEC/MOU, and with CRC members via the surrogate diesel fuel project (AVFL-18). The collaboration with Cummins is probably the most frequent and direct (vs. the AEC/MOU collaboration and CRC collaboration).

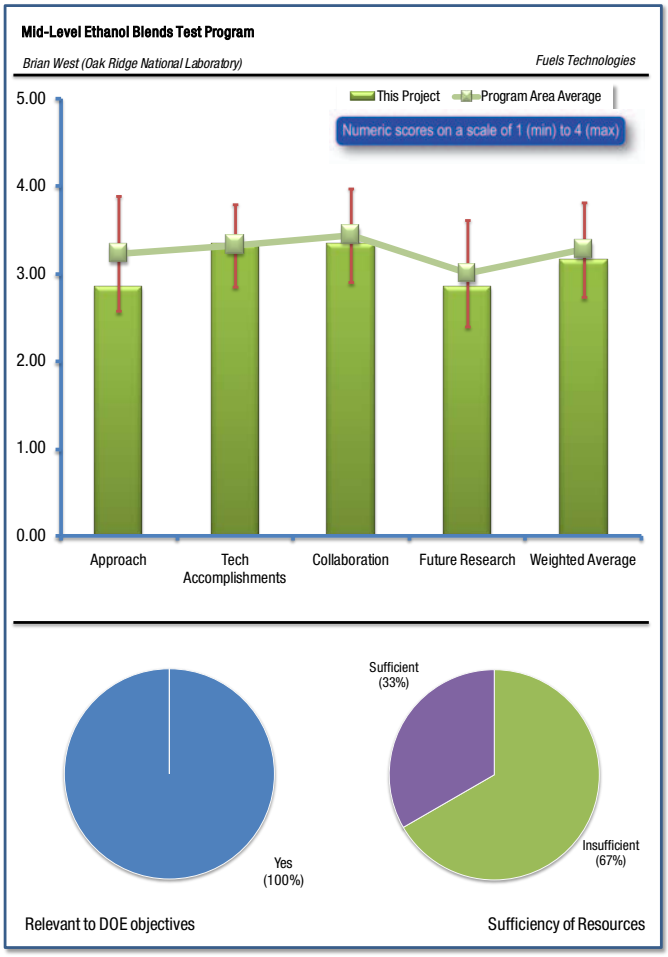
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The activities in continuing to look at impact of fuel properties/composition on liquid lengths and developing diesel fuel surrogates are valuable to advancing and achieving DOE goals. Similarly, a comment was received that liquid length is an important issue in advanced combustion, and higher volatility fuels should offer benefits. This reviewer felt that development of a surrogate is important for understanding fuel chemistry in complex fuels, and noted that it was difficult to add oxygen to diesel fuels. A reviewer pointed out that the work involves liquid length of multi-component hydrocarbon under unsteady in-cylinder conditions, and suggested a study of mixing HECC using a diesel. The final reviewer said there were good plans for future, but budget cuts may affect the outcome.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Comments for the resource question include that this program seems to be making fine progress and the current level of resources seems sufficient. A reviewer did point out that the work is funded at $730 K for 2010: this reviewer considered this a lower priority project.

Mid-Level Ethanol Blends Test Program: Brian West (Oak Ridge National Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The project was generally judged to be relevant to DOE objectives: using more ethanol would displace significant amounts of petroleum. Other comments include that the work is focused on higher amounts of ethanol in gasoline (which directly displaces petroleum), and that the work will enable informed decision making on E15 (this is a high priority project). A reviewer observed that ethanol is a main short+medium term biofuel and a main way to displace petroleum in the legacy fleet. The final comment was that this project and similar activities have national importance for fuels in our country.

