

# **Hydrogen and Fuel Cell Technical Advisory Committee Biennial Report to the Secretary of Energy**

*A Letter Report Prepared by the  
Hydrogen and Fuel Cell  
Technical Advisory Committee*

*Covering Activities of  
October 2006 to August 2007*

*Fulfilling the Requirements of the  
2005 Energy Policy Act,  
Section 807 of Title VIII, Hydrogen*

September 10, 2007



September 10, 2007

The Honorable Samuel W. Bodman  
Secretary of Energy  
7A-257 Forrestal Building  
U.S. Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585

Dear Mr. Secretary:

On behalf of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC or Committee), we are pleased to submit for your consideration our first report. This letter report summarizes the Committee's findings and recommendations developed during the period October 2006 – August 2007, as approved at the HTAC meeting of 7/31 to 8/1/2007 in Washington, DC.

The HTAC was chartered on June 12, 2006, in accordance with Title VIII, section 807, Hydrogen, of the Energy Policy Act (EPACT) of 2005 (see Attachment 1). The scope of the Committee is to review and make recommendations to the Secretary on: 1) the implementation of programs and activities under Title VIII of the EPACT 2005 (see Attachment 2); 2) the safety, economical, and environmental consequences of technologies for the production, distribution, delivery, storage or use of hydrogen energy and fuel cells; and 3) the plan called for by section 804 of EPACT.

HTAC is composed of members with varied backgrounds and experience in matters relating to the nation's energy needs (see Attachment 3). The Committee believes that hydrogen has the significant potential to play an important role in meeting the long term energy needs of the United States because it has the capability to carry energy from any source—fossil, renewable, nuclear—to the points of use with very low environmental footprint. Hydrogen can be produced in a distributed fashion and by using off peak power or intermittently available renewable energy resources such as sunlight. Hydrogen also has the ability to store this energy during off-peak power periods so that the energy can be made available when and where it is needed.

As with any energy transformation, the nation will need to invest billions of dollars over decades to unlock hydrogen's potential. Major corporations have demonstrated a commitment to funding a substantial portion of that investment, and numerous entrepreneurial companies have attracted capital to pursue innovative approaches to all aspects of the hydrogen transition. Part of Government's role is to support research, development and demonstrations to develop viable technology and to help transition from the present period of low volume/high cost hydrogen and fuel cell systems, and infrastructure (manufacturing, supply base and refueling) to a more technologically mature period of robust markets and consumer choices.

As the world's largest energy consumer, the United States has a unique opportunity to lead the technological changes necessary for this transition. Working along side, and integrated with, other alternative energy technologies, hydrogen and fuel cells will help deliver a diverse approach to our national energy and transportation systems, bringing a sustainable environmental advantage. Unfortunately, our nation is already falling behind in developing and implementing some renewable technologies such as solar, and is in danger of falling behind in the development

of hydrogen technologies despite the significant progress made over the last few years. There is significant economic value to be gained from commercializing clean, efficient energy systems that do not rely on imported oil, and the United States should position itself as the leader.

The HTAC findings and recommendations below are organized by the elements of the Committee's charter. Over the past year, the Committee has primarily focused on reviewing the implementation of programs and activities under Title VIII and the December 2006 *Hydrogen Posture Plan* (see Attachment 4), as required by elements 1 and 3 of the HTAC charter. In January 2007, the Posture Plan was submitted by DOE to Congress in response to section 804 of EPACT, which calls for a coordinated plan for fuel cells and hydrogen for DOE and portions of the Department of Transportation (DOT).

## **HTAC Findings and Recommendations**

### **I. Implementation of Programs and Activities under Title VIII, Hydrogen, Energy Policy Act of 2005**

- **The operational structure of the Interagency Task Force on Hydrogen and Fuel Cells, required by EPACT section 806, should include participation at a functional level of the Assistant Secretary or higher to ensure appropriate decision-making membership from each participating agency. The Committee recommends that the Interagency Task Force be charged with developing a “National Hydrogen and Fuel Cells Action Plan” to guide interagency cooperation and collaboration on hydrogen and fuel cells.**

On November 12, 2006, the Committee recommended the formation of an Interagency Task Force with Assistant Secretary-level or higher membership from each participating agency (see Attachment 5). The Committee is pleased that DOE adopted this recommendation and is hopeful that the newly created Interagency Task Force on Hydrogen and Fuel Cells (inaugural meeting held on August 1, 2007) will foster a higher level of commitment to implementation of the President's Hydrogen Fuel Initiative by all participating agencies. Effective interagency coordination and involvement of decision-makers who can influence program execution within their respective agencies is especially important in order to address cross-cutting issues related to codes and standards development, public education, training of code officials and first responders, and development of programs and incentives that can stimulate commercialization of hydrogen and fuel cell technologies (including federal procurement programs and the potential for creating a temporary program to address liability issues during the transition). A “National Hydrogen and Fuel Cells Action Plan” would serve to identify the particular actions that are needed, the roles and responsibilities of the respective agencies, and the timelines for completion. The Interagency Task Force is best positioned to facilitate federal procurement of hydrogen and fuel cell systems, beginning in fiscal year 2008.

The Committee believes that the proposed National Hydrogen and Fuel Cells Action Plan (the “Interagency Plan”) should orient the Hydrogen program to the overall energy strategy of the United States. Assuming the nation's high level energy goals are a

significant reduction of dependence on oil imported from politically sensitive parts of the world and management of energy resources in a carbon constrained environment, it is likely hydrogen will play a prominent role. The Interagency Plan should depict the role of hydrogen in the context of the evolving nation's overall energy strategy.

- **Funding for the hydrogen program should be increased at least to the \$3.275 Billion authorized by EPACT Title VIII for FY 2006 to FY 2010, commensurate with its importance to national security, environmental quality, climate change mitigation, and global technology competitiveness.**

The Committee believes that faster progress can be made with more funding for the DOE Hydrogen Program. Certain important activities are not being adequately funded, including exploratory research activities in both the “basic” and “applied” research programs and efforts in renewably generated hydrogen. Funding for hydrogen delivery and for longer-term hydrogen production efforts has been too low and should be increased. More funding is needed for activities directed towards overcoming market barriers (such as education, training, development of codes and standards, technology validation, and early adoption provisions such as those called for by sections 782 and 783 of EPACT). Specifically, the Committee supports funding a federal procurement program for stationary, portable and micro fuel cells at \$20 million in the first year for a total of \$345 million for a 5 year program as authorized in EPACT. The Committee also supports financial and regulatory incentives (inclusive of current tax credits) at the federal level for both fuel cell and hydrogen systems. The Committee urges stability in funding provided for basic and applied research, since consistent commitment and resources are needed to foster innovation and a vibrant, active scientific community and to keep researchers in universities, national labs, and industry labs engaged and committed to projects. The Committee strongly opposes earmarking of the hydrogen budget and finds that this has had a negative effect on the program. The Committee supports unencumbered budgets that allow the Secretary to allocate funding in accordance with the program's well-considered plans and priorities.

- **The Committee believes that national policies will be necessary to overcome market barriers to hydrogen and fuel cell systems during the transition period, and supports the development and passage of policies directed towards overcoming these barriers.**

There are significant economic and institutional barriers that inhibit or prevent hydrogen and fuel cells systems from moving from the technology readiness phase into consumer markets and widespread commercialization. Policies and incentives will be needed to enable these technologies to compete with conventional fuels and technologies. The Committee supports development of policies and incentives that help to overcome barriers to public acceptance and market entry. For instance, the lack of a track record with hydrogen limits the availability of reasonably priced insurance from commercial insurance providers; a program to provide coverage during the transition period would facilitate infrastructure formation. These policies should be designed to generate “market pull” rather than “technology push” and should provide consistent support throughout the transition period, after which the policies should phase down and expire. In addition, longer term incentive programs are needed to provide certainty for suppliers, investors, manufacturers and customers to maximize the benefits of such initiatives.

- **The Committee is pleased with the DOE Hydrogen Program's use of best management practices such as peer review in its solicitation processes, assessment of technical progress, individual project selection and monitoring, and overall program management.**

The Hydrogen Program activities are conducted to ensure quality, relevance, and leadership in the appropriate scientific and technical areas.

## **II. Safety, Economical, and Environmental Consequences of Technologies for the Production, Distribution, Delivery, Storage or Use of Hydrogen and Fuel Cells**

- **The Committee recommends that DOE continue the Technology Validation activity for fuel cell vehicle and fueling infrastructure technologies and capture the synergistic benefits that would be accrued by providing additional funding for demonstrations of fleet, stationary and portable power applications.**

The Committee finds that the learning demonstrations being cost-shared by DOE through the Technology Validation activity have been extremely valuable in providing real-world data to test and validate the safety, performance, reliability, operating costs, and efficiency of fuel cell vehicles and fueling stations. Given the technology lead times involved, it is critical that the validation effort be continued beyond FY 2008 to evaluate the status of next-generation technologies and continue to develop a credible database of real-world performance and reliability. Deployment of additional vehicles in a variety of geographic regions will help to improve the statistical significance of the data and to provide information critical for codes and standards development and insurance underwriting. Fleet, stationary, and portable power applications are closer to commercialization and less dependent on large-scale infrastructure development than other applications such as private vehicle operation. The addition of these demonstrations can validate these nearer-term technologies in public settings, contribute information to the safety and performance database, and accelerate manufacturing of components and systems, thereby accelerating commercialization. Further, the Committee believes that a like program for stationary power generation fuel cells (both distributed and central station) should be expanded. It is possible that such a program could be part of a federal procurement program, which provides some amount of cost share for the deployment of fuel cell systems throughout the federal government for a variety of stationary, portable and transportation applications.

## **III. Plan Called for under Section 804 of the Energy Policy Act of 2005**

The HTAC reviewed the December 2006 *Hydrogen Posture Plan* submitted to Congress in response to section 804 of EPACT. In general, the Committee found the Posture Plan to be well thought out and comprehensive. The Plan addresses each of the five points called for in section 804 of EPACT; however, a number of gaps were identified which the Committee recommends addressing in the next version of the Posture Plan. The Committee defers detailed comment on the technical program, including specific comments on the five-year plan and milestones, to the statutory committees created for external technical program review (these are being conducted

every four years by the National Academies, in accordance with section 811 of EPACT, or more often in some areas like FreedomCAR). Some HTAC members are also members of the National Academies' technical review panels. The HTAC will use the reports generated by the Academies, other advisory committees, and other relevant external review committees in its own deliberations.

#### **A. Positive Features of the 2006 Hydrogen Posture Plan**

- The Committee supports the Plan's approach to foster diversity of hydrogen supply pathways to ensure a broad domestic resource base for hydrogen production that includes renewable energy, fossil energy, and nuclear energy resources.
- The Committee commends the Plan's allocation of a large percentage of the research and development budget to activities at the component level, and we urge that these development activities be conducted in the context of systems and applications analysis.
- The Committee is pleased to see that the Posture Plan specifically addresses each of the five technical areas called for in the basic science solicitations (novel materials for hydrogen storage; membranes for separation, purification, and ion transport; design of catalysts at the nanoscale; solar hydrogen production; and bio-inspired materials and processes).
- The Committee finds that the current Posture Plan does a good job of connecting technology objectives with market value; aligning the research program with technical gaps; involving industry partners; aligning with national objectives to reduce dependency on foreign oil and to reduce the impact of the energy sector on the environment; recognizing the full "technology development" timeline; and continuing to provide a focus on critical work in codes and standards and communication.

#### **B. Gaps and Areas for Improvement in the 2006 Posture Plan**

- **The Posture Plan should more fully describe the market risks associated with developing hydrogen as an energy carrier.**  
A complete understanding of the risks and benefits is essential to create an understanding of why it is important to pursue hydrogen as an energy carrier and why the government needs to be involved. Hydrogen and fuel cells have the potential to address the nationally important issues of energy security, environmental quality, carbon emissions reductions, and global technology competitiveness. The risks, including technical performance, cost-competitiveness, fueling infrastructure development, market acceptance, and regulatory roadblocks, create the need for government risk-sharing throughout the research, development, and technology deployment timeline and lay the groundwork for the federal role.
- **The Posture Plan needs to better define the government role in commercialization.**

The Posture Plan does a very good job of describing the research and development plan for reaching the 2015 goal of “technology readiness.” It is the Committee’s opinion that a strong government role is needed beyond this point, to foster public acceptance and market entry of hydrogen and fuel cell technologies. Because the risks are high and the benefits are large, there is justification for a government role in helping industry move from technology development to market acceptance (known as the “valley of death” or “crossing the chasm” created by lengthy lead time between significant investment outlays, manufacturing and fueling infrastructure and the recovery of that investment). Increasing the level of R&D on portable and stationary power systems in the Plan would reduce the technical and market risks associated with longer-term applications in the transportation sector. The Posture Plan should include a discussion of DOE’s role in overcoming market barriers. This role should be complementary to research and development, and synchronous with industry’s efforts to move technologies into end-use applications and the consumer marketplace; this role should go beyond support for demonstrations and include needed policy initiatives. The DOE should initiate a market transformation program that allows federal agencies to apply for cost shared dollars to pay the incremental cost of fuel cell technologies as a transition strategy. The DOE should support fuel cell and appropriate financial and regulatory incentives (inclusive of current tax credits) for fuel cells and hydrogen systems.

