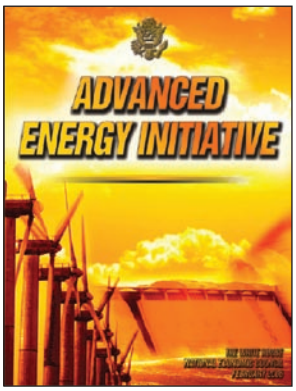
I. Introduction



In 2006, the President announced the Advanced Energy Initiative (AEI).[1] The AEI accelerates research on technologies with potential to reduce near-term oil use in the transportation sector, including advanced batteries for hybrid electric vehicles and cellulosic ethanol, and reinforces the President's Hydrogen Fuel Initiative, which aims to make hydrogen fuel cell vehicles and fueling stations available to consumers in the long term. The AEI also supports research to reduce the costs of advanced electricity production technologies in the stationary sector such as clean coal, nuclear energy, solar photovoltaics, and wind energy.

The President's Hydrogen Fuel Initiative (HFI), launched in 2003, accelerates research and development of technologies needed to commercialize hydrogen fuel cells for transportation and electricity generation.[2] In support of the HFI, the U.S. Department of Energy (DOE) Hydrogen Program –

- Conducts basic and applied research, technology development and learning demonstrations, and education and outreach activities.
- Focuses on addressing key technical challenges for fuel cells and hydrogen production, delivery, and storage, as well as institutional barriers including hydrogen codes and standards to maximize safety, and training and public awareness.
- Works with public- and private-sector partners including automotive and energy companies, power equipment and component manufacturers, electric and natural gas utilities, standards development organizations, other federal agencies, state and local government agencies, universities, federal laboratories, and other national and international stakeholder organizations.
- Integrates hydrogen activities in the DOE Offices of Energy Efficiency and Renewable Energy; Fossil Energy; Nuclear Energy, Science, and Technology; and Science.

In fiscal year (FY) 2006, Congress appropriated $235.9 million for the President's Hydrogen Fuel Initiative, compared to the FY 2005 appropriation of $222.0 million. The President's FY 2007 request for the Hydrogen Fuel Initiative is $289.5 million (appropriations yet to be finalized as of publication date). Funding will support hydrogen and fuel cell research and development (R&D) across four DOE offices – Energy Efficiency and Renewable Energy; Fossil Energy; Nuclear Energy, Science, and Technology; and Science – and the Department of Transportation.

In the past year, significant progress has been made toward achieving technical targets and program milestones as summarized below.

TECHNICAL PROGRESS

Independent Reviews Conducted to Verify Hydrogen Program Technical Progress

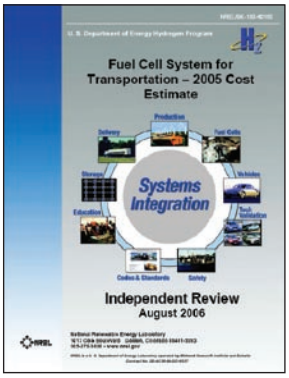
In 2006, the DOE Hydrogen Program commissioned independent reviews of various technologies being developed by the Program. These reviews analyzed technology potential and research progress to verify status against Program technical targets. Completed reviews are available to the public at www.hydrogen.energy.gov.

---

[1] Bush, George W. "2006 State of the Union Address." Capitol, Washington. 28 Jan. 2003. Available on the Web at <http://www.whitehouse.gov/stateoftheunion/2006/>.

[2] Office of the President. "Hydrogen Fuel: A Clean and Secure Energy Future." 30 Jan. 2003. Available on the Web at <http://www.whitehouse.gov/news/releases/2003/01/20030130-20.html>.

Fuel Cell System Cost



The Fuel Cell System Cost review focused on the analysis DOE uses to determine the high-volume production cost of the polymer electrolyte membrane automotive fuel cell power system. Annual projections of the cost estimate have been performed on behalf of DOE by TIAX, LLC. The review team found the methodology used by TIAX to be credible and to have calculated a reasonable high-volume production fuel cell system cost of $108 per kW. It also made recommendations for improving future cost analyses.

