

## I Introduction

In his 2003 State of the Union Address, President Bush communicated his vision to the American people that, "the first car driven by a child born today could be powered by hydrogen, and pollution-free." In the 2 years since President Bush launched the Hydrogen Fuel Initiative, the Department of Energy Hydrogen Program staff have worked tirelessly to make this vision a reality and to progress towards a clean and secure energy future.

### **Congress and Administration Continue to Strongly Support the Hydrogen Economy**

Congress has done its part by appropriating 65% more funding in Fiscal Year 2004—\$160 million for the first year of the Initiative—than in Fiscal Year 2003 for hydrogen and polymer fuel cell technology. The Senate, under the leadership of Senators Byron Dorgan and Lindsey Graham, have formed a Senate Hydrogen and Fuel Cell Caucus to bring attention to hydrogen's role in long-term national energy and environmental security.



The Administration continues to deliver on President Bush's commitment of \$1.2 billion over 5 years by requesting a Fiscal Year 2005 budget of \$228 million, a 40% increase over the Fiscal Year 2004 appropriations. The request totals approximately \$320 million when hybrid vehicle technologies under FreedomCAR are included. The Administration committed a combined \$1.7 billion over 5 years for research under the Hydrogen Fuel Initiative and the FreedomCAR hybrid program.

### **National Research Council (NRC) Provides Strategic Direction**

At the very beginning of the President's Initiative, the Department asked the NRC to advise us in our planning activities. Since receiving approximately 50 recommendations, the Department has made substantial changes. First, DOE's basic science office has become a formal part of the Initiative. DOE requested \$30 million in Fiscal Year 2005 for basic science to explore the underlying science in hydrogen production, storage and use. In addition, universities have become more dominant players in our new applied research projects in hydrogen storage and renewable production announced by Secretary Abraham.

"A transition to hydrogen as a major fuel in the next 50 years could fundamentally transform the U.S. energy system, creating opportunities to increase energy security through the use of a variety of domestic energy sources for hydrogen production while reducing environmental impacts, including atmospheric CO<sub>2</sub> emissions and criteria pollutants."

-National Research Council Report, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"

Second, we have established an independent systems analyses and integration capability at the National Renewable Energy Laboratory (NREL). Richard Truly, NREL Director, has personally overseen establishment of this critical program management function and has created a "firewall" between this function and the research at NREL to avoid conflict of interest. In addition, the Department has hired Mr. Frederick Joseck, as the Hydrogen Program's Technology Analyst, to make decisions regarding the viability of various hydrogen pathways based on energy, environmental and economic factors. The Department has also hired

"The effective management of the Department of Energy hydrogen program will be far more challenging than any activity previously undertaken on the civilian energy side of the DOE."

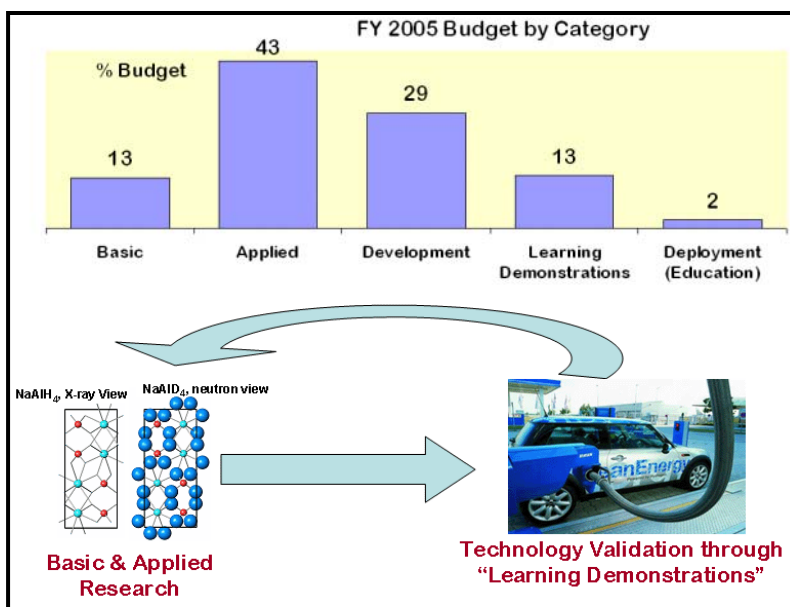
-National Research Council Report, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs"

Dr. JoAnn Milliken, as the Hydrogen Program's Chief Engineer, to ensure coherence and consistency among various hydrogen subsystems (production, delivery, storage, etc.) so that the entire system meets customer-driven performance and functional requirements. She is also responsible for establishing the technical baseline configuration and for controlling cost and schedule.

And finally, the Department has increased its effort on distributed hydrogen production (natural gas reforming and electrolysis) for the transition to a hydrogen economy. While the centralized natural gas option has been eliminated because of long-term supply and import concerns, more fundamental research on carbon-free hydrogen production such as solar-driven biological, photoelectrochemical, and thermochemical production has been enhanced and is a major focus of our new university projects.

As shown in the figure to the right, over 85% of the President's request is for research and development. The Department believes that higher risk research is the predominant role that government should currently play in advancing the hydrogen economy. Projects which lie to the right of the research and development continuum, such as learning demonstrations, are a smaller portion of the overall budget and are much more heavily cost-shared (50%) by the private sector.