- **The Posture Plan needs to present a broader vision of how hydrogen fits into the overall energy strategy for the United States, and convey the message that hydrogen will be a key part of the energy mix, which will include an array of advanced technologies using energy derived from fossil, nuclear, and the various renewable resources.**

The Committee strongly believes that achieving the goal of energy security in a carbon-constrained world while maintaining economic competitiveness will require that we draw on multiple energy resources and technologies. Conventional hydrocarbons will remain important energy resources for traditional end uses and for the production of hydrogen for at least two or three more decades. Nuclear energy will also have a role in providing stationary power and, potentially, in producing hydrogen. A long-term goal is to increase the use of renewable resources to produce hydrogen in the future. The Committee believes that hydrogen and fuel cells can play a very important role in reducing oil consumption and “de-carbonizing” the transportation sector, since hydrogen can be produced from any primary energy source and fuel cells are one of the few technologies that offer the potential for zero-emissions vehicles. The Posture Plan should present a balanced R&D program that focuses on near-term technologies for the transition, development of renewable resources and other long-term technologies for maximum impact; this will ensure that the “pipeline” is charged to work towards the ultimate goals of eliminating dependence on oil imports, diversifying energy sources, improving environmental quality, and greatly reducing carbon emissions.

- **The Posture Plan needs to expand its scope beyond the current focus on transportation to include stationary and portable fuel cell power applications.** The Committee understands that the Posture Plan was directed toward the DOE goal of reducing oil consumption, which is strongly linked to the transportation sector and well aligned with section 802 Purposes three and four. DOE has established five strategic



themes including “promoting America’s energy security through reliable, clean, and affordable energy,” consistent with the Purpose five. Commercialization of stationary and portable fuel cells supports this objective and can play a key role in ensuring reliable, high quality power, especially for critical infrastructure which is vital to our nation’s energy security. The Committee therefore recommends that the Plan provide more emphasis on portable and stationary power applications and the role that these technologies can play in enhancing electric grid reliability, addressing air quality and climate change concerns, developing early markets, consumer acceptance, component manufacturing capabilities, codes and standards, and early hydrogen production infrastructure. This recommendation is consistent with section 805, which directs the program to “demonstrate and commercialize the use of hydrogen for transportation (in light duty and heavy duty vehicles), utility, industrial, commercial, and residential applications.”

- **The Posture Plan should articulate a plan for a DOE leadership role through the Interagency Task Force in coordinating the multiple branches of government and rulemaking organizations in order to harmonize and expedite efforts to develop consistent codes and standards, which are needed to commercialize hydrogen and fuel cell technologies.**

The Committee believes that the pathway to commercialization of hydrogen and fuel cells would be greatly accelerated by uniform and rapid adoption by all governmental jurisdictions of consistent requirements for portable devices and hydrogen installations, including stationary power and fueling stations. Initial provisions for hydrogen in existing Codes and associated product Standards have been developed, but they have not yet been drawn into State and local regulations nor into training programs for permitting authorities; and they are not consistently applied. High priority should be given to educational programs for permitting officials and emergency responders who are not yet familiar with these new hydrogen provisions. In addition, revision of those provisions must be supported to accommodate new hydrogen technologies and high priority must be given to programs focused on the evaluation of their safety and demonstration of their safe operation to support revision of the existing requirements. For many portable hydrogen-fueled devices, the constraint of federal regulations limits the ability to transport them or travel with them (especially air travel) and presents a clear barrier to market acceptance. Internationally, the harmonization of requirements for both stationary and mobile applications should be a high priority, so that companies in the United States are able to move forward with commercialization plans and are not hindered in their efforts to compete globally by non-tariff trade barriers.

- **The challenges and costs associated with off-board storage and hydrogen delivery should be more fully described, and the budget for the Delivery sub-program should be shown separately from the Production sub-program.**

The importance of off-board storage and hydrogen delivery is under-emphasized in the Posture Plan. For centralized production facilities, the costs associated with transporting hydrogen from its point of production to its point of use can contribute heavily to the delivered cost of hydrogen and can have a big impact on how the infrastructure could evolve. Similarly, both for central and distributed production, the cost of storage at the

fueling station and the hardware for dispensing the hydrogen to vehicles must be addressed. The Committee believes it is important to more fully describe the challenges that need to be addressed, the plan for addressing the challenges, and the budget that is provided for hydrogen delivery.

- **The next version of the Posture Plan should reflect improved “well-to-wheels” analyses that depict the impact of each of the hydrogen pathways on the goals to reduce oil imports and our carbon footprint. The assumptions and results of these analyses should be corroborated with other, similar independent analyses. The carbon analyses should be expanded to include biofuels pathways and stationary power applications.**

The “well-to-wheels” analyses included in Appendix B of the Posture Plan are very good. However, the Committee notes some discrepancies between the costs and assumptions used in the DOE analyses and those used in similar analyses conducted by the National Academy of Science and DOE’s Fossil Energy Program, and the assumptions that led to the results should be clarified. The Committee would also like to see well-to-wheels analyses for *all* hydrogen pathways receiving funding from DOE (including biofuels pathways and stationary power applications). To the extent possible, the analyses should include synergies among the different pathways that would improve the efficiency or reduce the cost of the pathways. A similar analysis also should be done for stationary systems. We need to always do this in order to both reduce carbon emissions and to increase efficiency. Such an analysis in the stationary power sector will lead to a more distributed energy system in which waste heat allows for significant efficient improvements.

- **The Posture Plan should include analysis of strategies that evaluate the potential for reducing carbon emissions and oil imports through the development of a hydrogen economy.**

The Committee recommends analyses that use dynamic transition models, coupled with macroeconomic models for the United States and the world, that enable assessments of the relative benefits of these strategies to guide the program. The Committee would be pleased to provide guidance on strategy development. Such analyses should be presented in a way that clarifies the magnitude and timing of environmental impacts and oil imports through the development and implementation of a hydrogen economy under different pathways.

- **The Posture Plan should articulate a process for down-selecting pathways or for directing applied research efforts back to exploratory research efforts when these pathways encounter roadblocks that require major breakthroughs to resolve. This process should include go/no-go decision points and be consistent with the techno-economic progress of the pathways and the potential for the pathways to contribute to reducing oil consumption and carbon emissions in a cost-effective manner.**

The Committee suggests the use of “net-present-value” analysis, among other financial assessment techniques, especially for near-term technologies, to help guide research and select priorities in times of budget shortfalls.

- **The Posture Plan should give stronger emphasis to the importance of general human aspects—including developing a sufficient knowledge-base—that will be needed to sustain the growth, use, and maintenance of hydrogen and fuel cell technologies and infrastructure.**

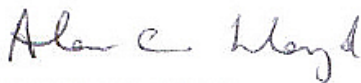
While the Plan does address the need for education and outreach activities, this discussion should be given greater emphasis. It should reflect the large magnitude of the task of educating all parties involved in the widespread adoption of new technologies. This discussion should address the following critical areas: (1) developing the necessary level of understanding among government officials (including safety, code, and zoning officials); (2) establishing a sufficient talent-base to supply the necessary technical workforce; (3) conducting education programs at all levels (K-12, trade schools, and universities); (4) developing the knowledge-base needed for a supply-chain infrastructure; and (5) and providing sufficient, broad-based education to allow for consumer understanding and acceptance.

- **The Posture Plan recognizes that manufacturing challenges are a significant problem for the commercialization of fuel cells, since high manufacturing yields at affordable costs are needed to make the economics viable. The Program’s manufacturing activity was only recently begun and should receive significant and continuous support.**

Members also recognize that work in this area will be quite costly and a challenge to conduct in parallel with technology R&D.

We thank you for the opportunity to serve on the Hydrogen and Fuel Cell Technical Advisory Committee and for the dialogue opportunities that you have provided to the Committee. Open and forthright communications will allow us to better serve the Department, as we strive together to enhance national energy security. Please do not hesitate to contact us with questions on these recommendations.

Sincerely,



Dr. Alan C. Lloyd  
HTAC Chair (2006-2007)  
and  
President  
International Council on Clean  
Transportation



Honorable Robert S. Walker  
HTAC Vice-Chair (2006-2007)  
and  
Chairman  
Wexler & Walker Public Policy  
Associates

**Attachments:**

1. HTAC Charter
2. Title VIII, Hydrogen, 2005 Energy Policy Act
3. HTAC Members
4. Hydrogen Posture Plan, Executive Summary, U.S. Department of Energy, December 2006. (Note: full plan can be found at [http://www.hydrogen.energy.gov/pdfs/hydrogen\\_posture\\_plan\\_dec06.pdf](http://www.hydrogen.energy.gov/pdfs/hydrogen_posture_plan_dec06.pdf))
5. November 12, 2006 HTAC letter to Secretary Bodman with its Resolution on the Interagency Task Force

cc: Distribution List

## Distribution List

\* denotes member present at the HTAC Letter Report approval meeting of July 31<sup>st</sup>/August 1<sup>st</sup>

### **HTAC Members (July 2006 – present)**

- \*Larry R. Bawden, President and CEO, Jadoo Power Systems
- \*John S. Bresland, Member of U. S. Chemical Safety Board
- \*Mark Chernoby, V.P., Advanced Vehicle Engineering, Chrysler Group Business Unit, DaimlerChrysler
- \*Mildred Dresselhaus, Institute Professor, Massachusetts Institute of Technology
- David J. Friedman, Research Director, Clean Vehicles Program, Union of Concerned Scientists
- \*John D. Hofmeister, President and U.S. Country Chair, Shell Oil Company
- \*Arthur T. Katsaros, Group V.P., Development and Technology, Air Products & Chemicals, Inc. (retired)
- Dan R. Keuter, V.P., Business Development, Entergy Nuclear, Inc.
- \*J. Byron McCormick, Executive Director, GM Global Fuel Cell Activities, General Motors Corp.
- Michael J. Mudd, CEO, FutureGen Alliance, Inc. and Technology Development Manager, American Electric Power, Inc.
- \*Randall W. Napoli, Director, Florida Division of State Fire Marshal (retired)
- \*Ian C. Purtle, Corporate VP, Director of Process Solutions Technology Development Center, Cargill, Inc.
- Michael P. Ramage, Executive VP, ExxonMobil Research and Engineering (retired)
- Geraldine L. Richmond, Noyes Professor of Chemistry, University of Oregon
- \*Roger B. Saillant, President and CEO, Plug Power Inc.
- \*Robert W. Shaw, President, Aretê Corporation
- Kathleen Taylor, Director of Materials Processing Laboratory, General Motors Research and Planning (retired)
- \*Jan van Dokkum, President, UTC Power
- \*Gregory M. Vesey, President, Chevron Global Power Generation
- \*John M. Wootten, Environment and Technology, V.P., Peabody Energy (retired)

### **New Members (July 2007)**

- Robert R. Rose, Executive Director, U.S. Fuel Cell Council
- Philip Ross, Senior Scientist, Lawrence Berkeley National Laboratory (retired)
- Gerhard Schmidt, Vice President, Research and Advanced Engineering, Ford Motor Co.

### **Past Members (July 2006-June 2007)**

- Uma Chowdhry, Senior V.P. & Chief Technology Officer, DuPont
- James Reinsch, Senior Vice President, Bechtel Power
- J. Craig Venter, J. Craig Venter Institute, Founder and President

## **Federal Government**

### **U.S. Department of Energy**

#### Office of Energy Efficiency and Renewable Energy:

- Alexander Karsner, Assistant Secretary
- Steven Chalk, Deputy Assistant Secretary for Renewable Energy
- JoAnn Milliken, Program Manager, Hydrogen, Fuel Cells & Infrastructure Technologies (HFCIT)
- Kathi Epping, Designated Federal Officer for HTAC

#### Office of Fossil Energy:

- C. Lowell Miller, Director, Office of Sequestration, Hydrogen & Clean Coal Fuels

#### Office of Nuclear Energy:

- Carl Sink, Program Manager, Nuclear Hydrogen Initiative

#### Office of Science, Basic Energy Sciences (BES):

- Pat Dehmer, Director, Office of Basic Energy Sciences

### **U.S. Department of Transportation**

- William Chericoff, Research and Innovative Technology Administration



## DEPARTMENT OF ENERGY

### Charter

### Hydrogen and Fuel Cell Technical Advisory Committee

1. Committee's Official Designation:

Hydrogen and Fuel Cell Technical Advisory Committee (HTAC, the Committee)

2. Committee's Objectives and Scope of Activities and Duties:

To provide advice to the Secretary on the program authorized by Title VIII, Hydrogen ("Spark M. Matsunaga Hydrogen Act of 2005"), of the Energy Policy Act of 2005, Public Law No.109-58.