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 comments were generally positive regarding the approach, but some suggestions were also made. A reviewer observed that this was a multiple parallel effort involving national labs and contractors. Another said that the project had a great approach toward understanding a myriad of effects on increased use of higher ethanol blends. A reviewer felt that this project had a good approach of testing effects of mid ethanol blends in vehicles and small engines. This reviewer questioned whether it is comprehensive enough (will enough data be collected and completely analyzed) for a correct decision to be made this summer on whether to allow a waiver for mid ethanol blends. This reviewer queried if there are enough replicates. A reviewer said that there was excellent coverage of emissions issues, but more work was needed in customer issues and in small engines. The project team should address potential customer impact issues of engine and fuel system durability. The final suggestion was that a larger focus on nonroad applications would greatly help inform decision makers about effect of blends of E10 and above on engines.

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

A reviewer observed that it looks like good progress was made in accomplishing the tasks developed for each of the individual programs. Another highlighted the excellent progress in catalyst durability and EPACT. A reviewer said that this is one of the largest research efforts to gauge the effect of a fuel on a wide range vehicles and engines. Despite the large policy implications of the results, this program has created very useful data to evaluated E15/E20 affects on newer vehicles and nonroad engines. A reviewer pointed out that the team has completed and published a legacy vehicle study and a detailed vehicle emissions study, along with an evaporative emissions study, a material compatibility study, and a full useful life vehicle emissions study. The final reviewer commented that there were great accomplishments limited by the funds available to execute the work.

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

Collaborations were judged to be very good overall, with one comment noting the great collaboration with a multiple list of institutions. Another said that there were good collaborations with OEM's and fuel producers via collaborative efforts with CRC.

Several reviewers highlighted specific organizations, including the good work with EPA, CRC, OEMs, and RIT; and the collaborations with CRC, EPA, UL, SwRI, TRC, ETC and Battelle. The final commenter noted the excellent collaboration by lab technical personnel: this reviewer would like to see expanded collaboration among stakeholders on overall program design and prioritization.

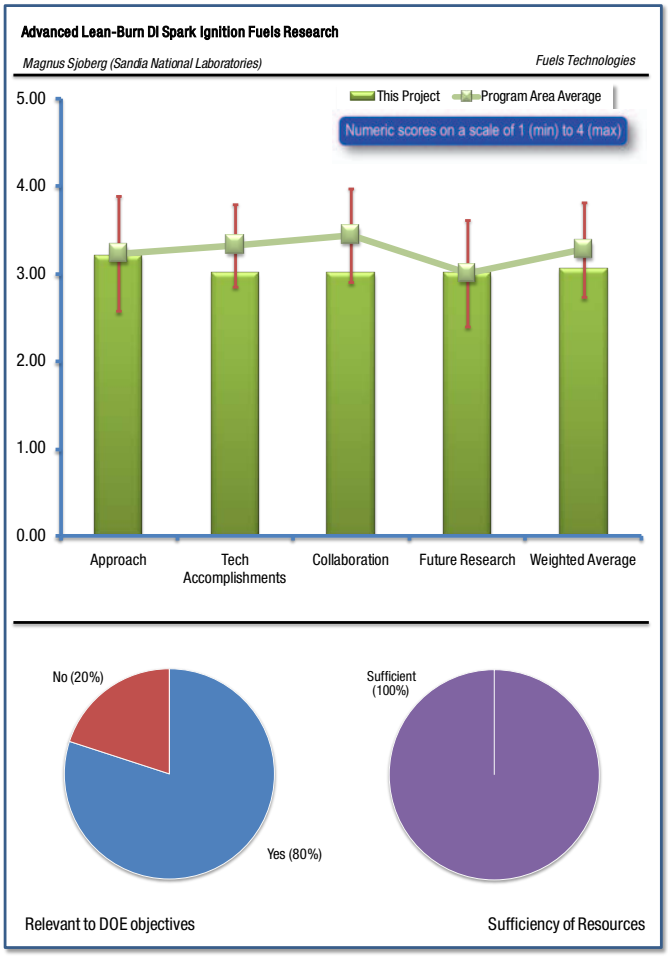
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