TIAX and Directed Technologies, Inc. are implementing several of these recommendations in the annual fuel cell cost analysis, including eliminating the concept of vertical integration and focusing on raw manufacturing costs; addressing in more detail quality control, system conditioning, non-recurring engineering costs for manufacturing equipment, and stack assembly; extending the price range of platinum to account for the possibility of higher prices; and incorporating additional sources for ionomer cost. Additionally, the recovery value of the platinum will be reported along with the fuel cell system manufacturing cost.

Cost of Hydrogen Production from Distributed Natural Gas

An independent review was also conducted to confirm that hydrogen can be produced from distributed natural gas at the DOE 2005 target of $3.00 per gallon of gasoline equivalent (gge). The panel used the H2A cost model to analyze data submitted by DOE industry partners and national laboratories for reforming technologies, and determined that the calculated hydrogen cost ranged from $2.75 to $3.50 for units capable of delivering 1,500 kilograms per day when reformer systems are manufactured in quantities of about 500 units per year.

Learning Demonstration Station Generates Initial Results

In FY 2006, the National Hydrogen Learning Demonstration Project completed the second full year of data collection. Sixty-three first-generation fuel cell vehicles and nine hydrogen refueling stations, supplied by delivered hydrogen and/or hydrogen produced on-site via electrolysis or natural gas reforming, are in operation.

Teams continue to collect and provide data to the Hydrogen Secure Data Center at the National Renewable Energy Laboratory. Twenty-six composite data products – which are technical ranges of values that do not identify which company provided the information – have been generated from the collected data. These initial products cover parameters such as fuel economy, vehicle driving range, on-board hydrogen storage performance, vehicle and infrastructure safety events, hydrogen impurities sampled from refueling stations, and vehicle refueling rates. The vehicle chassis dynamometer fuel economy from the four teams ranged between 49-67 miles per kg, and the on-road fuel economy ranged between 32-43 miles per kg. The EPA adjusted dynamometer driving range was between 103-190 miles[3], but as expected, demonstrated on-road driving range was found to be significantly lower due to limited infrastructure and reduced driver comfort associated with running out of fuel. Future results to be published will include fuel cell efficiency and durability.

In FY 2007, second-generation fuel cell vehicles will be deployed.

Results Being Achieved Across the Program

In addition to the highlights described above, the DOE Hydrogen Program made significant progress in other technical areas. Some of the Program accomplishments are summarized below.

[3] The range is calculated using fuel economy measured on a dynamometer and adjusted using EPA combined weighting factors (0.9 x City, 0.78 x Highway) for window sticker display on vehicles.

Fuel Cells

The Fuel Cell subprogram made significant advances in low- and non-platinum catalysts, membranes, electrodes, membrane electrode assemblies, and analysis of water transport and freeze effects. Results from Los Alamos National Laboratory, reported in the September 7, 2006 issue of Nature journal, showed for the first time a non-precious metal catalyst with promising activity and stability comparable to that of platinum-based oxygen reduction catalysts. This achievement with cobalt-polypyrrole composite materials opens up the possibility of making a variety of non-precious metal composite catalysts with potential to meet DOE 2010 catalyst targets.

Hydrogen Production

Renewable-Based Hydrogen. In the area of polymer electrolyte membrane (PEM) electrolysis, the Hydrogen Production subprogram successfully lowered stack cost by achieving a part count reduction of more than 50% – the part count per cell was reduced from 40 to 16, resulting in a reduction in stack cost from $2,500/kW in 2001 to approximately $1,250/kW today. For the distributed reforming technology pathway, a new reactor system was identified that allows the aqueous phase reforming (APR) of bio-sugars. Improvements to the APR technology to achieve the required hydrogen generation with appropriate catalyst, reactor configuration, and reaction conditions are underway.