The Committee's scope will be to review and make recommendations to the Secretary on (1) the implementation of programs and activities under the Spark M. Matsunaga Hydrogen Act of 2005; (2) the safety, economical, and environmental consequences of technologies for the production, distribution, delivery, storage, or use of hydrogen energy and fuel cells; and (3) the plan under section 804 of the Spark M. Matsunaga Hydrogen Act of 2005.

3. Time Period Necessary for the Committee to Carry Out Its Purpose:

The Committee is expected to be continuing in nature, as set forth in section 805 of the Spark M. Matsunaga Hydrogen Act of 2005.

4. Official To Whom This Committee Reports:

The Committee reports to the Secretary of Energy (Secretary) through the Assistant Secretary for Energy Efficiency and Renewable Energy (EERE). The Hydrogen, Fuel Cells and Infrastructure Technologies Program under the Office of EERE is responsible for coordinating the Committee's activities throughout the Department.

5. Agency Responsible for Providing Necessary Support for This Committee:

The Department of Energy's (DOE's) Hydrogen Program is responsible for providing support to the Committee. DOE's Hydrogen Program includes activities within the Office of EERE, the Office of Science, the Office of Fossil Energy, and the Office of Nuclear Energy, Science and Technology.

6. A Description of Duties for Which the Committee Is Responsible:

The duties of the Committee are solely advisory and are stated in Paragraph 2 above. The Secretary's Biennial Report as required by section 807(d)(2) of the Spark M. Matsunaga Hydrogen Act of 2005 shall describe any recommendations made by the Committee since the last report. The Secretary will consider, but need not adopt, any recommendations of the Committee.

7. Estimated Annual Operating Costs in Dollars and Person-Years:

The estimated annual operating cost of direct support to the Committee and its subcommittees is \$250,000, inclusive of 0.7 person-year for support.

8. Estimated Number and Frequency of Committee Meetings:

The Committee will meet at the call of the Designated Federal Officer, approximately twice a year. Subcommittees to address specific agenda items are anticipated and may meet more frequently.

9. Committee's Termination Date (if Less than 2 years from the Date of Establishment or Renewal):

Not Applicable.

10. Subcommittees:

The Committee will form subcommittees as it deems necessary.

11. Members:

The Secretary will appoint the Committee members. Membership will range from 12 to 25 persons. Members shall be experts in their respective fields or representatives of entities including domestic industry, academia, professional societies, government agencies, Federal laboratories, previous advisory panels, and financial, environmental, and other appropriate organizations based on the Department's assessment of the technical and other qualifications of the Committee's members and the needs of the Committee. Committee members will serve for a term of 3 years or less, and may be reappointed for a second successive term. Appointments may be made in a manner that allows the terms of the members serving at any time to expire at spaced intervals so as to ensure continuity in the functioning of the Committee.



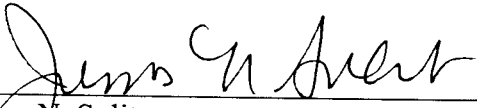
12. Chairperson:

The Chairperson will be elected by the Committee members from among their number. The Chairperson will serve a 2-year term and may be reappointed for an additional term.

This Charter for the Advisory Committee named above is hereby approved on:

6/12/06

Date:

  
\_\_\_\_\_  
James N. Solit  
Advisory Committee Management Officer

Date Filed:

JUN 12 2006



H. R. 6

# One Hundred Ninth Congress of the United States of America

AT THE FIRST SESSION

*Begun and held at the City of Washington on Tuesday,  
the fourth day of January, two thousand and five*

## An Act

To ensure jobs for our future with secure, affordable, and reliable energy.

*Be it enacted by the Senate and House of Representatives of  
the United States of America in Congress assembled,*

### SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the “Energy Policy Act of 2005”.

(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

Sec. 1. Short title; table of contents.

#### TITLE I—ENERGY EFFICIENCY

##### Subtitle A—Federal Programs

- Sec. 101. Energy and water saving measures in congressional buildings.
- Sec. 102. Energy management requirements.
- Sec. 103. Energy use measurement and accountability.
- Sec. 104. Procurement of energy efficient products.
- Sec. 105. Energy savings performance contracts.
- Sec. 106. Voluntary commitments to reduce industrial energy intensity.
- Sec. 107. Advanced Building Efficiency Testbed.
- Sec. 108. Increased use of recovered mineral component in federally funded projects involving procurement of cement or concrete.
- Sec. 109. Federal building performance standards.
- Sec. 110. Daylight savings.
- Sec. 111. Enhancing energy efficiency in management of Federal lands.

##### Subtitle B—Energy Assistance and State Programs

- Sec. 121. Low-income home energy assistance program.
- Sec. 122. Weatherization assistance.
- Sec. 123. State energy programs.
- Sec. 124. Energy efficient appliance rebate programs.
- Sec. 125. Energy efficient public buildings.
- Sec. 126. Low income community energy efficiency pilot program.
- Sec. 127. State Technologies Advancement Collaborative.
- Sec. 128. State building energy efficiency codes incentives.

##### Subtitle C—Energy Efficient Products

- Sec. 131. Energy Star program.
- Sec. 132. HVAC maintenance consumer education program.
- Sec. 133. Public energy education program.
- Sec. 134. Energy efficiency public information initiative.
- Sec. 135. Energy conservation standards for additional products.
- Sec. 136. Energy conservation standards for commercial equipment.
- Sec. 137. Energy labeling.
- Sec. 138. Intermittent escalator study.
- Sec. 139. Energy efficient electric and natural gas utilities study.
- Sec. 140. Energy efficiency pilot program.
- Sec. 141. Report on failure to comply with deadlines for new or revised energy conservation standards.

##### Subtitle D—Public Housing

- Sec. 151. Public housing capital fund.

H. R. 6—6

Sec. 783. Federal procurement of stationary, portable, and micro fuel cells.

Subtitle G—Diesel Emissions Reduction

Sec. 791. Definitions.  
Sec. 792. National grant and loan programs.  
Sec. 793. State grant and loan programs.  
Sec. 794. Evaluation and report.  
Sec. 795. Outreach and incentives.  
Sec. 796. Effect of subtitle.  
Sec. 797. Authorization of appropriations.

TITLE VIII—HYDROGEN

Sec. 801. Hydrogen and fuel cell program.  
Sec. 802. Purposes.  
Sec. 803. Definitions.  
Sec. 804. Plan.  
Sec. 805. Programs.  
Sec. 806. Hydrogen and Fuel Cell Technical Task Force.  
Sec. 807. Technical Advisory Committee.  
Sec. 808. Demonstration.  
Sec. 809. Codes and standards.  
Sec. 810. Disclosure.  
Sec. 811. Reports.  
Sec. 812. Solar and wind technologies.  
Sec. 813. Technology transfer.  
Sec. 814. Miscellaneous provisions.  
Sec. 815. Cost sharing.  
Sec. 816. Savings clause.

TITLE IX—RESEARCH AND DEVELOPMENT

Sec. 901. Short title.  
Sec. 902. Goals.  
Sec. 903. Definitions.

Subtitle A—Energy Efficiency

Sec. 911. Energy efficiency.  
Sec. 912. Next Generation Lighting Initiative.  
Sec. 913. National Building Performance Initiative.  
Sec. 914. Building standards.  
Sec. 915. Secondary electric vehicle battery use program.  
Sec. 916. Energy Efficiency Science Initiative.  
Sec. 917. Advanced Energy Efficiency Technology Transfer Centers.

Subtitle B—Distributed Energy and Electric Energy Systems

Sec. 921. Distributed energy and electric energy systems.  
Sec. 922. High power density industry program.  
Sec. 923. Micro-cogeneration energy technology.  
Sec. 924. Distributed energy technology demonstration programs.  
Sec. 925. Electric transmission and distribution programs.

Subtitle C—Renewable Energy

Sec. 931. Renewable energy.  
Sec. 932. Bioenergy program.  
Sec. 933. Low-cost renewable hydrogen and infrastructure for vehicle propulsion.  
Sec. 934. Concentrating solar power research program.  
Sec. 935. Renewable energy in public buildings.

Subtitle D—Agricultural Biomass Research and Development Programs

Sec. 941. Amendments to the Biomass Research and Development Act of 2000.  
Sec. 942. Production incentives for cellulosic biofuels.  
Sec. 943. Procurement of biobased products.  
Sec. 944. Small business bioproduct marketing and certification grants.  
Sec. 945. Regional bioeconomy development grants.  
Sec. 946. Preprocessing and harvesting demonstration grants.  
Sec. 947. Education and outreach.  
Sec. 948. Reports.

Subtitle E—Nuclear Energy

Sec. 951. Nuclear energy.  
Sec. 952. Nuclear energy research programs.

H. R. 6—251

shall inform foreign countries with air quality problems of the potential of technology developed or used in the United States to provide emission reductions in those countries.

**SEC. 796. EFFECT OF SUBTITLE.**

Nothing in this subtitle affects any authority under the Clean Air Act (42 U.S.C. 7401 et seq.) in existence on the day before the date of enactment of this Act.

**SEC. 797. AUTHORIZATION OF APPROPRIATIONS.**

There is authorized to be appropriated to carry out this subtitle \$200,000,000 for each of fiscal years 2007 through 2011, to remain available until expended.

## **TITLE VIII—HYDROGEN**

**SEC. 801. HYDROGEN AND FUEL CELL PROGRAM.**

This title may be cited as the “Spark M. Matsunaga Hydrogen Act of 2005”.

**SEC. 802. PURPOSES.**

The purposes of this title are—

(1) to enable and promote comprehensive development, demonstration, and commercialization of hydrogen and fuel cell technology in partnership with industry;

(2) to make critical public investments in building strong links to private industry, institutions of higher education, National Laboratories, and research institutions to expand innovation and industrial growth;

(3) to build a mature hydrogen economy that creates fuel diversity in the massive transportation sector of the United States;

(4) to sharply decrease the dependency of the United States on imported oil, eliminate most emissions from the transportation sector, and greatly enhance our energy security; and

(5) to create, strengthen, and protect a sustainable national energy economy.

**SEC. 803. DEFINITIONS.**

In this title:

(1) **FUEL CELL.**—The term “fuel cell” means a device that directly converts the chemical energy of a fuel, which is supplied from an external source, and an oxidant into electricity by electrochemical processes occurring at separate electrodes in the device.

(2) **HEAVY-DUTY VEHICLE.**—The term “heavy-duty vehicle” means a motor vehicle that—

(A) is rated at more than 8,500 pounds gross vehicle weight;

(B) has a curb weight of more than 6,000 pounds;

or

(C) has a basic vehicle frontal area in excess of 45 square feet.

(3) **INFRASTRUCTURE.**—The term “infrastructure” means the equipment, systems, or facilities used to produce, distribute, deliver, or store hydrogen (except for onboard storage).

H. R. 6—252

(4) **LIGHT-DUTY VEHICLE.**—The term “light-duty vehicle” means a motor vehicle that is rated at 8,500 or less pounds gross vehicle weight.

(5) **STATIONARY; PORTABLE.**—The terms “stationary” and “portable”, when used in reference to a fuel cell, include—

(A) continuous electric power; and

(B) backup electric power.

(6) **TASK FORCE.**—The term “Task Force” means the Hydrogen and Fuel Cell Technical Task Force established under section 806.

(7) **TECHNICAL ADVISORY COMMITTEE.**—The term “Technical Advisory Committee” means the independent Technical Advisory Committee established under section 807.

**SEC. 804. PLAN.**

Not later than 6 months after the date of enactment of this Act, the Secretary shall transmit to Congress a coordinated plan for the programs described in this title and any other programs of the Department that are directly related to fuel cells or hydrogen. The plan shall describe, at a minimum—

(1) the agenda for the next 5 years for the programs authorized under this title, including the agenda for each activity enumerated in section 805(e);

(2) the types of entities that will carry out the activities under this title and what role each entity is expected to play;

(3) the milestones that will be used to evaluate the programs for the next 5 years;

(4) the most significant technical and nontechnical hurdles that stand in the way of achieving the goals described in section 805, and how the programs will address those hurdles; and

(5) the policy assumptions that are implicit in the plan, including any assumptions that would affect the sources of hydrogen or the marketability of hydrogen-related products.