The Department is grateful to the NRC's hydrogen committee for its strategic insight and candidness in making recommendations that will improve our research program and make the best use of taxpayer resources.



### **Energy Industry Joins Partnership with Automakers and DOE**

In September 2003, DOE expanded its partnership with DaimlerChrysler, Ford and General Motors (through the United States Council for Automotive Research) to include the five major energy companies- BP, ChevronTexaco, ConocoPhillips, ExxonMobil and Shell. The energy companies have become important partners in helping focus DOE-sponsored research to overcome hydrogen infrastructure challenges. Three new technical teams, which consist of scientists and engineers from the 5 energy companies and DOE, were formed in the areas of hydrogen production, delivery and analysis to recommend research priorities and to evaluate technology progress. Hydrogen storage and codes/standards technical teams were expanded and now include members from the energy companies, as well as the automakers and DOE.

Under this partnership, both the energy and automotive industries will provide invaluable assistance to government technology managers by helping establish the technical and economic requirements for satisfying customer needs and for building a business case.

### **DOE-Sponsored Research Lowers Cost of Hydrogen and Fuel Cells**

Air Products and Chemicals, Incorporated, reduced the cost of natural gas-based hydrogen from \$5 per gallon gasoline equivalent (gge) in 2003 to \$3.60 per gge using innovative reforming and purification technologies. This cost does include co-production of electricity which enables a high capacity factor to be assumed. Further research is needed to achieve the target of less than \$2 per gge (untaxed) to be cost-competitive with gasoline.

National labs and fuel cell developers reduced the high-volume cost of automotive fuel cells from \$275/kW (2002) to \$175/kW (2004) using innovative processes for depositing platinum catalyst. Additional research is needed for fuel cells to achieve the cost target of less than \$45/kW to be competitive with gasoline-hybrid engine technologies.



Las Vegas Power Park Producing Hydrogen for Vehicles and Electricity

### **Secretary Abraham Announces Two Rounds of Competitive Grants Worth \$425 Million**

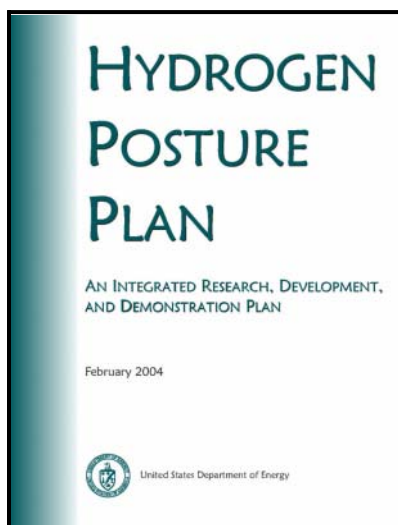
Using the National Hydrogen Energy Roadmap developed by industry and academia, the Department solicited and selected competitive proposals in the areas of hydrogen production, delivery, storage, fuel cells, education, and for hydrogen fuel cell vehicle/infrastructure "learning demonstrations." With private cost share included, the grants total approximately \$675 million. These multi-year projects represent the core research and technology validation to be conducted in the first phase of the President's Hydrogen Fuel Initiative. They involve 60 lead organizations and over 180 partners, including academia, industry and DOE national laboratories. This year's grants are in addition to \$75 million of fuel cell grants announced in 2003.

### **Secretary Abraham Establishes the International Partnership for the Hydrogen Economy**

Secretary Abraham conceived the International Partnership for the Hydrogen Economy (IPHE) and led 15 nations in signing an agreement on November 20, 2003, to formally coordinate research, development and deployment programs that advance the transition to a global hydrogen economy. The IPHE partners represent more than 85 percent of the world's gross domestic product and two-thirds of the world's energy consumption and greenhouse gas emissions. Cooperation is beginning in many areas of technology development and more countries have expressed a strong interest in joining this international partnership.



<http://www.iphe.net>

**Department, Government Agencies Better Integrate Hydrogen and Fuel Cell Activities**

[http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogen\\_posture\\_plan.pdf](http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogen_posture_plan.pdf)

Together, the DOE renewable, fossil, nuclear and science offices developed an integrated research, development and demonstration plan identifying the key milestones and activities which support an industry commercialization decision in 2015. At a broader level, the White House Office of Science and Technology Policy established a task force among all federal agencies involved in hydrogen and fuel cells. The interagency task force has developed a "taxonomy" of past, present and possible future R&D and a website ([www.hydrogen.gov](http://www.hydrogen.gov) soon to be launched) which will be a repository for all government-sponsored hydrogen and fuel cell activities.

In closing, the past several years have been exciting times as science and technology play a more important role in addressing our Nation's long-term energy and environmental concerns. From hydrogen technology, to FutureGen—a 10-year project to build the world's first coal-fired, emissions-free hydrogen and electricity power plant—to fusion, research in clean energy technology has been a major commitment by the Department of Energy. Since many of these concerns are global, we thank Secretary Abraham for his leadership in establishing the Carbon Sequestration Leadership Forum and the International Partnership for the Hydrogen Economy.

Finally, we are pleased to present the U.S. Department of Energy's Hydrogen Program Annual Progress Report for Fiscal Year 2004. This report documents the progress made on 162 projects currently being conducted. We are also interested in your comments on any projects and in your suggestions on how to better utilize taxpayer resources in advancing the hydrogen economy.

Steve Chalk, Program Manager

DOE Hydrogen Program