A reviewer observed that the plans seem to be to conclude programs by the end of 2010, and no specific plans were given for 2011. A reviewer suggested that the team complete the full useful life durability study, the evaporative study, and all other studies. Another suggestion was the need for additional work on engine and vehicle consumer-related issues. A reviewer thought that consumers of nonroad applications would greatly benefit from more research into marine engines and recreational vehicles. The final comment was that there is a continued need for more R&D on consumer impacts on vehicles and small engines, and cutting funds on this project would be disastrous for our country.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The general opinion of the group is that more funding is necessary: comments included that more resources are needed to address all of the potential vehicle and engine issues, and that more funding for this program has been and continues to be needed. A reviewer suggested that this program could use more funding to look at a more comprehensive look at marine, motorcycles, and snowmobiles. Additionally, there should be duplicate vehicles run as part of V4 in order to look at vehicle variability across the different ethanol blend levels. Another commenter observed that the programs appear to have been developed to fit available funding. Funding may not be sufficient to fully address issue of compatibility of mid level ethanol blends with existing infrastructure and vehicles (to get a good handle on type/percent of failures to expect). The final reviewer noted this is a $40 million dollar program but good scientific data may come too late for the E15 waiver decision. This reviewer would encourage more funding to address the consumer impact studies, and suggested the team include current fleet representation of test vehicles.

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



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Positive comments are that DISI engines have a good potential for high efficiency, and that improving gasoline/ethanol vehicle efficiency has a large impact on petroleum use. Another reviewer said that the project has a focus on lean burn DI for non-petroleum fuels which would directly displace petroleum if technically successful and widely deployed.

On the other hand, a reviewer felt that increasing the scientific understanding is generally good for the development of new technology, but believed the program could do a better job of bridging the gap in how this information will be applied. Another reviewer was still not convinced that this work is not competitive in nature, and perhaps should be done by OEMs at their expense, and not DOE's. DISI engines are being marketed today, so R&D by DOE on these engines perhaps should not be done.

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?

On the positive side, commenters felt that the approach of using metal engines, optical engines, and modeling is a good one; there was good imaging capability in the research engine platform; and that there was a good approach for the technology work planned to be performed (but relevance is the issue). A reviewer commented that occasional misfires/partial burn cycles are barriers. Engine knock must be avoided when operating with alternative fuels.

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

Review comments on the accomplishments were generally good. A reviewer said that the laboratory looks like it will be very helpful in generating good data and scientific understanding of objectives as things develop. Another felt the lab setup was good, and the equipment was very elegant. A reviewer noted that the engine has been installed, the new lab is ready, and engine tests will commence soon. A reviewer felt that development of the tool has been good, but this reviewer did not hear a strategy for its use to maximize benefits. The last reviewer said that most of the progress has been on setting up the DISI lab. No timeline was shown, so this reviewer did not know if engine setup is "on schedule" or not. Some work has been done in the HCCI lab on autoignition characteristics of gasoline and ethanol.

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

Collaborations were felt to be good with GM, the academy and others, in one reviewer's opinion. Another also highlighted the good collaboration with co-workers and GM and recognition of their contributions. A reviewer said that the primary industry collaborator seems to be GM. Collaborations with other OEMs and energy companies via the AEC/MOU were mentioned, but interaction via that mechanism is not likely as often, nor as direct as with GM. Collaborations with universities and other national labs were also

mentioned, according to this reviewer. A reviewer listed the collaborations he noted: SNL, LLNL, UW-M, UNSW and MOU. The final reviewer would like to see close collaboration with Oak Ridge activity.