**SEC. 805. PROGRAMS.**

(a) **IN GENERAL.**—The Secretary, in consultation with other Federal agencies and the private sector, shall conduct a research and development program on technologies relating to the production, purification, distribution, storage, and use of hydrogen energy, fuel cells, and related infrastructure.

(b) **GOAL.**—The goal of the program shall be to demonstrate and commercialize the use of hydrogen for transportation (in light-duty vehicles and heavy-duty vehicles), utility, industrial, commercial, and residential applications.

(c) **FOCUS.**—In carrying out activities under this section, the Secretary shall focus on factors that are common to the development of hydrogen infrastructure and the supply of vehicle and electric power for critical consumer and commercial applications, and that achieve continuous technical evolution and cost reduction, particularly for hydrogen production, the supply of hydrogen, storage of hydrogen, and end uses of hydrogen that—

(1) steadily increase production, distribution, and end use efficiency and reduce life-cycle emissions;

(2) resolve critical problems relating to catalysts, membranes, storage, lightweight materials, electronic controls, manufacturability, and other problems that emerge from the program;

H. R. 6—253

(3) enhance sources of renewable fuels and biofuels for hydrogen production; and

(4) enable widespread use of distributed electricity generation and storage.

(d) PUBLIC EDUCATION AND RESEARCH.—In carrying out this section, the Secretary shall support enhanced public education and research conducted at institutions of higher education in fundamental sciences, application design, and systems concepts (including education and research relating to materials, subsystems, manufacturability, maintenance, and safety) relating to hydrogen and fuel cells.

(e) ACTIVITIES.—The Secretary, in partnership with the private sector, shall conduct programs to address—

(1) production of hydrogen from diverse energy sources, including—

(A) fossil fuels, which may include carbon capture and sequestration;

(B) hydrogen-carrier fuels (including ethanol and methanol);

(C) renewable energy resources, including biomass; and

(D) nuclear energy;

(2) use of hydrogen for commercial, industrial, and residential electric power generation;

(3) safe delivery of hydrogen or hydrogen-carrier fuels, including—

(A) transmission by pipeline and other distribution methods; and

(B) convenient and economic refueling of vehicles either at central refueling stations or through distributed onsite generation;

(4) advanced vehicle technologies, including—

(A) engine and emission control systems;

(B) energy storage, electric propulsion, and hybrid systems;

(C) automotive materials; and

(D) other advanced vehicle technologies;

(5) storage of hydrogen or hydrogen-carrier fuels, including development of materials for safe and economic storage in gaseous, liquid, or solid form at refueling facilities and onboard vehicles;

(6) development of safe, durable, affordable, and efficient fuel cells, including fuel-flexible fuel cell power systems, improved manufacturing processes, high-temperature membranes, cost-effective fuel processing for natural gas, fuel cell stack and system reliability, low temperature operation, and cold start capability; and

(7) the ability of domestic automobile manufacturers to manufacture commercially available competitive hybrid vehicle technologies in the United States.

(f) PROGRAM GOALS.—

(1) VEHICLES.—For vehicles, the goals of the program are—

(A) to enable a commitment by automakers no later than year 2015 to offer safe, affordable, and technically viable hydrogen fuel cell vehicles in the mass consumer market; and

(B) to enable production, delivery, and acceptance by consumers of model year 2020 hydrogen fuel cell and other

H. R. 6—254

hydrogen-powered vehicles that will have, when compared to light duty vehicles in model year 2005—

- (i) fuel economy that is substantially higher;
  - (ii) substantially lower emissions of air pollutants;
- and
- (iii) equivalent or improved vehicle fuel system crash integrity and occupant protection.

(2) HYDROGEN ENERGY AND ENERGY INFRASTRUCTURE.—For hydrogen energy and energy infrastructure, the goals of the program are to enable a commitment not later than 2015 that will lead to infrastructure by 2020 that will provide—

- (A) safe and convenient refueling;
- (B) improved overall efficiency;
- (C) widespread availability of hydrogen from domestic energy sources through—
  - (i) production, with consideration of emissions levels;
  - (ii) delivery, including transmission by pipeline and other distribution methods for hydrogen; and
  - (iii) storage, including storage in surface transportation vehicles;
- (D) hydrogen for fuel cells, internal combustion engines, and other energy conversion devices for portable, stationary, micro, critical needs facilities, and transportation applications; and

(E) other technologies consistent with the Department's plan.

(3) FUEL CELLS.—The goals for fuel cells and their portable, stationary, and transportation applications are to enable—

- (A) safe, economical, and environmentally sound hydrogen fuel cells;
- (B) fuel cells for light duty and other vehicles; and
- (C) other technologies consistent with the Department's plan.

(g) FUNDING.—

(1) IN GENERAL.—The Secretary shall carry out the programs under this section using a competitive, merit-based review process and consistent with the generally applicable Federal laws and regulations governing awards of financial assistance, contracts, or other agreements.

(2) RESEARCH CENTERS.—Activities under this section may be carried out by funding nationally recognized university-based or Federal laboratory research centers.

(h) HYDROGEN SUPPLY.—There are authorized to be appropriated to carry out projects and activities relating to hydrogen production, storage, distribution and dispensing, transport, education and coordination, and technology transfer under this section—

- (1) \$160,000,000 for fiscal year 2006;
- (2) \$200,000,000 for fiscal year 2007;
- (3) \$220,000,000 for fiscal year 2008;
- (4) \$230,000,000 for fiscal year 2009;
- (5) \$250,000,000 for fiscal year 2010; and
- (6) such sums as are necessary for each of fiscal years 2011 through 2020.



H. R. 6—255

(i) **FUEL CELL TECHNOLOGIES.**—There are authorized to be appropriated to carry out projects and activities relating to fuel cell technologies under this section—

- (1) \$150,000,000 for fiscal year 2006;
- (2) \$160,000,000 for fiscal year 2007;
- (3) \$170,000,000 for fiscal year 2008;
- (4) \$180,000,000 for fiscal year 2009;
- (5) \$200,000,000 for fiscal year 2010; and
- (6) such sums as are necessary for each of fiscal years 2011 through 2020.

**SEC. 806. HYDROGEN AND FUEL CELL TECHNICAL TASK FORCE.**

(a) **ESTABLISHMENT.**—Not later than 120 days after the date of enactment of this Act, the President shall establish an inter-agency task force chaired by the Secretary with representatives from each of the following:

- (1) The Office of Science and Technology Policy within the Executive Office of the President.
- (2) The Department of Transportation.
- (3) The Department of Defense.
- (4) The Department of Commerce (including the National Institute of Standards and Technology).
- (5) The Department of State.
- (6) The Environmental Protection Agency.
- (7) The National Aeronautics and Space Administration.
- (8) Other Federal agencies as the Secretary determines appropriate.

(b) **DUTIES.**—

(1) **PLANNING.**—The Task Force shall work toward—

(A) a safe, economical, and environmentally sound fuel infrastructure for hydrogen and hydrogen-carrier fuels, including an infrastructure that supports buses and other fleet transportation;

(B) fuel cells in government and other applications, including portable, stationary, and transportation applications;

(C) distributed power generation, including the generation of combined heat, power, and clean fuels including hydrogen;

(D) uniform hydrogen codes, standards, and safety protocols; and

(E) vehicle hydrogen fuel system integrity safety performance.

(2) **ACTIVITIES.**—The Task Force may organize workshops and conferences, may issue publications, and may create databases to carry out its duties. The Task Force shall—

(A) foster the exchange of generic, nonproprietary information and technology among industry, academia, and government;

(B) develop and maintain an inventory and assessment of hydrogen, fuel cells, and other advanced technologies, including the commercial capability of each technology for the economic and environmentally safe production, distribution, delivery, storage, and use of hydrogen;

(C) integrate technical and other information made available as a result of the programs and activities under this title;

H. R. 6—256

(D) promote the marketplace introduction of infrastructure for hydrogen fuel vehicles; and

(E) conduct an education program to provide hydrogen and fuel cell information to potential end-users.

(c) AGENCY COOPERATION.—The heads of all agencies, including those whose agencies are not represented on the Task Force, shall cooperate with and furnish information to the Task Force, the Technical Advisory Committee, and the Department.

**SEC. 807. TECHNICAL ADVISORY COMMITTEE.**

(a) ESTABLISHMENT.—The Hydrogen Technical and Fuel Cell Advisory Committee is established to advise the Secretary on the programs and activities under this title.

(b) MEMBERSHIP.—

(1) MEMBERS.—The Technical Advisory Committee shall be comprised of not fewer than 12 nor more than 25 members. The members shall be appointed by the Secretary to represent domestic industry, academia, professional societies, government agencies, Federal laboratories, previous advisory panels, and financial, environmental, and other appropriate organizations based on the Department's assessment of the technical and other qualifications of Technical Advisory Committee members and the needs of the Technical Advisory Committee.

(2) TERMS.—The term of a member of the Technical Advisory Committee shall not be more than 3 years. The Secretary may appoint members of the Technical Advisory Committee in a manner that allows the terms of the members serving at any time to expire at spaced intervals so as to ensure continuity in the functioning of the Technical Advisory Committee. A member of the Technical Advisory Committee whose term is expiring may be reappointed.

(3) CHAIRPERSON.—The Technical Advisory Committee shall have a chairperson, who shall be elected by the members from among their number.

(c) REVIEW.—The Technical Advisory Committee shall review and make recommendations to the Secretary on—

(1) the implementation of programs and activities under this title;

(2) the safety, economical, and environmental consequences of technologies for the production, distribution, delivery, storage, or use of hydrogen energy and fuel cells; and

(3) the plan under section 804.

(d) RESPONSE.—

(1) CONSIDERATION OF RECOMMENDATIONS.—The Secretary shall consider, but need not adopt, any recommendations of the Technical Advisory Committee under subsection (c).

(2) BIENNIAL REPORT.—The Secretary shall transmit a biennial report to Congress describing any recommendations made by the Technical Advisory Committee since the previous report. The report shall include a description of how the Secretary has implemented or plans to implement the recommendations, or an explanation of the reasons that a recommendation will not be implemented. The report shall be transmitted along with the President's budget proposal.

(e) SUPPORT.—The Secretary shall provide resources necessary in the judgment of the Secretary for the Technical Advisory Committee to carry out its responsibilities under this title.

H. R. 6—257

**SEC. 808. DEMONSTRATION.**

(a) **IN GENERAL.**—In carrying out the programs under this section, the Secretary shall fund a limited number of demonstration projects, consistent with this title and a determination of the maturity, cost-effectiveness, and environmental impacts of technologies supporting each project. In selecting projects under this subsection, the Secretary shall, to the extent practicable and in the public interest, select projects that—

(1) involve using hydrogen and related products at existing facilities or installations, such as existing office buildings, military bases, vehicle fleet centers, transit bus authorities, or units of the National Park System;

(2) depend on reliable power from hydrogen to carry out essential activities;

(3) lead to the replication of hydrogen technologies and draw such technologies into the marketplace;

(4) include vehicle, portable, and stationary demonstrations of fuel cell and hydrogen-based energy technologies;

(5) address the interdependency of demand for hydrogen fuel cell applications and hydrogen fuel infrastructure;

(6) raise awareness of hydrogen technology among the public;

(7) facilitate identification of an optimum technology among competing alternatives;

(8) address distributed generation using renewable sources;

(9) carry out demonstrations of evolving hydrogen and fuel cell technologies in national parks, remote island areas, and on Indian tribal land, as selected by the Secretary;

(10) carry out a program to demonstrate developmental hydrogen and fuel cell systems for mobile, portable, and stationary uses, using improved versions of the learning demonstrations program concept of the Department including demonstrations involving—

(A) light-duty vehicles;

(B) heavy-duty vehicles;

(C) fleet vehicles;

(D) specialty industrial and farm vehicles; and

(E) commercial and residential portable, continuous, and backup electric power generation;

(11) in accordance with any code or standards developed in a region, fund prototype, pilot fleet, and infrastructure regional hydrogen supply corridors along the interstate highway system in varied climates across the United States; and

(12) fund demonstration programs that explore the use of hydrogen blends, hybrid hydrogen, and hydrogen reformed from renewable agricultural fuels, including the use of hydrogen in hybrid electric, heavier duty, and advanced internal combustion-powered vehicles.

The Secretary shall give preference to projects which address multiple elements contained in paragraphs (1) through (12).