Hydrogen from Coal. In the Office of Fossil Energy, significant advances were made in hydrogen membrane separation technology. Eltron Research, Inc., scaled up its hydrogen separation membrane, targeted for incorporation into the FutureGen facility in 2012. The membrane demonstrated greater than 100 scfh/ft^2 flux (DOE's 2010 target), "5-nines" hydrogen selectivity, and 8,000 hours of long-term continuous operation in simulated water-gas shift atmospheres. Eltron is currently operating at a scale of 1.3 lbs/day with future plans to scale up to 220 lbs per day and then to 4 tons per day.

Nuclear Hydrogen. Within the Office of Nuclear Energy, significant progress was made during 2006 in developing components for integrated laboratory-scale experiments to test high-temperature hydrogen production processes. In the area of thermochemical cycles, Sandia National Laboratories (SNL) developed and tested an innovative silicon carbide "bayonet" design for a sulfuric acid decomposer, which could be used in both the Sulfur-Iodine and the Hybrid Sulfur cycles. In FY 2007, a Sulfur-Iodine integrated laboratory-scale experiment will be assembled at the General Atomics facility in San Diego consisting of three separately developed sections: the sulfuric acid decomposer section developed at SNL, a hydriodic acid (HI) decomposer section constructed by General Atomics, and a Bunsen reaction section provided by the French Commissariat à L'Energie Atomique. In the high-temperature electrolysis (HTE) area, Idaho National Laboratory (INL) successfully conducted a 1,000-hour continuous test of a 25-cell stack. The hydrogen production rate throughout the test was in excess of 100 normal liters per hour. Long-duration testing of one-half of a module for the HTE integrated laboratory-scale experiment was performed at the Ceramatec facility in Salt Lake City. The half module (shown at right) consists of two stacks of 60 cells each. The fully integrated laboratory-scale experiment will consist of three modules, each containing four 60-cell stacks. The test was designed to test the cells, assembly and operating techniques that will be used in the integrated laboratory-scale experiment at the INL during 2007 and 2008.

Hydrogen Storage

The Storage subprogram continued its focused R&D strategy through the three established Centers of Excellence and over 35 independent projects comprised of approximately 40 universities, 15 companies and 10 federal laboratories, including 17 new basic science projects. The research projects supported by the subprogram have started to identify promising materials with high storage capacities (greater than 6 wt% and 45 gH_2/L). Significant progress was made in FY 2006 in the areas of chemical hydrogen storage, metal hydrides and carbon-based materials, but significant challenges remain. Future work will continue to emphasize materials R&D with a focus on optimizing thermodynamics and kinetics.

Hydrogen Delivery

Currently-funded research efforts focus on delivery infrastructure analysis, lower-cost pipelines, and lower-cost off-board storage at refueling stations. In addition, research on improved compression technology is being funded through two DOE Small Business Innovation Research projects.

In FY 2006, the Hydrogen Delivery subprogram successfully completed an analysis of the current costs of hydrogen delivery using pipelines, liquid trucks, and gaseous trucks. This analysis tied into the development of the H2A Delivery Component and Scenario Models, both of which are posted for public use along with comprehensive Users Guides at www.hydrogen.energy.gov/h2a_analysis.html. The subprogram made significant progress on developing a mechanistic understanding of hydrogen pipeline embrittlement, which included the development of a finite element code for the study of transient stress-driven hydrogen transport coupled with large strain material elastoplastic deformation. The subprogram also defined a feasible design for a hydrogen pipeline centrifugal compressor through the use of air foil bearings and seals; this activity will move to the research and development phase in FY 2007.

Safety, Codes & Standards

The Safety, Codes and Standards subprogram established two web-based resources to improve the distribution of hydrogen safety information and facilitate implementation of "lessons learned." The Hydrogen Incident Database (www.h2incidents.org) catalogs hydrogen-related incidents, including causes, severity, lessons learned and corrective action. The database entries are searchable and are not attributed to those who contribute. The Hydrogen Safety Bibliographic Database (www.hydrogen.energy.gov/biblio_database.html) contains over 400 references to hydrogen safety related publications. All of the entries include abstracts, and many of the publications are downloadable from the website.