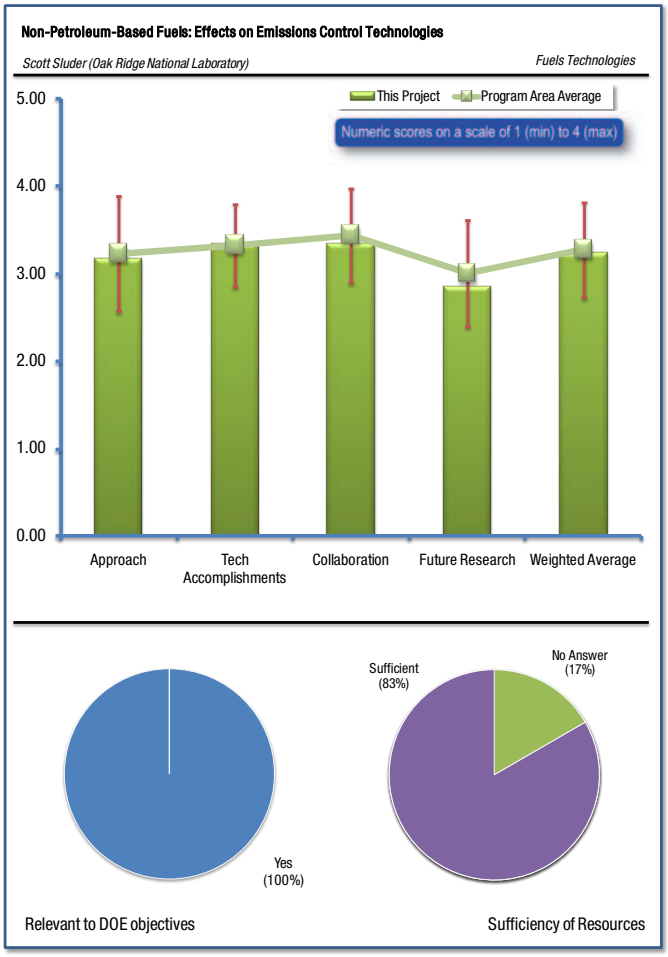
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The first of two comments on this aspect of the research was a recommendation to perform advanced high-speed optical diagnostics. The second commenter felt that the potential for improving efficiency of gasoline/ethanol engines is large. This reviewer would like to see a clearer connection to improved engine efficiency. According to this reviewer, this should be a good platform for investigating super/knock.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

A reviewer said that there is no indication that resources are not sufficient. The second reviewer said that this project is interesting and academic and is lower priority.

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



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer felt this work will help with engine optimization and emission control research for new fuels. Another thought the project was relevant, as it is reviewing the impacts of non-petroleum based fuels on the key emissions control systems. A reviewer offered that understanding of the impact of NPBF on emission system components is important for enabling the commercial use of these fuels. The last person stated that the project had inadequate data and predictive tools for fuel property effects. NPBF can be used more, resulting in petroleum displacement.

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 commenter liked the real world samples before modeling. Another said the team brings together targeted engine-based and bench reactor studies. The final reviewer approved of the good approach toward getting real impacts from non-petroleum based fuels on emissions systems.

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

Positive comments included the good list of accomplishments (especially the understanding of effects of biodiesel on deposits). Another simply stated the project was proceeding well toward DOE goals. Work on the emissions using B20 was interesting and important to another reviewer, as there is a push for higher levels of biodiesel. A reviewer said there was good progress in a number of areas, including: causes of greater fouling of EGR coolers with biodiesel vs. ULSD due to greater surface condensation; improved understanding of biodiesel PM reactivity; and acceptable sodium levels. The final reviewer noted the PM trap work and said the team should analyze fuel+lube if possible.

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

Opinions on collaboration were all positive, including the reviewer who said there was good work with OEMs and academic partners. Another felt there was a good list of collaborators and recognition of their contributions. Two reviewers noted the collaborations with Cummins, Ford, and GM and some universities.

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?