(b) **SYSTEM DEMONSTRATIONS.**—

(1) **IN GENERAL.**—As a component of the demonstration program under this section, the Secretary shall provide grants, on a cost share basis as appropriate, to eligible entities (as determined by the Secretary) for use in—

H. R. 6—258

(A) devising system design concepts that provide for the use of advanced composite vehicles in programs under section 782 that—

(i) have as a primary goal the reduction of drive energy requirements;

(ii) after 2010, add another research and development phase, as defined in subsection (c), including the vehicle and infrastructure partnerships developed under the learning demonstrations program concept of the Department; and

(iii) are managed through an enhanced FreedomCAR program within the Department that encourages involvement in cost-shared projects by manufacturers and governments; and

(B) designing a local distributed energy system that—

(i) incorporates renewable hydrogen production, off-grid electricity production, and fleet applications in industrial or commercial service;

(ii) integrates energy or applications described in clause (i), such as stationary, portable, micro, and mobile fuel cells, into a high-density commercial or residential building complex or agricultural community; and

(iii) is managed in cooperation with industry, State, tribal, and local governments, agricultural organizations, and nonprofit generators and distributors of electricity.

(c) IDENTIFICATION OF NEW PROGRAM REQUIREMENTS.—In carrying out the demonstrations under subsection (a), the Secretary, in consultation with the Task Force and the Technical Advisory Committee, shall—

(1) after 2008 for stationary and portable applications, and after 2010 for vehicles, identify new requirements that refine technological concepts, planning, and applications; and

(2) during the second phase of the learning demonstrations under subsection (b)(1)(A)(ii), redesign subsequent program work to incorporate those requirements.

(d) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out this section—

(1) \$185,000,000 for fiscal year 2006;

(2) \$200,000,000 for fiscal year 2007;

(3) \$250,000,000 for fiscal year 2008;

(4) \$300,000,000 for fiscal year 2009;

(5) \$375,000,000 for fiscal year 2010; and

(6) such sums as are necessary for each of fiscal years 2011 through 2020.

**SEC. 809. CODES AND STANDARDS.**

(a) IN GENERAL.—The Secretary, in cooperation with the Task Force, shall provide grants to, or offer to enter into contracts with, such professional organizations, public service organizations, and government agencies as the Secretary determines appropriate to support timely and extensive development of safety codes and standards relating to fuel cell vehicles, hydrogen energy systems, and stationary, portable, and micro fuel cells.

H. R. 6—259

(b) EDUCATIONAL EFFORTS.—The Secretary shall support educational efforts by organizations and agencies described in subsection (a) to share information, including information relating to best practices, among those organizations and agencies.

(c) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out this section—

- (1) \$4,000,000 for fiscal year 2006;
- (2) \$7,000,000 for fiscal year 2007;
- (3) \$8,000,000 for fiscal year 2008;
- (4) \$10,000,000 for fiscal year 2009;
- (5) \$9,000,000 for fiscal year 2010; and
- (6) such sums as are necessary for each of fiscal years 2011 through 2020.

**SEC. 810. DISCLOSURE.**

Section 623 of the Energy Policy Act of 1992 (42 U.S.C. 13293) shall apply to any project carried out through a grant, cooperative agreement, or contract under this title.

**SEC. 811. REPORTS.**

(a) SECRETARY.—Subject to subsection (c), not later than 2 years after the date of enactment of this Act, and triennially thereafter, the Secretary shall submit to Congress a report describing—

- (1) activities carried out by the Department under this title, for hydrogen and fuel cell technology;
- (2) measures the Secretary has taken during the preceding 3 years to support the transition of primary industry (or a related industry) to a fully commercialized hydrogen economy;
- (3) any change made to the strategy relating to hydrogen and fuel cell technology to reflect the results of a learning demonstrations;
- (4) progress, including progress in infrastructure, made toward achieving the goal of producing and deploying not less than—

(A) 100,000 hydrogen-fueled vehicles in the United States by 2010; and

(B) 2,500,000 hydrogen-fueled vehicles in the United States by 2020;

(5) progress made toward achieving the goal of supplying hydrogen at a sufficient number of fueling stations in the United States by 2010 including by integrating—

(A) hydrogen activities; and

(B) associated targets and timetables for the development of hydrogen technologies;

(6) any problem relating to the design, execution, or funding of a program under this title;

(7) progress made toward and goals achieved in carrying out this title and updates to the developmental roadmap, including the results of the reviews conducted by the National Academy of Sciences under subsection (b) for the fiscal years covered by the report; and

(8) any updates to strategic plans that are necessary to meet the goals described in paragraph (4).

(b) EXTERNAL REVIEW.—The Secretary shall enter into an arrangement with the National Academy of Sciences under which the Academy will review the programs under sections 805 and 808 every fourth year following the date of enactment of this Act. The Academy's review shall include the program priorities and

## H. R. 6—260

technical milestones, and evaluate the progress toward achieving them. The first review shall be completed not later than 5 years after the date of enactment of this Act. Not later than 45 days after receiving the review, the Secretary shall transmit the review to Congress along with a plan to implement the review's recommendations or an explanation for the reasons that a recommendation will not be implemented.

(c) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section \$1,500,000 for each of fiscal years 2006 through 2020.

**SEC. 812. SOLAR AND WIND TECHNOLOGIES.**

(a) SOLAR ENERGY TECHNOLOGIES.—The Secretary shall—

(1) prepare a detailed roadmap for carrying out the provisions in this title related to solar energy technologies and for implementing the recommendations related to solar energy technologies that are included in the report transmitted under subsection (e);

(2) provide for the establishment of 5 projects in geographic areas that are regionally and climatically diverse to demonstrate the production of hydrogen at solar energy facilities, including one demonstration project at a National Laboratory or institution of higher education;

(3) establish a program—

(A) to develop optimized concentrating solar power devices that may be used for the production of both electricity and hydrogen; and

(B) to evaluate the use of thermochemical cycles for hydrogen production at the temperatures attainable with concentrating solar power devices;

(4) coordinate with activities sponsored by the Department's Office of Nuclear Energy, Science, and Technology on high-temperature materials, thermochemical cycles, and economic issues related to solar energy;

(5) provide for the construction and operation of new concentrating solar power devices or solar power cogeneration facilities that produce hydrogen either concurrently with, or independently of, the production of electricity;

(6) support existing facilities and programs of study related to concentrating solar power devices; and

(7) establish a program—

(A) to develop methods that use electricity from photovoltaic devices for the onsite production of hydrogen, such that no intermediate transmission or distribution infrastructure is required or used and future demand growth may be accommodated;

(B) to evaluate the economics of small-scale electrolysis for hydrogen production; and

(C) to study the potential of modular photovoltaic devices for the development of a hydrogen infrastructure, the security implications of a hydrogen infrastructure, and the benefits potentially derived from a hydrogen infrastructure.

(b) WIND ENERGY TECHNOLOGIES.—The Secretary shall—

(1) prepare a detailed roadmap for carrying out the provisions in this title related to wind energy technologies and for implementing the recommendations related to wind energy

H. R. 6—261

technologies that are included in the report transmitted under subsection (e); and

(2) provide for the establishment of 5 projects in geographic areas that are regionally and climatically diverse to demonstrate the production of hydrogen at existing wind energy facilities, including one demonstration project at a National Laboratory or institution of higher education.

(c) PROGRAM SUPPORT.—The Secretary shall support programs at institutions of higher education for the development of solar energy technologies and wind energy technologies for the production of hydrogen. The programs supported under this subsection shall—

(1) enhance fellowship and faculty assistance programs;

(2) provide support for fundamental research;

(3) encourage collaborative research among industry, National Laboratories, and institutions of higher education;

(4) support communication and outreach; and

(5) to the greatest extent possible—

(A) be located in geographic areas that are regionally and climatically diverse; and

(B) be located at part B institutions, minority institutions, and institutions of higher education located in States participating in the Experimental Program to Stimulate Competitive Research of the Department.

(d) INSTITUTIONS OF HIGHER EDUCATION AND NATIONAL LABORATORY INTERACTIONS.—In conjunction with the programs supported under this section, the Secretary shall develop sabbatical, fellowship, and visiting scientist programs to encourage National Laboratories and institutions of higher education to share and exchange personnel.

(e) REPORT.—The Secretary shall transmit to the Congress not later than 120 days after the date of enactment of this Act a report containing detailed summaries of the roadmaps prepared under subsections (a)(1) and (b)(1), descriptions of the Secretary's progress in establishing the projects and other programs required under this section, and recommendations for promoting the availability of advanced solar and wind energy technologies for the production of hydrogen.

(f) DEFINITIONS.—For purposes of this section—

(1) the term “concentrating solar power devices” means devices that concentrate the power of the sun by reflection or refraction to improve the efficiency of a photovoltaic or thermal generation process;

(2) the term “minority institution” has the meaning given to that term in section 365 of the Higher Education Act of 1965 (20 U.S.C. 1067k);

(3) the term “part B institution” has the meaning given to that term in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061); and

(4) the term “photovoltaic devices” means devices that convert light directly into electricity through a solid-state, semiconductor process.

(g) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated such sums as are necessary for carrying out the activities under this section for each of fiscal years 2006 through 2020.

H. R. 6—262

**SEC. 813. TECHNOLOGY TRANSFER.**

In carrying out this title, the Secretary shall carry out programs that—

- (1) provide for the transfer of critical hydrogen and fuel cell technologies to the private sector;
- (2) accelerate wider application of those technologies in the global market;
- (3) foster the exchange of generic, nonproprietary information; and
- (4) assess technical and commercial viability of technologies relating to the production, distribution, storage, and use of hydrogen energy and fuel cells.

**SEC. 814. MISCELLANEOUS PROVISIONS.**

(a) REPRESENTATION.—The Secretary may represent the United States interests with respect to activities and programs under this title, in coordination with the Department of Transportation, the National Institute of Standards and Technology, and other relevant Federal agencies, before governments and nongovernmental organizations including—

- (1) other Federal, State, regional, and local governments and their representatives;
- (2) industry and its representatives, including members of the energy and transportation industries; and
- (3) in consultation with the Department of State, foreign governments and their representatives including international organizations.

(b) REGULATORY AUTHORITY.—Nothing in this title shall be construed to alter the regulatory authority of the Department.

**SEC. 815. COST SHARING.**

The costs of carrying out projects and activities under this title shall be shared in accordance with section 988.

**SEC. 816. SAVINGS CLAUSE.**

Nothing in this title shall be construed to affect the authority of the Secretary of Transportation that may exist prior to the date of enactment of this Act with respect to—

- (1) research into, and regulation of, hydrogen-powered vehicles fuel systems integrity, standards, and safety under subtitle VI of title 49, United States Code;
- (2) regulation of hazardous materials transportation under chapter 51 of title 49, United States Code;
- (3) regulation of pipeline safety under chapter 601 of title 49, United States Code;
- (4) encouragement and promotion of research, development, and deployment activities relating to advanced vehicle technologies under section 5506 of title 49, United States Code;
- (5) regulation of motor vehicle safety under chapter 301 of title 49, United States Code;
- (6) automobile fuel economy under chapter 329 of title 49, United States Code; or
- (7) representation of the interests of the United States with respect to the activities and programs under the authority of title 49, United States Code.



## Attachment 3. HTAC Members

### Current

Larry R. Bawden, President and CEO, Jadoo Power Systems

John S. Bresland, Member of U. S. Chemical Safety Board

Mark Chernoby, V.P., Advanced Vehicle Engineering,  
Chrysler Group Business Unit, DaimlerChrysler

Mildred Dresselhaus, Institute Professor, Massachusetts  
Institute of Technology

David J. Friedman, Research Director, Clean Vehicles Program,  
Union of Concerned Scientists

John D. Hofmeister, President and U.S. Country Chair,  
Shell Oil Company

Arthur T. Katsaros, Group V.P., Development and Technology,  
Air Products & Chemicals, Inc. (retired)

Alan C. Lloyd, Elected HTAC Chair, 2006-2007, President,  
International Council on Clean Transportation

Dan R. Keuter, V.P., Business Development, Entergy Nuclear, Inc.

J. Byron McCormick, Executive Director, GM Global  
Fuel Cell Activities, General Motors Corp.

Michael J. Mudd, CEO, FutureGen Alliance, Inc. and Technology  
Development Manager, American Electric Power, Inc.

Randall W. Napoli, Director, Florida Division of State Fire Marshal (retired)

Ian C. Purtle, Corporate VP, Director of Process Solutions  
Technology Development Center, Cargill, Inc.

Michael P. Ramage, Executive VP, ExxonMobil Research  
and Engineering (retired)

Geraldine L. Richmond, Noyes Professor of Chemistry, University of Oregon

Robert Rose, U.S. Fuel Cell Council

Philip Ross, Senior Scientist, Lawrence Berkeley National Laboratory (retired)

Roger B. Saillant, President and CEO, Plug Power Inc.

Gerhard Schmidt, Ford, Executive Director

Robert W. Shaw, President, Areté Corporation

Kathleen Taylor, Director of Materials Processing Laboratory,  
General Motors Research and Planning (retired)

Jan van Dokkum, President, UTC Power

Gregory M. Vesey, President, Chevron Global Power Co.

