

Review of the Research Program of the FreedomCAR and Fuel Partnership

Summary of the Second Report

Background

- DOE and USCAR partnership formed in Jan. 2002
- Five energy companies added in September 2003
- Research Goal: To enable all light-duty vehicles to operate free from petroleum and harmful emissions while sustaining freedom of mobility and vehicle choice

Companies

- **USCAR**
 - Chrysler
 - Ford
 - General Motors
- **Energy Companies**
 - BP America
 - Chevron
 - ConocoPhillips
 - ExxonMobil
 - Shell Hydrogen (U.S.)

Pathway toward Goals

This is a comprehensive program with the goal to enable an automotive transportation system that uses sustainable energy resources and produces minimal emissions. It supports high-risk research to develop:

- More fuel efficient internal combustion engines
- Hybrid electric vehicles (including plug-in hybrids)
- All electric vehicles
- An infrastructure to produce and supply hydrogen and the components for fuel cell powered vehicles

History

- Funding for research, development and demonstration programs over 4 years has totaled \$1.29 billion.
- Funds go to universities, national laboratories and private companies, often on a cost-shared basis.
- During 2004-2005 NRC reviewed the program and issued a Phase 1 report. This is the second such report.

Statement of Task for Review

1. Review the technical goals and timetables for R&D efforts
2. Review and evaluate research progress since the Phase 1 review and relevance of research to goals
3. Evaluate adequacy and balance and rate of progress of the research program
4. Comment on the appropriate role for federal involvement in the various technical areas
5. Comment on Partnership's strategy for accomplishing its goals
6. Assess responses to Phase 1 report recommendations

Committee Membership

Craig Marks, Chair	Christopher Magee
Peter Beardmore	Robert Nowak
David Bodde	Michael Ramage
Glenn Eisman	Vern Roan
W. Robert Epperly	Bernard Robertson
David Foster	R. Rhodes Stephenson
John Heywood	Kathleen Taylor
Harold Kung	Giri Venkataramanan
James MacKenzie	Brijesh Vyas

