

Review of the 21st Century Truck Partnership

Second Report

Board on Energy and Environmental Systems · Division on Engineering & Physical Sciences · November 2011

In July 2010, the National Research Council (NRC) appointed the Committee on Review of the 21st Century Truck Partnership, Phase 2 to conduct an independent review of the 21st Century Truck Partnership (21CTP). The 21CTP is a cooperative research and development (R&D) partnership including four federal agencies—the U.S. Department of Energy (DOE), U.S. Department of Transportation (DOT), U.S. Department of Defense (DOD), and the U.S. Environmental Protection Agency (EPA)—and 15 industrial partners. The purpose of this Partnership is to reduce fuel consumption and emissions, increase heavy-duty vehicle safety, and support research, development, and demonstration to initiate commercially viable products and systems. This is the NRC's second report on the topic and it includes the committee's review of the Partnership as a whole, its major areas of focus, 21CTP's management and priority setting, efficient operations, and the new SuperTruck program.

Background and Introduction

Since the Phase 1 review, the NRC report *Review of the 21st Century Truck Partnership* published in 2008, the Partnership has evolved in the face of changing budgets and new initiatives. The 21CTP leadership responded substantively to most of the recommendations of the NRC's Phase 1 review, which helped to contribute to an improved program during this Phase 2 review; the committee commends the leadership of the Partnership for this effort. The Phase 1 committee's review of the overall 21CTP has helped to communicate to the various stakeholders and Congress the ongoing R&D efforts in the agencies and on the various projects, and it is anticipated that the current (Phase 2) report and review will also help to continue this communication to the various stakeholders and other interested parties.

Overview of Some of the Committee's Findings and Recommendations

The key benefit of the 21CTP is the coordination of research programs directed toward the

goal to reduce fuel consumption and emissions while increasing heavy-duty vehicle safety. Federal involvement is bringing stakeholders to the table and accelerating the pace of development. That is, given the Federal regulatory requirements to reduce emissions and fuel consumption, cost-shared R&D between the government and U.S. manufacturers of trucks and buses or heavy-duty vehicle components have emerged to develop new technologies. Thus, the 21CTP is providing access to extraordinary expertise and equipment in Federal laboratories, in addition to seed funding. In particular, the America Recovery and Reinvestment Act provided by Congress in 2009–2010 have significantly enhanced the ability of the Partnership to meet and demonstrate the goals in prototype vehicles.

The 21CTP should be continued to help meet the nation's goal of reduced fuel consumption in the transportation sector. In addition, the Partnership needs to review whether additional partners who can contribute to the R&D program should be

recruited, such as major truck and component manufacturers that are not currently members. Research funding should be commensurate with well-formulated goals that are strategic to reducing fuel consumption of heavy-duty vehicles while improving safety, and all projects should be prioritized so that the program can be implemented within the available budget. In addition, 21CTP program goals should continue to be established, reviewed, updated, related to available funding, and clearly stated in measurable engineering terms.

Management Strategy and Priority Setting

The 21CTP is a “virtual” organization facilitating communication between four agencies, government laboratories, and with industry, but it has no direct control over research activities or funding across the agencies or by its industry partners. The committee continues to believe that the lack of single-point authority is far from optimal, though the committee recognizes that this is necessary because of the different Congressional committees that the agencies report to, and which provide their budgets.

The DOE is urged to continue to improve the functioning of the 21CTP “virtual” management structure in every way possible, including strengthening inter-agency collaboration (particularly involving EPA and DOD), and documenting and publishing specific 21CTP activity within all four agencies. Specifically, DOE should issue a brief annual report documenting the specific projects within 21CTP and the progress made.

Engine Systems and Fuels

Combustion

The committee reviewed nine diesel engine programs, that were funded at over \$100 million by DOE and industry, that included “High Efficiency Clean Combustion” (HECC), “Waste Heat Recovery” (WHR), and others. Some programs met or exceeded their goals, such as a 10.2 percent improvement in brake thermal efficiency (BTE) versus a 10 percent goal, whereas others did not quite meet the goals of 5 percent or 10 percent improvement in BTE. By combining HECC and WHR, each demonstrating over 10 percent im-

provement in BTE, together with other technologies, it should be possible to improve BTE by 20 percent to achieve the original DOE target of 50 percent peak BTE. However, the DOE target of 50 percent peak BTE was not met by the original goal of 2010.

The DOE funded research in advanced engine combustion at the national laboratories, industry, and universities is well managed and addresses important aspects for achieving integration of advanced combustion processes that should be important enablers for achieving the 55 percent BTE goal as well as provide ongoing improvements. There appears to be good interaction between the researchers performing the work and the industry stakeholders. Efforts to achieve 55 percent BTE are going to require complex and expensive technologies. The fundamental research program should continue to provide important enablers for the 55 percent BTE goal and DOE should continue to look for leverage opportunities with other government- and industry-funded projects.

Fuels

In spite of efforts to reduce light-duty and heavy-duty vehicle fuel consumption and develop biomass-derived fuels—which, except for corn-based ethanol, has not progressed as much as had been expected—petroleum will remain the primary source of light-duty and heavy-duty vehicle fuel for many years to come. While future gasoline demand is expected to be flat for the next 20 years, diesel fuel demand will grow, necessitating changes in refinery operations. DOE should reinstate its program for advanced petroleum-derived fuels with the objective of maximizing the efficiency of their use. In addition, the DOE fuel goals should be re-evaluated in line with the 2012 budget and the recommendations of this report.