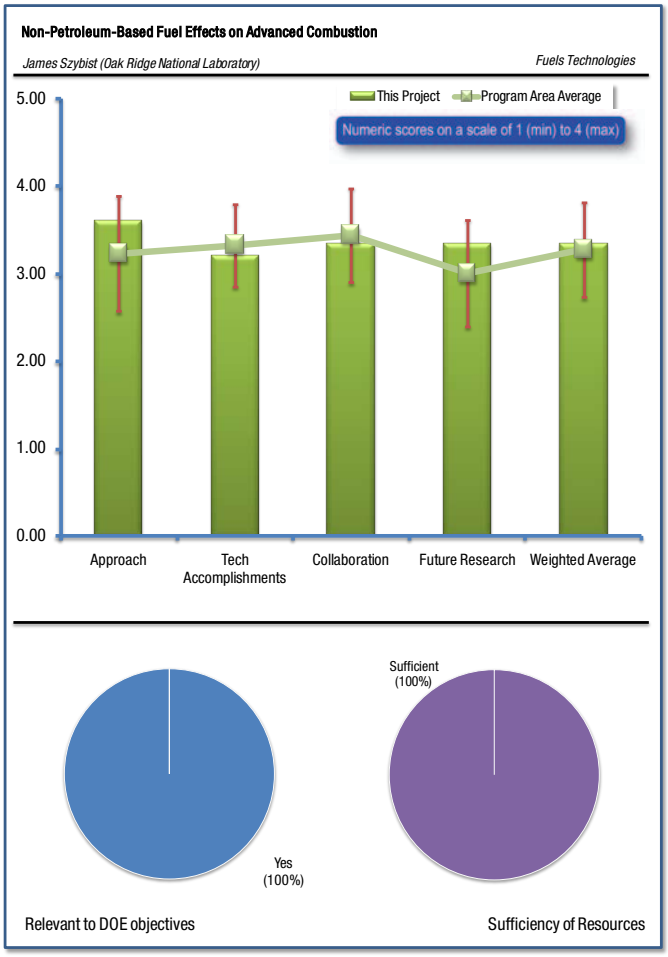
A reviewer thought the plans to continue and build on current program areas and results seem very appropriate. Another highlighted the good proposed future research. A reviewer was OK with the shift from diesel to biodiesel-related work. This reviewer thought that

use of diesel in light-duty vehicles could become detrimental from an energy balance standpoint due to projected changes in gasoline/ethanol and diesel supply balance. In this reviewer's opinion, effort on biodiesel should be balanced by noting that there is significant potential for vehicle use impacts, and that the overall impact of biodiesel on petroleum demand is limited by raw material supply. The final reviewer said the project needs some more focus on ethanol effects over biodiesel, since the impact of ethanol in the U.S. fleet is much bigger than biodiesel.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer felt that progress seems to be on track, so no indication that resources are not sufficient. The other reviewer simply noted that total resources were $1.1 million.

Non-Petroleum-Based Fuel Effects on Advanced Combustion: James Szybist (Oak Ridge National Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer said that this work is necessary given the changes in typical fuel constitution, especially given the pressures on next generation biofuels from RFS2. Another felt that this research is fundamental in nature and provides potential improvements to engines to be used to optimize the use of biofuels. A reviewer noted that the focus is on non-petroleum based fuels, which if successful, would directly displace petroleum. Reviewers noted that the project will assess fuel property effects on advanced combustion, perform emissions and engine optimization, increase the thermal efficiency of E85 engines, improve engine efficiency, and better utilize gasoline/ethanol.

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 said there was good use of statistical tools to make the most out of limited data, and a good job looking at ethanol-gasoline blends. Reducing the fuel economy gap between E85 and gasoline would be useful, according to this reviewer. Another commenter highlighted the excellent approach of combining testing of fuels in several different advanced combustion engine platforms and kinetics/modeling work. A reviewer supported the emphasis on gasoline/ethanol fuels using an advanced engine platform. Other comments included a note that there was a great approach on the technical program, and that the team was focusing on ethanol effects this year. A reviewer listed several aspects of the research as his comment: focus on a single cylinder approach; use of low and high octane gasolines and three ethanol blends; and use of a multi-cylinder diesel engine platform and single cylinder platform approach.

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

The first reviewer noted that the project is progressing well toward the overall DOE goals. A second said there was good progress in improved understanding of gasoline/ethanol performance. A third thought this was a very interesting investigation into the reasons behind the E85 and gasoline energy efficiency difference. Finding out the deeper understanding will help improve engine design, according to this commenter. A fourth reviewer said this work involved a very interesting comparison of the reasons for performance differences between gasoline and ethanol blends in the single cylinder GDI engine with VVA. A reviewer suggested that the team also consider the effects of octane sensitivity on engine efficiency from work at MIT (Heywood) and others.