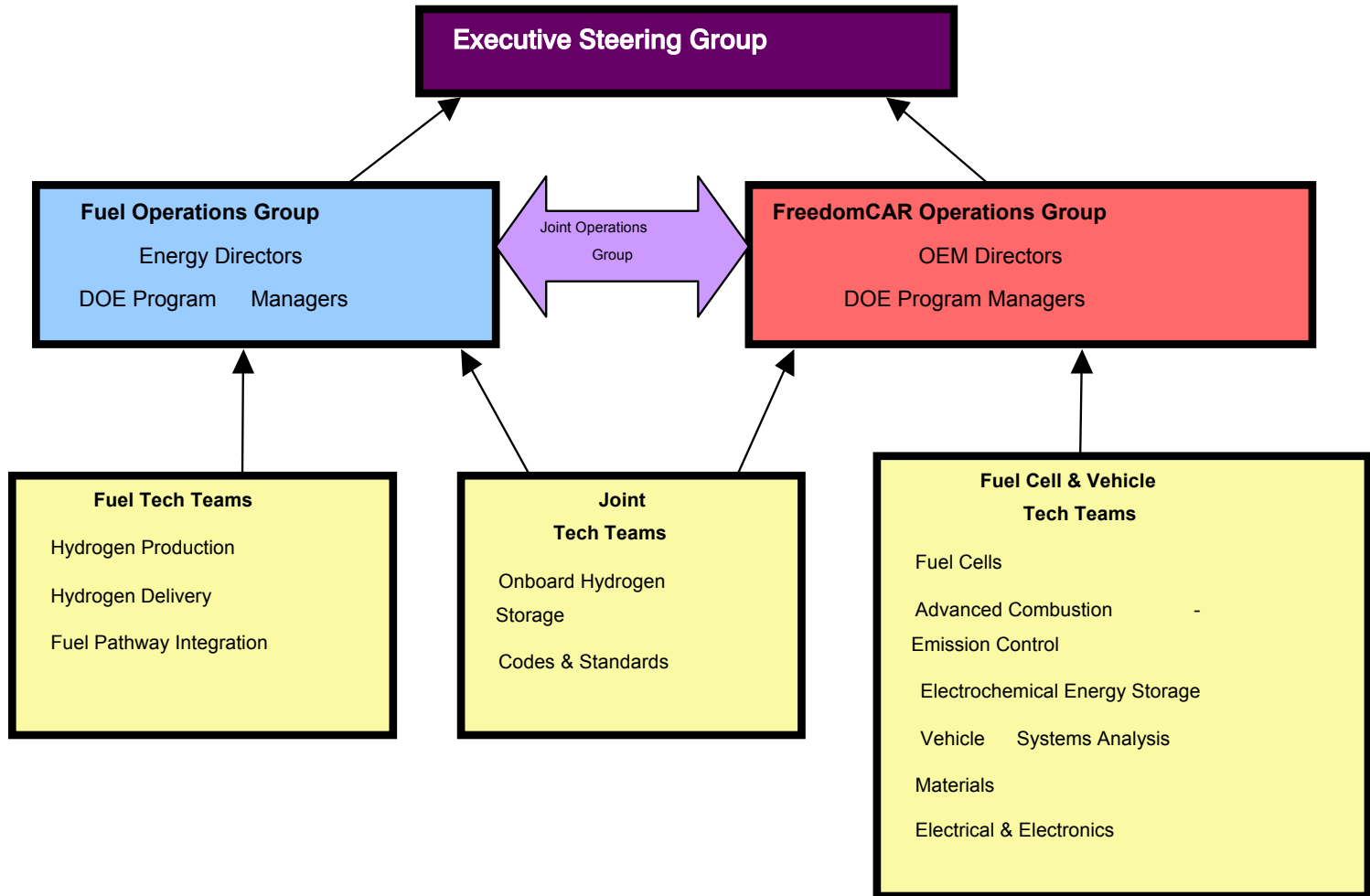
Sub-Groups

- Systems Analysis and Simulation
- Safety
- Advanced Combustion Engines and Emissions Control
- Electrochemical Energy Storage
- Fuel Cells
- Electric Propulsion, Electrical Systems and Power Electronics
- Materials
- Hydrogen Production, Delivery and Distribution
- Onboard Hydrogen Storage

General Observations

- Program is well managed and is pursuing appropriate research to enable technically feasible and economically viable solutions to some very challenging problems.
- Huge benefits from strong auto and energy company input helping to define the critical issues and set appropriate goals.
- Significant progress since Phase 1 report and management was generally receptive to recommendations in that report.
- Major increase in national and congressional interest in reducing transportation dependence on petroleum and emissions of carbon dioxide since last report.

Organization



Decision Making

- Complex program both technically and organizationally
- Effective systems analysis and modeling tools enable appropriate decisions at all levels
- Need overall analysis model to judge impact on petroleum consumption and emissions of progress in each area

Strategic Planning

- FreedomCAR and Fuel Program activities are enablers for a sustainable transportation system
- Opportune time for a strategic review by the Executive Steering Group to assure that these activities are adequate to meet the challenges that are now evident

Safety

- Safety is a critical overarching requirement for all program activities
- Hydrogen presents unique challenges which must be understood and appropriate revisions made to codes and standards to enable its widespread use in vehicles.
- DOE and DOT safety plans need to be supported and expanded

Technical Validation

- “Real World” test of fuel cell vehicles and refueling stations
- Data collected, made non-proprietary and shared, helping to set goals and priorities and establish new requirements
- Long-range plan needed to continue and expand this program

Progress and Recommendations

- Fuel cells
- Onboard Hydrogen storage
- Hydrogen production, Delivery and Dispensing

Fuel Cells

- Developing viable fuel cell vehicles and the infrastructure to fuel them is the most challenging but potentially most rewarding approach to a sustainable transportation system.
- Major progress has been made.
- Current focus: cost and durability
- Time to reassess the allocation of funding between various parts of the program based on needs to meet critical goals

Onboard Hydrogen Storage

- Meeting program goals will require a storage technology as yet undiscovered.
- Current demonstration vehicles all use 5,000 or 10,000 psi compressed gas.
- Program has finally received more adequate funding and Centers of Excellence established
- Studies needed to establish risk and other consequences of having to use high pressure for vehicle storage, delivery and dispensing

Hydrogen Production, Delivery and Dispensing

- Envision a gradual transition (>10 years) from petroleum-based fuel to hydrogen
- Initially, central production, distributed by tube trailer or liquid carrier
- Next, steam reforming or water electrolysis in distributed stations
- Finally, pipeline distribution from central production facilities
- Extend studies of various scenarios to 2030-2035