Hon. Robert S. Walker, Elected HTAC Vice Chair, 2006-2007, Chairman,  
Wexler & Walker Public Policy Associates

John M. Wooten, Environment and Technology, V.P., Peabody Energy (retired)

### Past

Uma Chowdhry, Senior Vice President and Chief Science  
and Technology Officer, DuPont Central R&D

E. James Reinsch, President, Bechtel Nuclear

J. Craig Venter, CEO, Synthetic Genomics, Inc.



# Hydrogen Posture Plan

## An Integrated Research, Development and Demonstration Plan

December 2006



United States Department of Energy



United States Department of Transportation

# A National Commitment

---

In his 2003 State of the Union address, President Bush announced a hydrogen initiative to reverse America's growing dependence on foreign oil and improve the environment. The President urged the development of commercially viable fuel cells for cars, trucks, homes, and businesses:

*With a new national commitment, our scientists and engineers will overcome obstacles...so that the first car driven by a child born today could be powered by hydrogen, and pollution-free. Join me in this important innovation to make our air significantly cleaner, and our country much less dependent on foreign sources of energy.*

— President George W. Bush  
State of the Union Address, January 28, 2003

The National Academies' February 2004 report on the DOE Hydrogen Program concluded that:

*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 resources for hydrogen production while reducing environmental impacts, including atmospheric CO<sub>2</sub> emissions and criteria pollutants.*

— The National Academies  
The Hydrogen Economy: Opportunities,  
Costs, Barriers, and R&D Needs  
February 2004

In his speech for Earth Day 2005, DOE Secretary Samuel W. Bodman emphasized the importance of partnerships to fulfill the President's vision:

*Numerous partnerships between all levels of government, the automotive and energy industries and their suppliers are making significant progress toward developing and deploying new hydrogen vehicles and the infrastructure to support them.*

— U.S. DOE Secretary Samuel W. Bodman  
April 22, 2005

At the 2005 DOE Hydrogen Program Review, DOE Under Secretary David Garman remarked upon the need for teamwork among visionaries and pragmatists:

*Imagining the hydrogen energy economy is easy enough for visionaries and dreamers, but ultimately it doesn't happen unless scientists and engineers overcome technical obstacles, entrepreneurs take risks, corporate boards commit capital, and consumers choose. What is remarkable about our efforts is that the visionaries and the pragmatists are working together, in close partnership, to make the hydrogen energy economy a reality.*

— David K. Garman, Under Secretary, U.S. DOE  
May 23, 2005

When he signed the Energy Policy Act of 2005, President Bush reiterated his commitment to the hydrogen initiative and acknowledged the support of Congress:

*The bill I sign today also includes strong support for hydrogen fuel technology. When hydrogen is used in a fuel cell, it can power consumer products from computers to cell phones to cars that emit pure water instead of exhaust fumes. I laid out a hydrogen fuel initiative, and I want to thank the members of Congress for adding to the momentum of this initiative through this energy bill.*

— President George W. Bush  
Signing of the Energy Policy Act of 2005, August 8, 2005

# Foreword

---

Energy is the life-blood of our nation. It is the mainstay of our standard of living, economy, and national security. Clean forms of energy are needed to support sustainable global economic growth while mitigating impacts on air quality and the potential effects of greenhouse gas emissions. Our growing dependence on foreign sources of energy threatens our national security. As a nation, we must work to reduce our dependence on foreign sources of energy in a manner that is affordable and preserves environmental quality.

To address these challenges, the President's National Energy Policy, the Energy Policy Act of 2005, and the U.S. Department of Energy (DOE) Strategic Plan call for expanding the development of diverse domestic energy supplies. In 2006, the President announced the Advanced Energy Initiative (AEI).<sup>1</sup> The AEI accelerates research on technologies having the potential to reduce near-term oil use in the transportation sector including advanced batteries for hybrid 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 longer 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 Hydrogen Fuel Initiative accelerates the pace of research and development on hydrogen production and delivery infrastructure technologies needed to support hydrogen-powered fuel cells for use in transportation and electricity generation. Working with industry, academia, and the national labs, the DOE developed a long-term plan for moving toward widespread implementation of hydrogen technologies — a solution that holds the potential to provide virtually limitless clean, safe, secure, affordable, and reliable energy from diverse domestic resources. Ultimately, hydrogen could become one of a diverse set of alternatives that will address the energy needs of the United States. To realize this goal, the Nation must develop and validate advanced hydrogen fuel cell and infrastructure technologies while continuing to promote complementary near-term energy efficiency and renewable energy solutions, such as ethanol and hybrid electric vehicles.

The 2006 Hydrogen Posture Plan satisfies Section 804 of the Energy Policy Act of 2005, which requires that the Secretary of Energy transmit to Congress a coordinated plan for the Department's hydrogen and fuel cell programs. This plan also updates the previous plan, issued in February 2004, for successfully integrating ongoing and future hydrogen research, development and demonstration (RD&D) activities into a focused Hydrogen Program. The program will integrate technology for hydrogen production (from fossil, nuclear, and renewable resources), infrastructure development (including delivery and storage), and fuel cells for transportation and stationary applications. A coordinated Hydrogen Program will improve the effectiveness and accountability of the government's RD&D activities and increase the Program's ability to achieve its goals. Activities by the Department of Transportation (DOT) and the DOE are included.

The policy assumptions implicit in the Hydrogen Posture Plan are:

- ◆ The program is focused on the research and development activities needed to overcome the barriers to making hydrogen and fuel cell technologies competitive with alternative technologies.
- ◆ Learning demonstrations will be used to measure progress; identify issues during real-world operation that will provide feedback to the R&D program; validate the performance, durability, and cost of the technologies; address systems engineering issues; enable the DOE to provide information to Congress and the public on the status of the technology; and educate the public, especially safety and code officials and first responders.

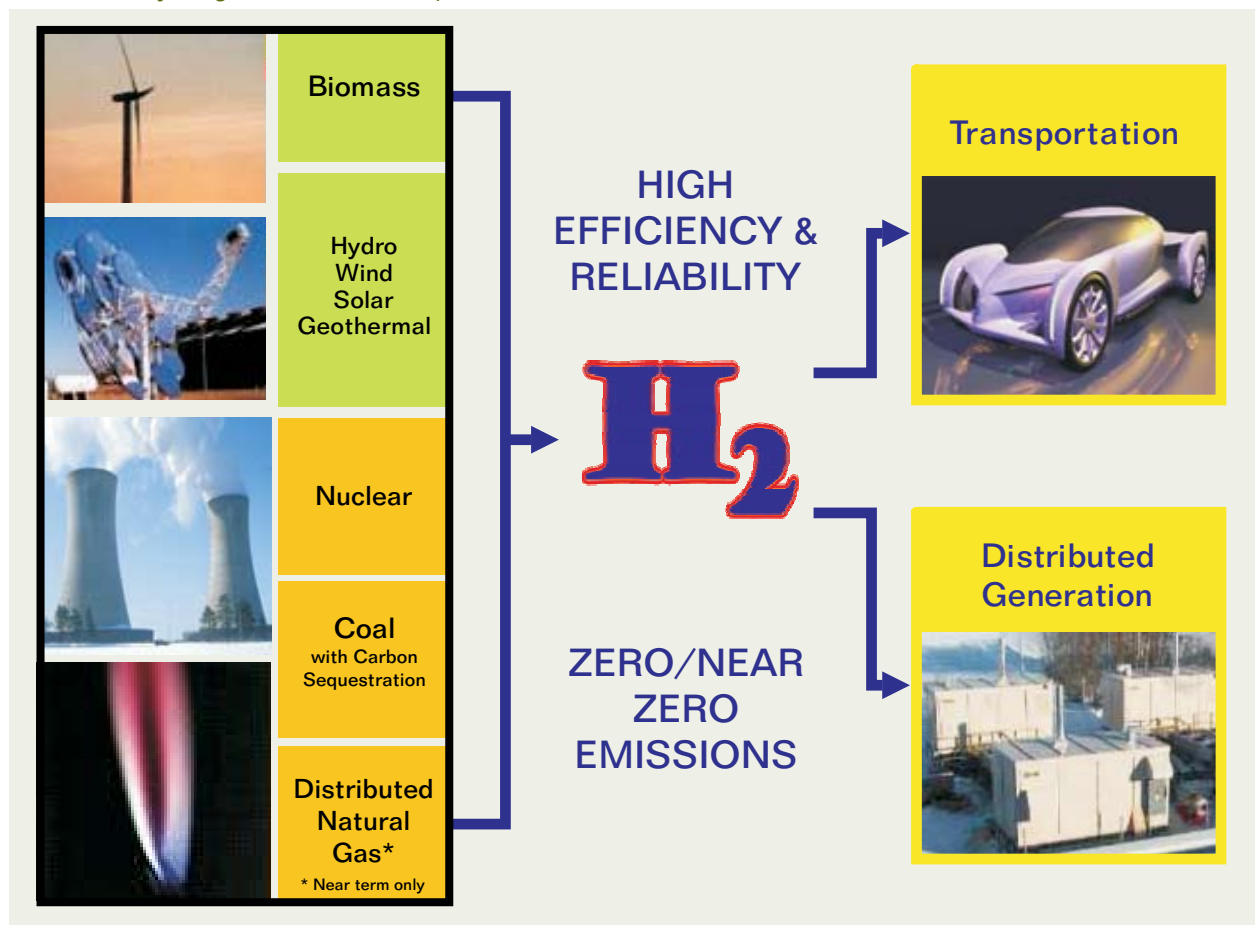
- ◆ Commercial demonstrations and market transformation will occur only when the performance and durability of the technologies are validated. The decision to commercialize rests entirely with the private sector. Automakers may decide to market a fuel cell vehicle in a different time frame (perhaps earlier, perhaps later) than the DOE validation activities might suggest.
- ◆ When the performance and durability of the technologies are validated, the government may consider becoming an “early adopter” by purchasing or leasing hydrogen fuel cell vehicles and hydrogen refueling technologies to promote public acceptance of the technologies.

The goal of the Program is to develop hydrogen production, delivery, storage, and fuel cell technologies that enable the automobile and energy companies to opt for commercial availability of fuel cell vehicles and hydrogen fuel infrastructure by 2020.

Hydrogen has the long-term potential to reduce our dependence on foreign oil and lower carbon and criteria pollutant emissions from the transportation sector. In the near-term, gasoline-electric hybrid vehicles and biofuels (ethanol and biodiesel) offer excellent options for reducing oil use.

Ultimately, hydrogen from diverse domestic resources may be used in a clean, safe, reliable, and affordable manner in fuel cell vehicles, stationary, and portable power applications. Development of hydrogen, along with other domestic energy resources, will ensure that the United States has an abundant, reliable, and affordable supply of clean energy to maintain the Nation’s prosperity throughout the 21st century.

#### Domestic Hydrogen Production Options



# Executive Summary

The Hydrogen Posture Plan was prepared by the U.S. Department of Energy (DOE) Offices of Energy Efficiency and Renewable Energy; Fossil Energy; Science; Nuclear Energy, Science and Technology; and the U.S. Department of Transportation (DOT) to outline the activities, milestones, and deliverables that the Federal government plans to pursue to support the development of hydrogen-based energy systems. The Hydrogen Posture Plan integrates the planning and budgeting for program activities that will aid in this development. More specifically, this Plan outlines the DOE role in hydrogen energy research and development, in accordance with the National Hydrogen Energy Vision and Roadmap.<sup>2,3</sup> The Plan lays the foundation for a coordinated response, including collaboration with the DOT, to the President's plan for accelerating implementation of hydrogen infrastructure and fuel cell technologies.