Education

The Education subprogram launched two new projects focused on meeting critical near-term information needs. The Introduction to Hydrogen Safety for First Responders is an interactive, web-based course intended to provide a basic, "awareness-level" overview of hydrogen to fire, law enforcement, emergency medical, and other personnel who may witness a hydrogen release and must initiate an emergency response sequence. Modules include hydrogen basics/properties, vehicles, dispensing, stationary facilities, codes and standards, and emergency response. Course development included a broad review seeking input and feedback from the hydrogen and first responder communities. The Education subprogram also launched a new community information program called "Increase Your H2IQ," designed to raise awareness of hydrogen and fuel cell technologies in communities where hydrogen fueling stations or other demonstration projects are located. The program uses radio, print, and other forms of media to introduce hydrogen as a form of energy and drive people to the "Increase Your H2IQ" tool box on the DOE Hydrogen Program website (www.hydrogen.energy.gov), where they'll find fact sheets, audio files, a state activities database, safety information, and links to other resources.

Systems Analysis

The Systems Analysis subprogram initiated five model development projects that address critical infrastructure, hydrogen pathway, and market issues for hydrogen production and delivery; hydrogen quality; and parameters affecting vehicle penetration. In FY 2006, the Macro-System Model, which links models of different architecture to enable a complete hydrogen pathway analysis, was developed as a test version and reviewed by the Systems Analysis Peer Review Team.

Manufacturing R&D

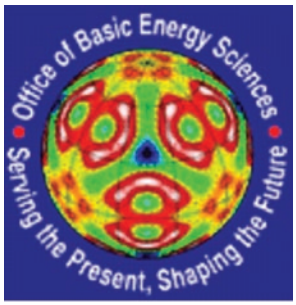
In December 2005, the draft Roadmap on Manufacturing R&D was released for public and stakeholder comments. The DOE Hydrogen Program is currently reviewing a final draft incorporating some of the comments submitted in the open review process.

Subject to appropriation, in FY 2007 the DOE Hydrogen Program will initiate a new Manufacturing R&D subprogram; the President's FY 2007 Budget Request included $1.9 million for manufacturing research and development related to hydrogen. The DOE Hydrogen Program is currently developing an R&D plan for Manufacturing, which will specify technical objectives, challenges, tasks, and milestones.

Subject to appropriation, the Program plans to release a solicitation, with selection expected by September 2007. Industry/government cost-shared research projects will focus on addressing near-term process development needs for proton exchange membrane fuel cells, compressed hydrogen on-board storage tanks, and distributed hydrogen production technologies.

Basic Research Addresses the Program's Key Scientific Challenges

The Office of Basic Energy Sciences (BES) within the DOE Office of Science supports fundamental research addressing critical scientific challenges related to hydrogen production, storage, and fuel cells. This basic research complements the applied research and development projects supported by the other offices in the DOE Hydrogen Program.



In FY 2006, the BES Contractors Meeting, featuring fundamental research underpinning advancement of Hydrogen Storage, was co-located with other Hydrogen Storage subprogram presentations at the 2006 DOE Hydrogen Program Merit Review and Peer Evaluation Meeting. The DOE Hydrogen Program coordinates basic and applied research for on-board hydrogen storage and conducted a Theory Focus Session at the same meeting to identify key research needs related to theory/modeling approaches for hydrogen storage materials. In FY 2007, the BES Contractors Meeting will feature fundamental research underpinning advancement of fuel cell technology and will be co-located with other Fuel Cell subprogram presentations at the 2007 DOE Hydrogen Program Merit Review and Peer Evaluation Meeting.

Program Releases Solicitations and Selects Projects to Address Key Targets

In FY 2006, the DOE Hydrogen Program developed several solicitations and selected a significant number of projects focused on addressing key barriers.

The Program selected:

- 25 new projects ($100 million over four years, $127 million with cost share) to overcome fuel cell cost and durability barriers. Research and development will focus on fuel cell membranes, water transport within the stack, advanced cathode catalysts and supports, cell hardware, innovative fuel cell concepts, and effects of impurities on fuel cell performance and durability. Awards also include stationary fuel cell demonstration projects that foster international and intergovernmental partnerships.
- 12 new projects ($19 million over five years, $24 million with cost share) for research on polymer electrolyte-type membranes with improved performance at higher temperatures and lower humidity.
- Six new projects ($17.9 million) to develop advanced technologies for the alternative production of hydrogen from coal and to demonstrate the use of hydrogen as a fuel in reciprocating internal combustion engines.
- Two projects ($2 million over five years) for fuel cell cost analysis.