Hydrogen Production Sources and Delivery Issues

- Natural Gas
 - Imports
 - CO₂ Emissions and size of distributed plants
- Coal
 - Carbon Sequestration
- Biomass
 - Production R&D
 - Water and land use
- Electrolysis: R&D
- Nuclear: Basic research
- Delivery: cost and energy required

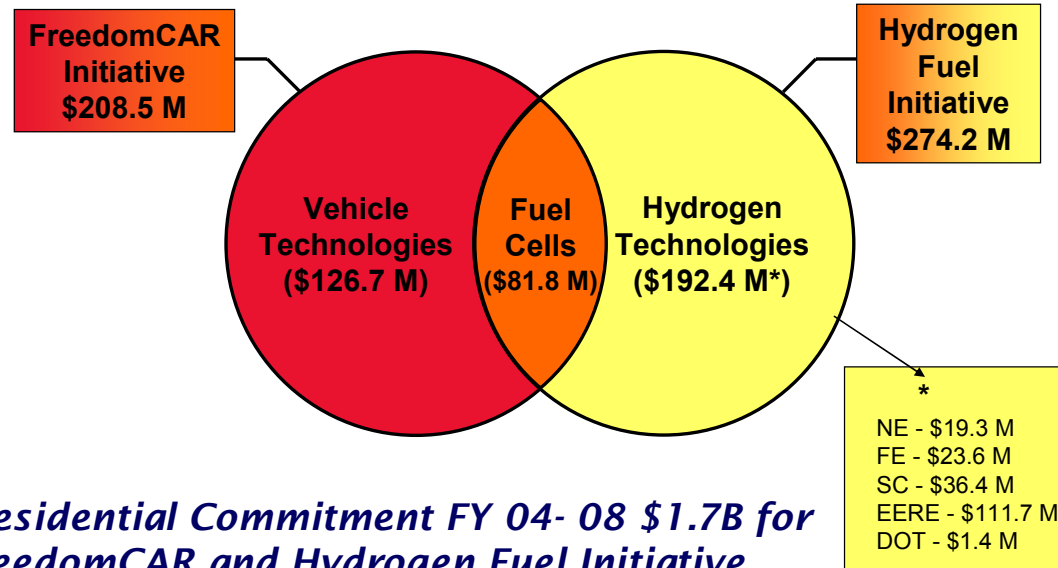
Program Needs

- Studies
 - Review CCS program for H₂ timing
 - Review biomass to H₂ barriers for timing
- More Emphasis (funding)
 - Space requirements for forecourt H₂ generation
 - Electrolysis: fundamental R&D and demonstrations
 - Delivery and dispensing program: funding vs. timing
- Involve energy companies in biomass programs

Adequacy and Balance

Continuing Resolution Funds

FY07 Appropriations = \$400.9 M



Presidential Commitment FY 04- 08 \$1.7B for FreedomCAR and Hydrogen Fuel Initiative

Adequacy and Balance

- Hydrogen funds continue at 70% of total
- Increase in funds for near-term activities: hybrid, plug-in hybrid and ICE
- Issues
 - Earmarks
 - Technology validation cuts
 - CCS program adequacy – timing
 - DOT Safety program funding
 - Sustainable availability of biomass
 - Structural materials budget increase

Response to Phase 1 Report

- DOE provided a very complete analysis of report and explanation of actions they have taken
- Committee especially gratified with increased funding for:
 - Hydrogen storage
 - High-energy batteries
 - New and ongoing systems analyses
 - Anticipating and planning to deal with public concerns
- Committee reiterates need to deal with
 - Allocation of funds to structural materials work
 - DOT safety funding

Overall Assessment

- The FreedomCAR and Fuels Partnership has developed an extremely effective way to conceive, fund and execute programs that can enable beneficial, long-term, transformational change in our automotive transportation system.
- Significant progress has been made in all of the key research areas that could make the transportation system sustainable in a resource constrained and environmentally responsible world.
- The expertise, experience and judgment of the leadership of this Partnership constitute a resource uniquely qualified to help define the overall energy transportation policy of this country. Achievements in this program provide the credentials for this role.

Overall Assessment (Cont'd.)

- All of the diverse technical activities addressed by the Program have made significant progress.
- Management has set appropriate goals, provided excellent oversight and, within the constraints imposed by the funding process, adjusted priorities appropriately.
- The potential societal value of achieving the very difficult goals of the Program justifies current expenditures and successes to date may justify expansion of the program in the future.