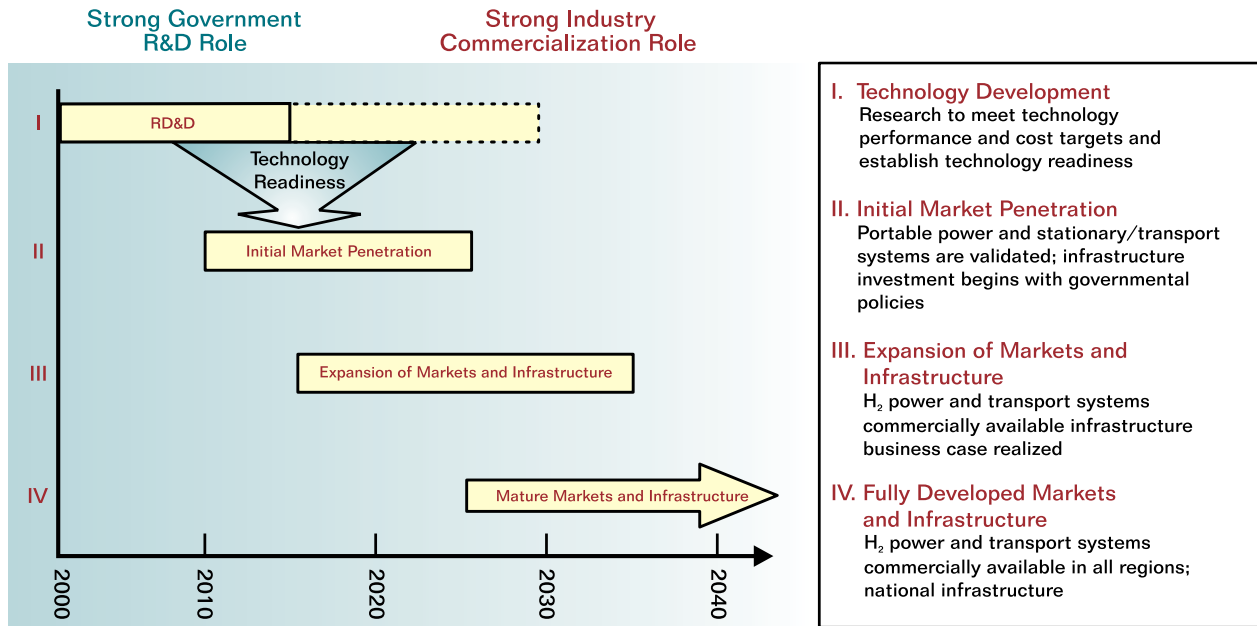
## Key Points

- ◆ Use of hydrogen as an energy carrier, together with other alternative domestic fuels and technologies, can enhance long-term energy security while mitigating the effects of air pollution and greenhouse gas emissions.
- ◆ Technical challenges to developing cost effective hydrogen technologies include lowering the cost of hydrogen production, delivery, storage, fuel cells, and end-use applications. Hydrogen systems require effective safety codes and standards, not only to ensure that these systems are safe, but to help define design standards for future hydrogen vehicles and infrastructure. In addition, education and outreach are vital to raise awareness, accelerate technology transfer, and to increase public understanding of hydrogen energy systems. These challenges and the general paths forward are discussed in detail in the *National Hydrogen Energy Roadmap*.
- ◆ The *Hydrogen Posture Plan* integrates existing and future activities by DOE to pursue the R&D priorities laid out in the Roadmap and overcome the related technical challenges. The DOE, DOT, and other Federal agencies will play a leadership role in the development of hydrogen technologies.
- ◆ Hydrogen and fuel cell technologies must meet market-based requirements for cost, operability, safety, maintenance, and overall performance. Given the uncertainty of overcoming all the technical hurdles, this plan assumes that the major policy (at this time) is to conduct the research, development, and validation necessary to address key technical and cost targets. The goal is "technology readiness" of hydrogen production, delivery, storage, and fuel cell technologies, to enable the automobile and energy companies to opt for commercial availability of fuel cell vehicles and hydrogen fuel infrastructure by 2020. Technology that meets consumer requirements is necessary, but not sufficient, for industry to move forward with commercialization. Portable and stationary power systems, which generally have less stringent cost targets, will likely be commercialized sooner than vehicles.

*"This committee believes that investigating and conducting RD&D activities to determine whether a hydrogen economy might be realized are important to the nation."*

— The National Academies  
Committee on Alternatives and  
Strategies for Future Hydrogen  
Production and Use

Figure ES-1. Possible Scenarios for Hydrogen Technology Development and Market Transformation



The timeframe is long and the investment is large to develop a hydrogen and transportation market that reduces our Nation's dependence on foreign sources of energy while minimizing environmental impacts.

- ◆ As shown in Figure ES-1, the Federal government will play a key role in the near term, supporting the materials and component research necessary to overcome critical path technology barriers. When the performance and durability of the technologies are validated, the government may consider becoming an early technology adopter, and could enact policies to nurture the development of an industry capable of delivering significant quantities of hydrogen to the market place. Industry's role would become increasingly dominant as market penetration increases.
- ◆ The Hydrogen Program mission is to research, develop, and validate technologies for producing, storing, delivering and using hydrogen in an efficient, clean, safe, reliable, and affordable manner. Related efforts that contribute to resolving technical barriers include DOT's fuel cell bus program, developing high-temperature fuel-flexible fuel cells for stationary applications, clean coal technologies, advanced "Gen IV" nuclear reactor technologies, carbon sequestration and carbon management technologies, renewable electric power generation, biomass and biorefinery technologies, and basic research on biological production. DOE will also continue to support development of advanced hybrid components and electric powertrain technologies for use in the next generation of hybrid vehicles and future fuel cell vehicles.
- ◆ Key program technical milestones for hydrogen technology readiness include the following:
  - Hydrogen produced from diverse, domestic resources at \$2.00-\$3.00 per gallon of gasoline equivalent (delivered, untaxed)<sup>4</sup>
  - On-board hydrogen storage systems with improved capacity to enable a driving range greater than 300 miles for most light-duty vehicles<sup>5</sup>
  - Polymer electrolyte-membrane (PEM) automotive fuel cells that cost \$30-\$45 per kilowatt and deliver 5,000 hours of service (service life of vehicle)<sup>6</sup>



## Program Accomplishments

- ◆ Built the world's first energy station that co-produces electricity and hydrogen from natural gas. This energy station demonstrated a reduction in the cost of natural gas-based hydrogen production from \$5.00<sup>7</sup> per gallon gasoline equivalent (gge) in 2003 to \$3.00<sup>8</sup> per gge using innovative reforming and purification technologies. The station demonstrates the synergy between the transportation and electric generation sectors of the hydrogen infrastructure. Data from laboratory research, when used in the H2A Model (see page B-2), indicate a hydrogen cost of \$3.10/gge<sup>9</sup> based on today's natural gas reforming technology projected to high volume production.
- ◆ Reduced the high-volume cost of automotive fuel cells from \$275/kW (50kW system) in 2002 to \$110/kW (80kW system) in 2005<sup>10</sup> using innovative processes developed by national labs and fuel cell developers for depositing platinum catalyst. Additional research is needed for fuel cells to achieve the cost equivalent target of \$30/kW.
- ◆ Assessed, through independent review, the status of two major technical milestones:

  - Verified the 2005 modeled cost of \$110/kW for 80-kW transportation fuel cell systems (based on 500,000 units/year)<sup>11</sup> (the 2006 and 2010 DOE targets are \$110<sup>12</sup> and \$45<sup>13</sup> per kilowatt, respectively)
  - In hydrogen production, completed research on distributed natural gas reforming to achieve a hydrogen production cost of \$3.00 per gallon of gasoline equivalent assuming an installation rate of 500 new forecourt stations per year (this technology will need to be validated later at full-scale)<sup>14</sup>
- ◆ Developed an analytical tool - the H2A model - to address the need for consistent analysis methodology and transparent reporting.<sup>15</sup> The model, which assesses the minimum hydrogen cost (including a return on capital investment) for a variety of hydrogen production pathways, will be used by the Program and its contractors to evaluate technologies on a common basis, to assess technology tradeoffs, and to aid systems analysis efforts. The H2A model has been beta tested using several hydrogen production pathways, including coal, natural gas, biomass, electrolysis, and forecourt receiving and dispensing. An H2A model has also been developed to assess hydrogen delivery options.
- ◆ Issued Program Research, Development, and Demonstration Plans for the Offices of Energy Efficiency and Renewable Energy; Fossil Energy; and Nuclear Energy, Science and Technology. Issued *Basic Research Needs for the Hydrogen Economy*, an Office of Science report that describes priority basic research areas for fuel cells and hydrogen production, storage, and delivery. (See Appendix E.)
- ◆ Expanded the partnership with DaimlerChrysler, Ford, and General Motors to include major energy companies (ExxonMobil Corporation, ConocoPhillips, Chevron Corporation, BP America, and Shell). Known as the FreedomCAR and Fuel Partnership, these companies will help DOE establish the technical requirements and evaluate research results for hydrogen and fuel cell technology development.

- ◆ Competitively selected over \$640 million in projects (over \$920 million with private cost share), subject to appropriations, to overcome critical technology barriers and to bring hydrogen and fuel cell technology from the laboratory to the showroom. Through these awards, DOE:
  - Selected 71 new hydrogen production and delivery projects (\$120 million over four years) to address major technical and economic hurdles in renewable, nuclear, and coal-based hydrogen production and delivery technologies (\$75 million for distributed natural gas and renewables; \$43 million for coal, including 3 hydrogen utilization projects; and \$2 million for nuclear-based hydrogen)<sup>16</sup>
  - Created a National Hydrogen Storage Project (\$150 million over five years) that includes three Centers of Excellence, over 20 independent projects addressing applied research, and 17 new basic research projects.<sup>16</sup> The focus of these efforts, which include approximately 40 universities, 15 companies, and 10 Federal laboratories, is to develop high capacity materials and low-pressure storage technologies
  - Selected 42 new fuel cell projects, including: five projects which address critical fuel cell cost and durability issues for consumer electronics and other applications (\$13 million over three years); 12 projects (\$19 million over five years) for research on polymer electrolyte-type membranes with improved performance at higher temperatures and lower humidity; and 25 projects (\$100 million over four years) for research in a range of fuel cell topic areas including fuel cell membranes, water transport within the stack, advanced cathode catalysts and supports, cell hardware, innovative fuel cell concepts, effects of impurities on fuel cell performance and durability, and stationary fuel cell demonstration projects to help foster international and intergovernmental partnerships<sup>16</sup>
  - Established a national vehicle and infrastructure “learning demonstration” project (\$170 million for four teams over six years) to measure progress and help guide R&D — auto and energy company partners will identify challenges encountered when hydrogen and fuel cell technologies are operated in real-world environments.<sup>16</sup> This project has provided data on vehicle range, fuel cell efficiency and durability, and hydrogen quality that enables an accurate assessment of the status of the technologies in integrated operating systems
  - Selected 70 projects (\$64 million over three years) in basic research to address the fundamental science underpinning hydrogen production, storage, and use<sup>16</sup>
  - Developed an “Introduction to Hydrogen Safety for First Responders,” held pilot “Hydrogen 101” Workshops for state and local governments in six states, and launched middle school and high school curricula and teacher professional development programs (\$5 million over five years)<sup>16</sup>
- ◆ DOE and DOT have initiated the development of first responder and code official training and education.
- ◆ Completed the Hydrogen Program Systems Analysis Plan.

- ◆ Conducted the third annual integrated Hydrogen Program Merit Review and Peer Evaluation.
- ◆ Selected members for the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC) and convened the first HTAC meeting on October 2-3, 2006.
- ◆ Following a recommendation from the National Academy of Engineering, implemented a systems analysis and integration effort to integrate all Program elements (hydrogen production, delivery, and storage; fuel cells; safety, codes and standards; and education) and to monitor progress toward technology targets.
- ◆ Initiated the International Partnership for the Hydrogen Economy (IPHE), which currently includes sixteen nations and the European Commission, to foster world-wide collaboration on hydrogen technology RD&D.<sup>17</sup> Since the inaugural IPHE Ministerial meeting in November 2003, two IPHE Committees (Steering Committee and Implementation-Liaison Committee) have met to identify and develop collaboration mechanisms and opportunities.
- ◆ Developed the *Draft Roadmap on Manufacturing R&D for the Hydrogen Economy*.<sup>18</sup> The roadmap addresses challenges to manufacturing the hydrogen production, storage, and fuel cell technologies that will be required for the new hydrogen infrastructure and proposes R&D solutions to overcome such challenges. The roadmap (released by Energy Secretary Bodman on January 24, 2006) is based on the results of a July 2005 workshop and consolidates recommendations of hydrogen and fuel cell experts from industry, universities, and national laboratories. An open public comment period will gather additional feedback that will be incorporated into the final roadmap. Led by the DOE and the National Institutes of Standards and Technology, the workshop and roadmap are a result of a collaboration of the Interagency Working Group on Manufacturing R&D established through the President's National Science and Technology Council.

## Next Steps

---

- ◆ Assess, through independent review, the potential of cryogenic-compressed hydrogen tanks to meet DOE's 2010 targets<sup>19</sup>
- ◆ Transfer lessons learned from distributed reforming of natural gas to distributed reforming of renewable liquids.
- ◆ Continue to coordinate the detailed multi-year RD&D plans and priorities for hydrogen and related technology development efforts within DOE and DOT to make them consistent with this planning document, the Energy Policy Act of 2005, and the recommendations of the National Academies' studies of the Hydrogen Economy<sup>20</sup> and the FreedomCAR and Fuel Partnership.<sup>21</sup>
- ◆ Strengthen coordination by continuing to utilize the Hydrogen Program Coordination Group composed of representatives from the DOE Offices of Energy Efficiency and Renewable Energy (EE); Fossil Energy (FE); Nuclear Energy (NE); Science (SC); Policy and International Affairs (PI); and the Chief Financial Officer (CFO); and the DOT.