- One new project to conduct a study – as required under section 1820 of the Energy Policy Act of 2005 – of the likely effects of a transition to a hydrogen economy on overall employment in the U.S., to be completed by February 2007.
- Two projects that partner with industry in studying the economic feasibility of producing hydrogen at existing commercial nuclear power plants using low-temperature electrolysis.

In addition, at the time of publishing, proposals were being evaluated by the Office of Fossil Energy to support the centralized production of hydrogen at large-scale facilities, which will result in an additional $5 million in DOE funding. Other solicitations have been conducted to address key topics related to addressing barriers to deploying hydrogen and fuel cell technologies. These projects will –

- Develop a coordinated approach to supporting hydrogen codes and standards activities;
- Develop hydrogen storage technologies for on-board vehicular applications;
- Analyze the potential environmental impacts of hydrogen systems;
- Gather and synthesize the lessons learned from stationary power generation.

OTHER PROGRAM ACCOMPLISHMENTS/ACTIVITIES

Program Implements Energy Policy Act of 2005

In 2005, Congress passed and the President signed into law the first comprehensive energy legislation in over a decade. The Energy Policy Act of 2005 (EPACT) demonstrates unified commitment among our Nation's leaders to reduce our dependence on foreign oil through the development of efficient energy technologies and alternative, domestically-produced transportation fuels. Title VIII focuses on the development of hydrogen and fuel cell technologies to accomplish the high-level energy objectives supported by Congress.

EPACT requires a number of studies, reports, and actions from the Department to determine the impact of hydrogen and fuel cell technology deployment. A report required under section 1812 of EPACT, the *Solar and Wind Technologies for Hydrogen Production Report to Congress*, was published in December 2005 and provides information on solar and wind hydrogen projects and recommendations for promoting the availability of solar and wind technologies for the production of hydrogen. In August 2006, the Department submitted to Congress the *Hydrogen Goal-Setting Methodologies Report to Congress*, required under section 1819, which summarizes the processes used to set Hydrogen Program goals and milestones. Both of these reports can be found on the DOE Hydrogen Program website at www.hydrogen.energy.gov/congress_reports.html.

Section 804 requires submission of a coordinated five-year plan for the programs authorized under Title VIII. The Department is updating the Hydrogen Posture Plan to address the requirements under this section and highlight the progress made since the launch of the Hydrogen Fuel Initiative. The Plan outlines the activities undertaken by the Department of Energy and Department of Transportation to develop hydrogen and fuel cell technologies and how these activities are integrated.

In August of 2006, the Department announced a loan guarantee program to address some of the financial barriers to deploying innovative technologies. Loan guarantees will allow the Department to share the financial risk of projects that employ new or significantly improved energy technologies that avoid, reduce, or sequester air pollutants and greenhouse gases. The loan guarantee program was authorized in Title XVII of EPACT. Hydrogen and fuel cell technologies are eligible for loan guarantees under the program.

Over the next year, the Department will focus on completing other hydrogen-related reports required under EPACT. In addition, the Department will utilize the expertise of the National Academies to complete a budget roadmap required by section 1825 for the development of fuel cell technologies and analyze the potential transition from petroleum to hydrogen in the U.S. vehicle fleet.

EPACT sections 782 and 783 authorize federal leasing and purchasing of stationary, portable, and micro fuel cells, as well as fuel cell vehicles for federal fleets. The Department will continue to evaluate these and other authorizations, and will call upon the Interagency Hydrogen and Fuel Cell Technical Task Force and the Hydrogen and Fuel Cell Technical Advisory Committee – both formally recognized in EPACT – for recommendations based on the status of the technology.

