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Review of the Research Program of the FreedomCar and Fuel Partnership: First Report—*Summary*

BOARD ON ENERGY AND ENVIRONMENTAL SYSTEMS

Background

The FreedomCAR and Fuel Partnership is a collaborative effort among the Department of Energy (DOE), the U.S. Council for Automotive Research (USCAR), and five major energy companies to manage research on technologies that will enable the vision of “a clean and sustainable transportation energy future.” It envisions a transition from more efficient internal combustion engines (ICEs), to advanced ICE hybrid electric vehicles, to enabling a private-sector decision by 2015 on commercialization of hydrogen-fueled vehicles using fuel cells. The program involves joint industry/government research teams and covers a number of vehicle, fuel production, and infrastructure technologies. This report, which builds on an earlier NRC report, *The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*, presents an evaluation of the Partnership’s research efforts directed at a hydrogen-fueled transportation system, and provides findings and recommendations about technical directions, strategies, funding, and management.

Findings and Recommendations

Overview The Partnership is an extremely challenging program. Many technical barriers need to be overcome and fundamental invention is probably needed to meet its technical and cost goals. In addition, making the transition to a hydrogen economy will be a formidable social and economic challenge. Research to support the vision of the Partnership, however, is justified by the potentially enormous benefits for the nation. Further, no insurmountable barriers to its achievement have yet been identified, although there are several critical components. The large number of unknowns and the need for breakthroughs, however, make it inappropriate at this time to speculate on whether the program, according to its current plan, will achieve its long-term vision.

Advanced Combustion Engines The ICE will be the primary automotive power plant for several decades during the transition, and reducing fuel consumption and emissions is critically important. Novel emission reduction and control technologies are needed.

Fuel Cells and Hydrogen Storage The development of commercially viable fuel cells and onboard hydrogen storage is the most difficult vehicular aspect of the Partnership program. For most of the technical challenges, solutions depend on components and manufacturing technologies that have not yet been conceived or proven. While the current DOE research strategy for fuel cell and hydrogen storage is appropriate, certain areas—including membrane R&D, catalyst systems, and electrode design—should be

expanded and given higher priority. Furthermore, the Partnership should report annually to all program participants, DOE, and Congress on the state of hydrogen storage technology worldwide relative to the goals and targets of the program.

Electrochemical Energy Storage Given the difficulties facing hydrogen, other alternatives should be explored as well. Electric vehicles equipped with high-energy density batteries might be such an alternative. Higher priority should be placed on searching for breakthrough technology for high-energy batteries.

Electrical Systems and Electronics Multiple systems in a fuel cell hybrid electric vehicle require both control and integration. The integrating role of a vehicle's electrical system makes it a critical-path technology, and closer coordination of research activities in this area is essential. Furthermore, the benefits of integrating electronics and electrical motors should be considered and more aggressive targets for 2010 and 2015 developed.

Hydrogen Fuel Production and Distribution A widespread, hydrogen-fueled transportation system will require a massive infrastructure change. The transition is critical, and DOE should make sure that the technical team responsible for the transition places greater emphasis on it in the teams' systems analysis work. To the extent that hydrogen is derived from fossil fuels, it is also critical that production systems successfully provide for carbon sequestration. DOE should create a technical subteam on carbon capture and storage and make it part of the Hydrogen Fuel Initiative.

Materials Significant vehicle weight savings are essential to achieving major fuel economy improvements. Nevertheless, an affordable, 50 percent weight reduction, which is the Partnership program goal, is unlikely within the program's time frame. More extensive research on carbon-fiber-reinforced polymers and direct cooperation with major fiber manufacturers is necessary if there is any hope to achieve this goal. Furthermore, DOE should review its expenditures on materials research to see if some should be applied to areas with more potential.

Safety Real and perceived safety issues exist with a transition to hydrogen as a primary transportation fuel. DOE needs to deal with these issues effectively to ensure program success and should form a crosscutting safety technical team with that mission.

Public Concerns Some issues about societal acceptance of a hydrogen-fueled transportation system might ultimately determine the feasibility of such a fleet. These issues must be addressed just as certainly as the technical challenges. DOE, along with the Environmental Protection Agency, should take steps to identify and assess possible long-term ecological and environmental effects of large-scale hydrogen use.

Program Balance and Funding The current balance between long-term and shorter-term goals within Partnership program is appropriate. Nevertheless, congressional actions to divert program funds away from activities focused on important goals, particularly those about hydrogen, increase the risk of missing critical program milestones.

Strategy for Accomplishing Goals The Partnership has made good progress in program management and communications across the many activities and participants. Setting priorities, however, needs more emphasis. The Partnership should perform an overall program evaluation and set priorities that focus resources on those programs that will contribute the most to solving critical problems. Finally, the learning demonstration program is very important to validate current component and systems concepts and to uncover new issues. The programs are well designed.

For further information;

Copies of *Review of the Research Program of the FreedomCAR and Fuel Partnership: First Report* are available from the National Academy Press; call (800) 624-6242 or (202) 334-3314 (in the Washington metropolitan area), or visit the NAP Web site at <<http://www.nap.edu>>.

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