- ◆ Complete and publish the DOE Hydrogen Program Safety Plan and the DOE Hydrogen Program Risk Management Plan.
- ◆ Promote the sharing of safety-related information and maintain a database of safety “learnings.”
- ◆ Conduct the fourth annual integrated Hydrogen Program Merit Review and Peer Evaluation.
- ◆ Reflect the importance of the following activities in the Department’s out-year planning and budgeting:
  - Basic and applied research in hydrogen storage, production and delivery, and fuel cell cost and durability
  - Hydrogen delivery and analysis of infrastructure development (these activities will be closely coordinated with the DOT, which is responsible for efforts to ensure the safety of the hydrogen delivery system)
  - Economic and systems analyses for determining and mitigating investment risks associated with hydrogen infrastructure and related technologies (e.g., fuel cell systems engineering and manufacturing plants)
  - Education activities focused on the key target audiences directly involved in near-term hydrogen technology validation
- ◆ Strengthen existing interagency coordination efforts to ensure that Federal investments in hydrogen and fuel cell technology development are leveraged to the maximum extent. The Interagency Hydrogen and Fuel Cell Technical Task Force, in accordance with the Energy Policy Act of 2005, will work toward a safe, economical, and environmentally sound hydrogen fuel infrastructure by coordinating the efforts of the Office of Science and Technology Policy; the Departments of Energy, Transportation, Defense, Commerce, and Agriculture; the Office of Management and Budget; National Science Foundation; Environmental Protection Agency; National Aeronautics and Space Administration; and other agencies as appropriate. In 2005, the task force created a website at [www.hydrogen.gov](http://www.hydrogen.gov) to provide information on all Federal hydrogen and fuel cell activities.
- ◆ Increase awareness of the nation’s regulatory framework of energy, economic, and environmental policies at the Federal, state, and local levels, and work with the appropriate agencies to coordinate the timing of policy instruments and regulatory actions to allow technology to meet market requirements.
- ◆ Continue DOT and DOE participation in the development of Global Technical Regulations for fuel cell light duty vehicles.
- ◆ Identify opportunities to work more closely with emerging state-led initiatives to advance hydrogen infrastructure development.
- ◆ Strengthen international cooperation on hydrogen-related research, development, and demonstration programs and on the development of interoperable codes and standards through the International Partnership for the Hydrogen Economy and the International Energy Agency.
- ◆ Continue to implement relevant provisions of the Energy Policy Act of 2005 (see box on page xi) as appropriate.

In summary, a great deal of progress has been made in planning and carrying out the RD&D since the Hydrogen Initiative was announced in 2003. The Department of Energy expects significant results to be achieved through the President's Hydrogen Fuel Initiative in FY 2007 and beyond.

### **Energy Policy Act of 2005**

On July 29, 2005, Congress passed the first comprehensive energy legislation in over a decade. The Energy Policy Act of 2005 (P.L. No: 109-058)<sup>22</sup> was signed into law by the President on August 8, 2005 at Sandia National Laboratory in Albuquerque, New Mexico. This historic bill follows many of the principles outlined by President Bush in the National Energy Policy to strengthen our nation's electrical infrastructure, reduce our dependence on foreign oil, increase conservation, and expand the use of clean renewable energy. Title VIII of the bill focuses on hydrogen and indicates the strong support of Congress for research and development of hydrogen and fuel cell technologies. The Energy Policy Act of 2005, together with the Advanced Energy Initiative and the President's Hydrogen Fuel Initiative, shows that we have a unified commitment by our nation's leaders to reduce our dependence on foreign oil through development of more efficient energy technologies and alternative, domestically produced transportation fuels.



# Table of Contents

---

Foreword.....	i
Executive Summary.....	iii
1. Introduction.....	1
2. Key Drivers for Developing Hydrogen as an Energy Carrier.....	5
Energy Security.....	5
Environmental Quality.....	6
Economic Competitiveness.....	7
3. Development of Hydrogen as an Energy Carrier.....	9
Status of Hydrogen Today.....	9
Technology Development and Market Transformation.....	9
4. Hydrogen Program.....	13
Program Mission.....	13
Program Strategy.....	13
Program Activities and Highlights.....	14
Program Milestones.....	26
Integrated Program Management and Coordination.....	27
5. Next Steps.....	33
Notes.....	35
Appendices.....	39
Appendix A. Sample Scenario for Domestic Hydrogen Production Options and Resource Needs.....	A-1
Appendix B. Hydrogen Production and Delivery Pathways.....	B-1
Appendix C. Hydrogen Fuel Initiative Budget: FY 04-07.....	C-1
Appendix D. Glossary/Acronyms.....	D-1
Appendix E. Contacts, Resources, and Weblinks.....	E-1





November 12, 2006

The Honorable Samuel W. Bodman  
Secretary of Energy  
7A-257 Forrestal Building  
U.S. Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585

Dear Mr. Secretary:

We are delighted to report on the inaugural meeting of the Hydrogen and Fuel Cell Technical Advisory Committee (HTAC), authorized by EPAct 2005 and chartered by you in June 2006. At the October 2-3, 2006, meeting in Arlington, Virginia, the 23 members in attendance, from a total membership of 25, were briefed on the Hydrogen Program by your representatives, and subsequently discussed the Charter, EPAct deliverables, possible organizational structures, priority issues, and the schedule for reporting recommendations.

The HTAC members elected their first Chair, the 1996-1997 chair of the HTAP Committee, linking HTAC to the predecessor committee, thus taking advantage of previous work and historical experience. For Vice-Chair the HTAC chose a former Chair of the House Science Committee, who brings to the Committee familiarity with legislative processes and the activities of the federal government.

The Committee's charter stipulates the requirement for broad reviews and the responsibility for making recommendations regarding – *the implementation of programs, plans, and activities, as well as safety, economic, and environmental issues related to production, distribution, delivery, storage, and use of hydrogen energy and fuel cells.* We recognize the challenges ahead as we endeavor to fulfill our purpose. With the Department's and the Interagency Task Force's support, the Committee is prepared to perform objectively and make value-added recommendations as we observe the national goal stated in EPAct– *to create, strengthen, and protect a sustainable national energy economy.*

The Interagency Hydrogen and Fuel Cell Technical Task Force, authorized by EPAct, emerged as an area needing attention by the Committee. The HTAC recognizes the importance of an Interagency Task Force for coordinating related efforts among federal agencies. The Committee notes that EPAct Section 806 states, “...*the President shall establish an interagency task force chaired by the Secretary.*” The current Interagency Working Group (IWG), established in 2003 shortly after the President announced his Hydrogen Fuel Initiative, consists of staff-level federal agency representatives.

The Honorable Samuel W. Bodman  
Page 2  
November 12, 2006

The most recent charter for the IWG, dated July 26, 2006, states that it fulfills the responsibilities assigned in EPO Act Section 806. The current working group membership, however, does not include the level of participation that may be interpreted as being directed by EPO Act.

HTAC submits, for the Department's consideration, the enclosed *Resolution on the Composition of the Interagency Task Force* that requires participation, at the functional level of Assistant Secretary or higher in the Interagency Working Group. We believe this is necessary to ensure appropriate decision-making membership from each participating agency or department.

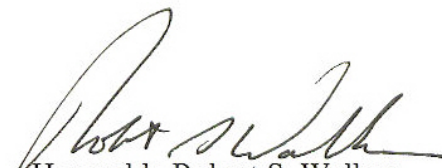
On behalf of the HTAC, we thank the Department for the technical support of the Offices of Energy Efficiency and Renewable Energy (JoAnn Milliken), Fossil Energy (Lowell Miller), Nuclear Energy (Carl Sink), and Science (Harriet Kung), and of the Designated Federal Official (Kathi Epping). We are also pleased that a Department of Transportation representative supported the meeting. Finally, we are appreciative of Under Secretary, David Garman, for his encouragement at the meeting, and Dr. JoAnn Milliken for providing critical information on the status and goals of the Hydrogen Program.

We thank you for the opportunity to serve on HTAC and the dialogue opportunities that you will provide to the Committee. Open and forthright communications will allow us to better serve you, as we strive together to enhance national energy security. Please do not hesitate to contact us with questions or suggestions on the Resolution or the Committee's activities.

Sincerely,



Dr. Alan C. Lloyd  
HTAC Chair (2006-2007)  
and  
President  
International Council on Clean  
Transportation



Honorable Robert S. Walker  
HTAC Vice-Chair (2006-2007)  
and  
Chairman  
Wexler & Walker Public Policy  
Associates

Enclosure: Resolution on the Composition of the Interagency Task Force  
cc: Distribution List

***Resolution on the Composition of the Interagency Task Force  
November 2006***

*"Whereas, the Interagency Working Group On Hydrogen and Fuel Cells (Interagency Working Group) serves an important role in assuring coordination of hydrogen policy and activities among Federal agencies; and*

*Whereas, Congress has mandated the President to establish an interagency task force on hydrogen to be chaired by the Secretary of Energy (Energy Policy Act of 2005, Section 806, P.L. 109-58); and*

*Whereas, the role of coordination demands participation by decision makers who can influence program implementation at their respective departments and agencies; and*

*Whereas, the work of the Hydrogen and Fuel Cell Technical Advisory Committee will be enhanced by an Interagency Working Group capable of implementation of its recommendations;*

*Therefore be it resolved, the Hydrogen and Fuel Cell Technical Advisory Committee recommends to the Secretary of Energy that the operational structure of the Interagency Working Group On Hydrogen and Fuel Cells requires participation at a functional level of the Assistant Secretary or higher, to ensure appropriate decision-making membership from each participating agency."*

***Hydrogen and Fuel Cell Technical Advisory Committee (HTAC)  
Created by Section 807 of Title VIII, Hydrogen, of the Energy Policy Act of 2005  
Chartered in June 2006 by the Secretary of the United States Department of Energy***

***Outcome of the Inaugural October 2-3, 2006, meeting in Arlington, Virginia***

Distribution List:

**HTAC Members Present at Inaugural Meeting**

Larry R. Bawden, President and CEO, Jadoo Power Systems  
John S. Bresland, Member of U. S. Chemical Safety Board  
Mark Chernoby, V.P., Advanced Vehicle Engineering, Chrysler Group Business Unit, DaimlerChrysler  
Uma Chowdhry, Senior Vice President and Chief Science and Technology Officer, DuPont Central R&D  
Mildred Dresselhaus, Institute Professor, Massachusetts Institute of Technology  
David J. Friedman, Research Director, Clean Vehicles Program, Union of Concerned Scientists  
Arthur T. Katsaros, Group V.P., Development and Technology, Air Products & Chemicals, Inc.  
Dan R. Keuter, V.P., Business Development, Entergy Nuclear, Inc.  
J. Byron McCormick, Executive Director, GM Global Fuel Cell Activities, General Motors Corp.  
Michael J. Mudd, CEO, FutureGen Alliance, Inc. and Manager of Technology Development,  
American Electric Power, Inc.  
Randall W. Napoli, Director, Florida State Fire Marshall  
Ian C. Purtle, Corporate VP, Director of Process Solutions Technology Development Center, Cargill, Inc.  
Michael P. Ramage, Executive VP (retired), ExxonMobil Research and Engineering,  
E. James Reinsch, President, Bechtel Nuclear  
Geraldine L. Richmond, Noyes Professor of Chemistry, University of Oregon  
Roger B. Saillant, President and CEO, Plug Power Inc.  
Robert W. Shaw, President, Aretê Corporation  
Kathleen Taylor, Director of Materials Processing Laboratory (retired),  
General Motors Research and Planning  
Jan van Dokkum, President, UTC Power  
J. Craig Venter, CEO, Synthetic Genomics, Inc.  
John M. Wootten, Environment and Technology, V.P. (retired), Peabody Energy

**HTAC Members Not Present at Inaugural Meeting**

John D. Hofmeister, President and U.S. Country Chair, Shell Oil Company  
Gregory M. Vesey, President, Chevron Global Power Generation

**Federal Government**

**U.S. Department of Energy**

David K. Garman, Under Secretary

Office of Energy Efficiency and Renewable Energy:

Arlene Anderson  
Christy Cooper  
Patrick Davis  
Kathi Epping (DFO)  
Sigmund Gronich  
JoAnn Milliken  
Antonio Ruiz  
Sunita Satyapal

Office of Fossil Energy

Lowell Miller

Office of Nuclear Energy

Sink, Carl

Office of Science

Kung, Harriet  
Vetrano, John  
Zhu, Jane

**U.S. Department of Transportation**

William Chernicoff