Hydrogen Quality Issues of Performance Versus Cost Are Being Examined

The quality of the hydrogen fuel used in fuel cell vehicles is expected to have a strong influence on the performance and durability of the fuel cell systems. Fuel quality affects the lifecycle costs of fuel cell systems – higher-quality fuel allows for lower fuel cell system and vehicle costs. On the other hand, higher fuel quality requirements correlate to higher lifecycle costs of hydrogen production, purification, distribution, storage, and analytical systems. DOE established a Hydrogen Quality Working Group to quantify these relationships and to develop a roadmap to define R&D priorities in this cross-cutting area. The Working Group includes participants from the automotive and energy industries, national laboratories, and the DOE Hydrogen Program.

H2A Production and Delivery Models Released

The H2A Production and Delivery Models were developed to address the need for consistent analysis methodology and transparent reporting independent of hydrogen production and delivery pathways. These cash flow analysis tools, which assess the minimum hydrogen cost (including a 10% return on capital investment) for a variety of hydrogen production and delivery technologies, will be used by the Program, its contractors, and stakeholders to evaluate technologies on a common basis, assess technology tradeoffs, and aid systems analysis efforts. The models were issued for public use after peer review and beta testing. The models are available through the Hydrogen Program website at www.hydrogen.energy.gov/h2a_analysis.html.

Hydrogen Analysis Resource Center (HyARC) Website Available to the Public

The Program developed a new web-based Hydrogen Analysis Resource Center (HyARC) to provide key data required for Program-related analysis. HyARC, accessible at www.hydrogen.energy.gov/resource_center.html, includes the "Hydrogen Data Book," which contains well-documented, reliable data to be used as the basis for calculations, modeling, and other analytical activities. Data can be accessed from data files housed in the site itself, as well as through links to important websites such as those maintained by the Energy Information Administration, DOE programs, other U.S. government agencies, and non-government sources. The site's search feature allows users to seamlessly search available data, independent of whether the data are from internal or external sources. The website also provides guidelines and a set of assumptions for use in Hydrogen Program analysis projects (these assumptions will be updated annually). In addition, the website contains several calculator tools for performing useful conversions and other simple calculations relevant to hydrogen and fuel cells, and includes links to websites housing more sophisticated analysis tools, such as the GREET website and others.

Program Initiates Scenario Analysis

In FY 2006, the DOE Hydrogen Program began analyzing hydrogen fuel cell vehicle and infrastructure deployment scenarios, including possible policy actions. The Program is conducting analysis and interfacing with private and public partners to ensure that stakeholder input is included. The results of the analyses and the proceedings of the meetings will be incorporated into a report to be issued in FY 2007.

EXTERNAL INPUT AND COORDINATION ACTIVITIES

DOE Utilizes Expertise from Stakeholder Community and Government Partners

The following activities facilitate interaction and coordination with other technology experts in industry, government, and academia, as well as with international partners:

Hydrogen and Fuel Cell Technical Advisory Committee

In June 2006, the Secretary of Energy appointed 25 members to the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) and approved its charter, and the committee held its first meeting in October 2006. HTAC members include representatives of domestic industry, academia, professional societies, government agencies, financial organizations, and environmental groups, as well as experts in the area of hydrogen safety. HTAC will advise the Secretary on issues related to the development of hydrogen and fuel cell technologies and give recommendations to the Secretary regarding DOE's programs, plans, and activities, as well as safety, economic, and environmental issues related to hydrogen. Following guidance provided in EPACT, the Secretary will deliver a biennial report to Congress describing committee recommendations and how DOE will implement those recommendations, as well as a rationale for not implementing recommendations if necessary. The Committee plans to meet at least twice a year to fulfill its duties.

National Academy of Sciences

A primary component of a 2002-2004 review by the National Research Council (NRC) and the National Academy of Engineering of the National Academies was to assess the effectiveness of the DOE Hydrogen Program and to provide recommendations for improvement. The NRC published a report outlining the recommendations of the review titled *The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*.[4] The committee was "impressed by how well the hydrogen program has progressed,"[5] but also provided feedback on improvements that could be made. The DOE Hydrogen Program has developed a comprehensive evidence document to outline how the Department has implemented the recommendations in the 2004 report. This document provides detailed explanations of each recommendation, describes actions taken to address the recommendations and includes a list of relevant documents.