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

Collaborations with outside contributors were judged to be good by two reviewers. The third reviewer observed that the main industry partners appear to be Delphi and an unspecified energy company: there are also collaborations with University of Wisconsin and Reaction Design. The AEC/MOU consortia provides opportunity for feedback from OEMs and energy companies two times per year, but this is probably less directed input than from avenues such as Delphi.

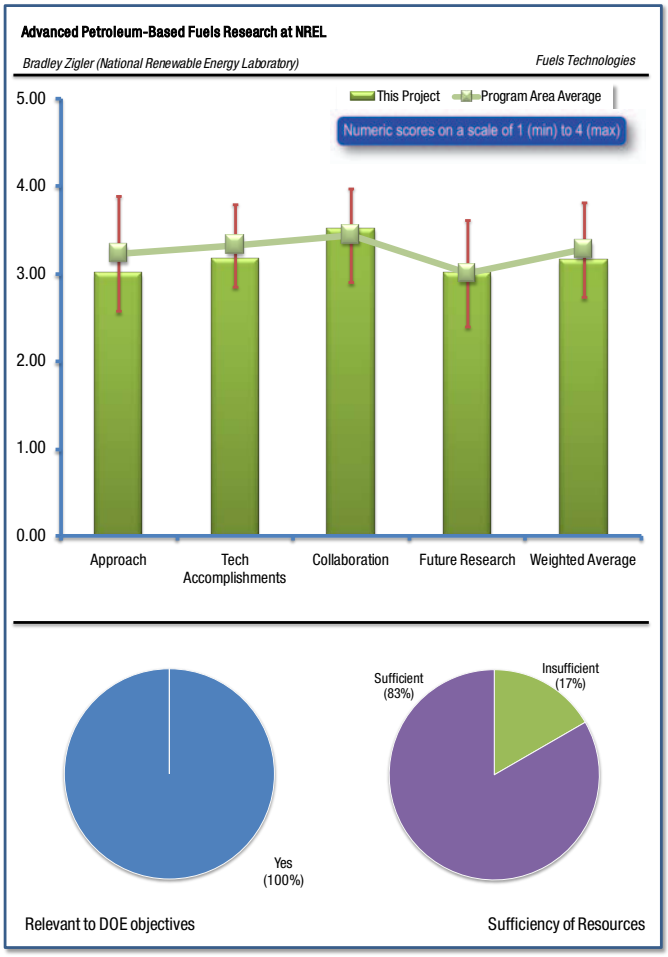
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

A reviewer said there were good plans for the future, but that the team should include more emphasis on ethanol and other alcohols. A reviewer suggested that the team continue ethanol optimization on a multi-cylinder engine, the SA-HCCI strategy, the multi-cylinder HECC work, and the work planned in statistical analysis and kinetics research. The final reviewer endorsed the plans to study multi-cylinder engine. Dual/fuel work also has large potential to improve efficiency. This reviewer said the team should look at ethanol effect on knock-limits in modern DI boosted engines. This reviewer had heard anecdotally that benefits are better than predicted by standard octane tests.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

A reviewer said the resources seem sufficient. Another observed that total funding for 2010 was $1470 K, and said that the single-cylinder approach may not relate to real world conditions.

Advanced Petroleum-Based Fuels Research at NREL: Bradley Zigler (National Renewable Energy Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer said this was very relevant research for non-petroleum based fuels optimization. A reviewer said that investigating how fuel chemistry affects advanced combustion will be invaluable in shaping how these combustion strategies develop and meet DOE objectives. A third reviewer observed that the work is focused on understanding combustion fundamentals which can lead to fuel efficiency improvements and use of alternative fuels. A reviewer pointed out the work on fuel impacts on advanced combustion and predictive tools for fuel effects. Improving fuel efficiency was noted by two reviewers as the relevance.