Propulsion Materials and the High Temperature Materials Laboratory

The propulsion materials program is addressing a broad range of materials issues associated with heavy truck propulsion systems. Many of the initiatives are funded as cooperative R&D agreements with significant industry cost share, showing strong support by industry for this area of work.

The High Temperature Materials Laboratory (HTML), located at Oak Ridge National Laboratory, was established more than 20 years ago as a National User Facility to provide specialized instruments for materials research and characterization of value not only to 21CTP but other programs needing fundamental understanding of material properties. The HTML continues to be a valuable resource for materials research for the 21CTP, providing specialized and in many cases unique instrumentation and professional expertise. The expertise of those who oversee the laboratory, and therefore the value of HTML to all users, is enhanced by the participation of the HTML staff themselves in the research.

The DOE should continue to provide 21CTP researchers, and other potential users, access to HTML and should make every effort to maintain support for HTML and to maintain the “cutting edge” capability of the facility. Moreover, DOE should provide sufficient funding for HTML, and for the research specialists who oversee and operate the facility, to enable continued research collaboration with the academic community, other government laboratories, and industry. In particular, HTML support should not be reduced to a level that allows only maintenance of the equipment for paying users.

Hybrid Vehicles

As partners of the 21 CTP, EPA and DOT’s National Highway Traffic Safety Administration should take the opportunity afforded by their final rules issued on September 15, 2011, “Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles,” and work with the California Air Resources Board (CARB) to develop test procedures for the certification process for criteria emissions. This would enable the emission benefits of hybridization to be recognized and allow for the reduction in size or simplification of the emission control system.

Safety

The DOT has met its heavy truck safety goals for the past four years. However, the committee observes that a study by the NRC’s Transportation Research Board has shown that other nations have established more

aggressive initiatives and goals with impressive results that suggest the possibility of even greater improvement in highway safety in the United States. The DOE should consider the possibility of establishing more aggressive initiatives and goals for highway safety in general, including more aggressive goals for heavy-duty truck safety.

SuperTruck Program

The SuperTruck program is funding the development and demonstration of full vehicle systems integrating a number of technologies into Class 8 long-haul trucks with the aim of reducing load-specific fuel consumption (e.g., gal/ton-mile). This new effort follows on the Phase 1 report that called for integrating new technologies, including advanced diesel engines, into vehicle systems. Three projects have been selected for awards under the SuperTruck program; they will receive \$115 million in DOE funding to develop and demonstrate full vehicle system level technologies by 2015 that will:

- Achieve a 50 percent increase in vehicle freight efficiency measured in ton-miles per gallon, which translates to a 33 percent reduction in load specific fuel consumption (gal/1,000 ton-mile).
- Achieve at least a 20 percent improvement through engine thermal efficiency development, and achieve 50 percent brake thermal efficiency (BTE) under highway cruise conditions.
- Evaluate potential approaches to 55 percent BTE in an engine via modeling, analysis, and potentially also lab tests.

The three SuperTruck projects will be the flagship projects under the 21CTP for fiscal years 2011–2014, and the goals are in concert with recommendations made in the 2008 NRC Phase 1 review. A large portion of the DOE 21CTP budget will be devoted to these three projects. Each SuperTruck project integrates a wide range of technologies into a single demonstration vehicle—for example, engine, waste heat recovery, driveline, rolling resistance, tractor and trailer aerodynamics, idle reduction, and weight reduction technologies—and the contractors are pursuing sufficiently different technical paths to avoid excessive duplication of effort. The results will help determine which fuel-saving technologies are ready and cost effective for OEM level product development programs.

The SuperTruck projects go beyond the scope of previous 21CTP projects. Instead of relying entirely on simulations and laboratory testing, these projects will result in a drivable truck. The committee believes that it is important to take technologies that have been developed to date and implement them in a real vehicle. Often, the application of new technologies in real world applications yields unexpected results, and these results must be explored before any new technology can be considered ready for production implementation.

Efficient Operations

Specific goals for efficient operations should be developed, with strong consideration given to exploiting the potential for intelligent transportation systems (ITS) to reduce fuel consumption. In addition, priorities should be set for the R&D, testing, and data collection needed to analyze the benefits, drawbacks, and potential unintended consequences of removing barriers, including regulatory barriers, to the application of fuel-saving features. The 21CTP partners, trucking fleets, and major suppliers should be involved in setting goals and research priorities.

Committee to Review the 21st Century Truck Partnership, Phase 2: John H. Johnson, Michigan Technological University, Chair; **Joseph M. Colucci**, NAE, Automotive Fuels Consulting, Inc.; **David Foster**, University of Wisconsin, Madison; **Larry J. Howell**, Consultant, Royal Oak, Michigan; **John Kassakian**, NAE, Massachusetts Institute of Technology, Cambridge; **David F. Merrion**, Consultant; **Detroit Diesel Corporation (retired)**, Brighton, Michigan; **Thomas Reinhart**, Southwest Research Institute, San Antonio, Texas; **Bernard Robertson**, Chrysler Corporation (retired), Bloomfield Hills, Michigan; **Charles Salter**, Consultant, Chambersburg, Pennsylvania; **Kathleen Taylor**, NAE, General Motors (retired), Fort Myers, Florida; **Wallace R. Wade**, NAE, Ford Motor Company (retired), Novi, Michigan

Project Staff: **James J. Zucchetto**, Senior Program/Board Director, Board on Energy and Environmental Systems, Study Director; **Madeline Woodruff**, Senior Program Officer; **E. Jonathan Yanger**, Senior Project Assistant; **LaNita Jones**, Administrative Coordinator; **Dana Caines**, Financial Manager

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