FreedomCAR and Fuel Partnership All Tech Team Meeting

In December 2005, the FreedomCAR and Fuel Partnership, a unique public-private partnership among the U.S. Department of Energy, BP America, Chevron Corporation, ConocoPhillips, ExxonMobil Corporation, Shell Hydrogen LLC and USCAR – the U.S. Council for Automotive Research, a legal partnership among DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation – held its biennial All Technical Team Meeting in Detroit, Michigan. The Technical Teams – composed of representatives from the auto and energy companies, DOE, and national laboratories – are focused on vehicles, hydrogen fuels, and cross-cutting technical areas. The meeting in Detroit offered an opportunity for all teams, Director-level participants from the companies, DOE program leadership, and senior laboratory personnel to discuss the progress, coordinate future activities, and plan the partnership direction and priorities. To better understand the current technological needs and R&D priorities, breakout sessions were conducted around the following topic areas: 70 MPa Storage, Advanced and Novel Materials, Alternative Fuels and Advanced Combustion,

[4] National Research Council/National Academy of Engineering. The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs. Washington, D.C.: The National Academies Press. 2004. Available on the Web at http://fermat.nap.edu/catalog/10922.html.

[5] Ibid.

Advanced Battery Technologies, Hydrogen Purity, System Interfaces, Low Cost Carbon Fiber, and Thermal Sciences. Specific actions were identified in each area to provide a focus for the Technical Teams for the next year.

Interagency Task Force

Many federal agencies are involved in hydrogen and fuel cell research, development, and demonstration. The Interagency Hydrogen and Fuel Cell Technical Task Force provides a forum in which these agencies can coordinate their activities, share results, and ensure efficient use of taxpayer resources. Now co-chaired by DOE and the White House Office of Science and Technology Policy, the task force is focused on fulfilling responsibilities assigned to it in EPACT, including the coordination of RD&D efforts, education, support of codes and standards development efforts, and assisting with decisions related to federal procurement of hydrogen and fuel cell systems. In the last year, the task force developed a charter and obtained formal recognition as an Interagency Working Group under the President's National Science and Technology Council Committee on Technology. It also formed two new ad hoc committees – one to support the coordination of a regulatory framework for a hydrogen economy (led by the Department of Transportation), and another to support collaboration on biomass-to-hydrogen production and the use of fuel cells for rural and agricultural applications (led by DOE and the Department of Agriculture). The interagency website, www.hydrogen.gov, provides a portal to information about all federal hydrogen and fuel cell activities, programs, and news. It now includes an interactive map, developed by the regulatory ad hoc committee, to illustrate, share, and examine the current U.S. statutes and regulations that may be applicable to hydrogen.

International Partnership for the Hydrogen Economy

The International Partnership for the Hydrogen Economy (IPHE), whose members include 16 countries and the European Commission (see table below), is a forum for governments to work together to advance the global hydrogen and fuel cell technology research, development, and deployment. IPHE is also a forum for international R&D managers, researchers, and policymakers to openly share program strategies.

In June 2006, IPHE members convened a workshop in Lyon, France to openly set high-level goals and establish research priorities for international collaborative activities. In September 2006, IPHE officially recognized 13 collaborative projects that cover a broad range of topics including socio-economics aspects of hydrogen production, hydrogen storage, fuel cell technology and demonstration activities of fuel cell technology in small power vehicles and buses. These outstanding projects illustrate the on-going collaborative efforts to advance the organization's goals. For more information, please visit www.iphe.net/.