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?

To one reviewer, developing the FACE fuels will be important to move advanced combustion forward. Another said that there was a good combination of fundamental combustion measurements in IQT instrument and single cylinder engine testing. The third said that the work focused on fuel properties, ignition kinetics, combustion and emissions and had a good approach.

Two reviewers had some similar reservations about the ignition quality tester. One said that the IQT could be a good tool to validate kinetics, but the researchers would need to be cautious in extrapolating to engine. Another said that the work has a generally good approach, but one area of concern is emphasis on IQT as a surrogate for diesel engine. For cetane number measurement, IQT may be fine, but for fundamental diesel kinetics and modeling, IQT fidelity to a real diesel engine needs to be demonstrated.

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

Reviewers said there was good progress in understanding behavior of IQT and good technical accomplishments to date. Also noted was the good use of the FACE research cube to develop better engine models: the rapid characterization of fuel samples is very interesting. A reviewer thought the work was progressing well. It supports development of efficient computational strategies. It rapidly characterizes ignition properties of fuel samples. The final reviewer observed good progress in a number of areas: measurement of ignition delay times of a variety of diesel fuels (including FACE diesel fuels); characterized spray and developed KIVA CFD model; and compared IQT results for n-heptane with several kinetic models in the literature.

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

Collaborations were generally said to be good. One reviewer stated there were good collaborations with academics and applicable industry players. Another said the presenter provided a very good description of the type of collaboration with outside groups, and gave acknowledgement of their contribution. Collaborations with industry were done via CRC (AVFL and FACE committees) and with UC Berkeley and CSM. These three organizations were also noted by another reviewer, and a third said that the team is collaborating well with CRC and other groups.

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 general plan builds on past progress and generally addresses overcoming the barriers. This reviewer suggested expanding IQT-based experimental and modeling research. Light-duty CNG optimization is exciting, commented one reviewer. Another said that the team should focus on ethanol blends over biodiesel, since the impact will be much greater.

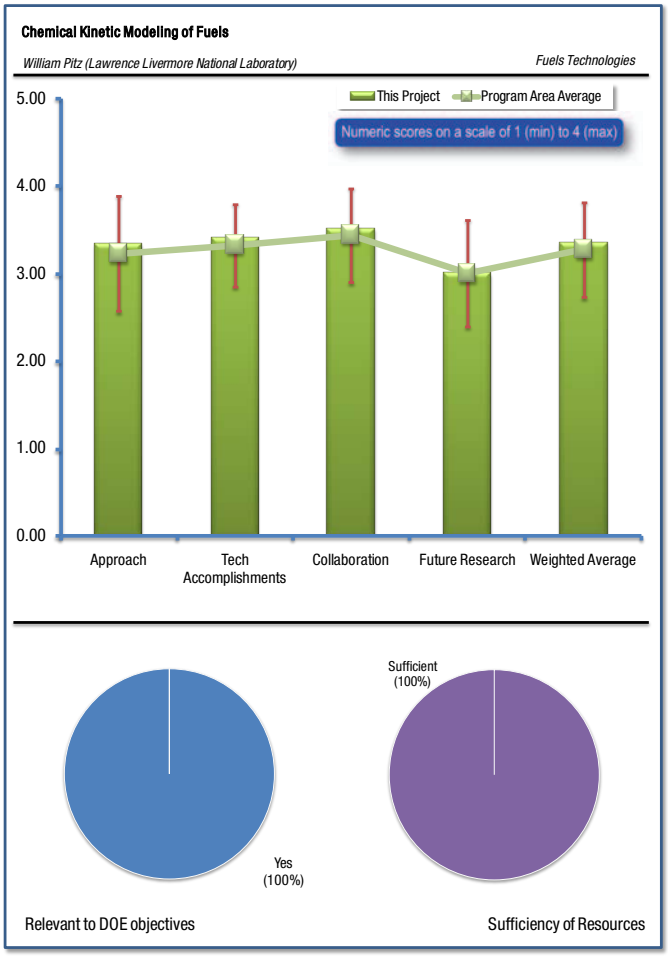
A reviewer said that the reduction in NREL's ABPF 2010 budget (and presumably for 2011) has led to NREL having to disengage from some of the CRC programs (especially AVFL-16 and FACE). This is leading to a decrease in collaboration with industry.