Membership of International Partnership for the Hydrogen Economy

Australia	Germany	Norway
Brazil	Iceland	Republic of Korea
Canada	India	Russia
China	Italy	United Kingdom
European Commission	Japan	United States
France	New Zealand	

International Energy Agency

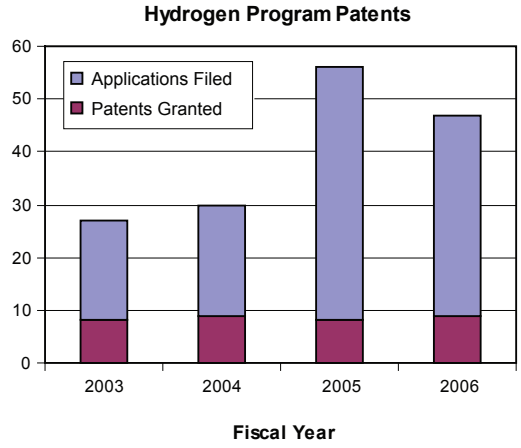
The International Energy Agency (IEA) provides a mechanism for member countries to task- and cost-share research activities through two Implementing Agreements, one supporting hydrogen activities and one supporting fuel cell activities. The DOE Hydrogen Program participates in both.

The Hydrogen Implementing Agreement (HIA) is focused on facilitating, coordinating, and maintaining innovative research, development, and demonstration activities through international cooperation and information exchange. There are currently seven annexes – Technology, Energy Security, Environmental, Economic, Market, Deployment, and Outreach. The HIA recently expanded its tasks to include hydrogen from biomass, hydrogen storage materials, hydrogen production from wind energy, and hydrogen from steam reformation. Information about the IEA-HIA is available at www.ieahia.org.

The IEA Advanced Fuel Cells Implementing Agreement is focused on the complementary research, development, and demonstration activities for fuel cells. There are currently six annexes in the Fuel Cell Implementing Agreement – Molten Carbonate Fuel Cells, Polymer Electrolyte Fuel Cells, Solid Oxide Fuel Cells, Fuel Cells for Stationary Applications, Fuel Cells for Transportation, and Fuel Cells for Portable Applications. Information about the IEA Advanced Fuel Cells Implementing Agreement is available at www.ieafuelcell.com.

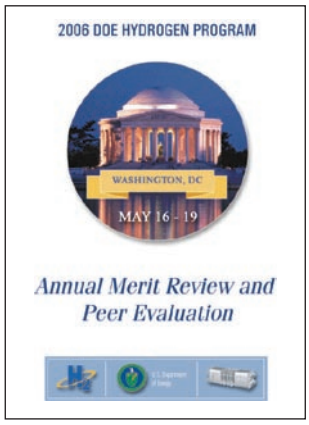
New Patents

One measure of the innovation and robustness of a research and development program is the number of patents applied for and granted. Each year, the DOE Hydrogen Program tracks the number of patents that are filed by or awarded to projects it sponsors. In FY 2006, nine new patents were issued to research and development discoveries emerging from DOE Hydrogen Program projects; 38 more applications were filed or are in the process of being awarded. While FY 2005 showed a larger number of patents being filed (one project accounted for 10 of those), an upward trend is unmistakable.



FY 2006 Annual Merit Review and Peer Evaluation

The DOE Hydrogen Program held its Annual Merit Review in May 2006 in Arlington, Virginia. Over 900 people attended the review, and 289 DOE Hydrogen Program projects were presented – 156 of which were peer reviewed. This meeting provides an opportunity for the DOE Hydrogen Program to not only showcase its accomplishments and progress, but also to obtain an expert peer review of the projects it supports. Reviewers evaluate the projects and make recommendations to DOE's principal investigators, and DOE uses their evaluations to make programmatic and funding decisions for the upcoming fiscal year. The report compiling reviewer comments is available at www.hydrogen.energy.gov/annual_review06_report.html. The FY 2007 Review will be held in May in Arlington, Virginia.



SUMMARY

We are pleased to present the U.S. Department of Energy's Hydrogen Program Annual Progress Report for Fiscal Year 2006. The 319 projects outlined in this document represent the work currently sponsored by the Hydrogen Program and are responsible for many of the significant accomplishments outlined above. The report is divided into chapters and organized by technology area (e.g., Hydrogen Storage, Fuel Cells, etc.); each chapter opens with an overview written by the DOE Technology Development Managers that summarizes the progress and accomplishments of this Fiscal Year.

JoAnn Milliken

Acting Program Manager
DOE Hydrogen Program