A final reviewer said that the IQT work is correctly focused on supporting model development. This reviewer spotlighted a need to correlate the IQT to an engine to ensure relevance. This reviewer felt that work on future diesel fuel effects is a lower priority, since research has not indicated that advanced combustion is very sensitive to diesel fuel properties. New diesel fuel components will only gradually enter diesel pool. (This reviewer said this comment applies broadly to diesel-related fuels work, not only this activity).

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

A commenter noted that a midyear cutback in NREL's 2010 APBF funding has led them to being unable to contribute the cost share that they had committed to for the CRC AVFL-16 program, which suggests that funding is insufficient for the plans/commitments that they have. The other review commenter noted that the project was funded at $1.0 million for 2010: some funds may be redirected to other programs.

Chemical Kinetic Modeling of Fuels: William Pitz (Lawrence Livermore National Laboratory)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The first reviewer said that the models from this work will be useful to optimize fuels for use in advanced combustion to improve fuel efficiency. A similar comment from another reviewer stated that this was fundamental research to support DOE/industry fuel technology projects: models can be used to optimize fuels, thus improving efficiency. A reviewer said that the work was focused on developing fundamental kinetic and combustion data and models for petroleum and non petroleum based fuel components: this will lead to fuel efficiency improvements and potentially use of non petroleum based fuels. The final reviewer said that this project is looking at the fundamentals on combustion of fuels, both conventional and non-petroleum based. With this understanding, we can optimize biofuels in the U.S. fuels supply.

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 said this work had a very good approach in developing the fundamental reaction mechanisms for various fuel components and comparing model results to data available in the literature. Another felt that the development and validation approaches were sound, and that models can play an important role in engine/fuel development. A reviewer highlighted the very good approach to deriving fundamental kinetics and reaction mechanisms for combustion. The final commenter stated that the team was developing chemical kinetics reaction models for each fuel component: models for methyl stearate, methyl decanoate, and methyl oleate were developed.

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

Among the positive comments were that there was nice development of validated mechanisms and a good list of accomplishments to date. A reviewer said that the accomplishments were good on the first two methyl esters: this reviewer can't wait until the team can model biodiesel next year. A reviewer offered that there was very good progress in a number of areas including: review of kinetic mechanisms in the literature; and development of reaction mechanisms for two of the five components in soy SME biodiesel. The final reviewer observed that the team had assembled a chemical kinetic model for two of the five main components of biodiesel.

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

Positive comments on the collaboration included a statement that all FT groups are collaborating well and that there was a great list of collaborators and recognition of their input. A reviewer said there had been good work with UConn and other university contacts: this was reflected in another's listing of the collaborators he saw (University of Toronto, National University of Ireland, and UConn as well as CRC ACE.) A reviewer saw mostly collaborations with other national labs and universities. Collaboration with industry has been mainly through some participation in CRC working groups (especially AVFL-18 diesel surrogate fuel development).

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 thought that modeling actual biodiesel will be very useful, and that interesting work is being done on profiling butanols. Another thought there was a good plan for future work, and noted that the team is developing the capability to simulate the IQT which predicts cetane number. The reviewer also suggested developing a model for iso-pentanol. A reviewer offered that developing kinetic mechanisms for the remaining SME components will be very useful, and that the value of work on alcohols higher than ethanol will depend on whether they are ultimately viewed by the government and the public as being more like ethanol or like ethers (MTBE). A reviewer thought it may be more beneficial to address big gaps in understanding chemical kinetics of major constituents of diesel fuel. The final comment was that there were good plans for future work, but plans may be impacted by funding.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

The two comments for resource sufficiency were that there is no indication that resources are not sufficient, and that this is good research work (albeit very academic).