Statement of

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Before the

Subcommittee on Energy and Resources
Committee on Government Reform
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Mr. Chairman, Mrs. Watson, and Members of the Subcommittee, I appreciate the opportunity to appear before you today to discuss the Federal effort in hydrogen research and development.

America's energy challenges must be met with dedicated leadership and advanced technologies to improve the production, distribution, and use of energy. Beginning with his National Energy Policy Report in 2001, President Bush has established a clear path for our Nation to achieve a clean, secure, and affordable energy future through advances in technology. The President has launched key research and development initiatives in hydrogen, clean coal, carbon sequestration, biomass, nuclear energy, and fusion. These technologies, together with other elements of the President's energy plan, have the long-term potential to substantially reduce our Nation's dependence on foreign sources of energy while improving the environment. That is why it is so critical that Congress pass and send to the President's desk this week the comprehensive energy bill, which authorizes the President's key energy policies.

In concert with his research initiatives, the President has also advocated new energy efficiency standards for Federal and State governments and consumer products, tax incentives for the use of renewable sources of energy like wind and solar power, and tax incentives for the purchase of fuel-efficient hybrid vehicles. He has proposed extending the ethanol tax credit to encourage its continued use as an alternative source of fuel, and has promoted the safe expansion of nuclear energy, one of the cleanest forms of energy generation.

At a more fundamental level, the Administration has focused interagency research efforts in key areas such as nanotechnology, manufacturing, and high-end computing, in order to achieve the scientific understanding needed for substantial changes in our energy infrastructure. The important role of basic research in developing new energy systems and conversion processes has been highlighted in two reports by the President's Council of Advisors on Science and Technology.[1]

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[1] "The National Nanotechnology Initiative at Five Years: Assessment and Recommendations of the National Nanotechnology Advisory Panel," May 2005, and "Improving Efficiency in the Nation's Electrical System," February 2003.

One of the most promising opportunities for improving our energy infrastructure is hydrogen technology and America leads the world in hydrogen research. Two years ago, the President announced $1.2 billion over five years for the Hydrogen Fuel Initiative so that the first cars driven by today's children could be powered by hydrogen, and pollution-free. Successful development of technologies for the production, storage, distribution and use of hydrogen could dramatically reduce our dependence on foreign oil, as well as the emissions associated with fossil fuels.

Currently, two-thirds of U.S. oil consumption is in the transportation sector, and oil provides over 95% of the energy used by vehicles. By making a significant investment in research and development now, we can begin replacing our hydrocarbon-based transportation infrastructure with a hydrogen-based infrastructure. Leading the way in this effort is the Shell hydrogen fueling station here in Washington, DC, which the President recently toured on May 25, 2005.

At first, hydrogen will be produced primarily from natural gas, as it is today. In this case, net carbon emissions from fuel-cell vehicles on a well-to-wheels basis would be 25 percent less than gasoline-hybrid vehicles, and 50 percent less than today's conventional internal combustion engine vehicles. In the future, we expect that hydrogen would be produced from a combination of domestic energy sources and processes such as coal gasification with carbon sequestration, nuclear energy, photoelectrochemical water splitting, biological water splitting, wind-powered electrolysis, and biomass reformation. The Administration funds related research efforts in each of these technologies. For example, the Generation IV International Forum, with nine other nations as partners, is working on nuclear reactor designs that are safe, economical, secure, and able to produce both electricity and hydrogen. As hydrogen production shifts more to these alternative sources, our transportation sector could dramatically reduce emissions of air pollutants and greenhouse gases.

We envision a future in which hydrogen serves, along with electricity, as a primary energy carrier for the U.S. economy, produced from a diversity of domestically available feedstocks. The optimal combination of energy sources will likely depend on regional factors such as market availability, environmental constraints, and state regulations. Similarly, hydrogen distribution and delivery systems will most likely involve a combination of centralized production facilities and pipelines, local production at neighborhood fueling stations, and truck delivery to rural areas.

Achieving the hydrogen vision will involve several significant steps. A hydrogen infrastructure must be built that will enable convenient, safe, and affordable refueling across the Nation. Hydrogen-powered fuel cell vehicles must be safe, reliable and cost-competitive with the conventional vehicles that they replace, and they must have sufficient hydrogen storage to provide a 300-mile driving range without excessive size, weight, or cost. Industry codes and standards will be needed to guide the safe design, handling, and operation of hydrogen systems.

The President's Hydrogen Fuel Initiative, led by the Department of Energy (DOE), funds research in each of these areas, with the goal to enable an industry commercialization decision by 2015 to begin production of fuel-cell vehicles. So far, in FY 2004 and 2005, DOE has competitively selected more than $510 million in multi-year research and development (R&D)

projects, subject to appropriations, in the areas of hydrogen production, storage, distribution, and fuel cells. This includes $150 million over five years for hydrogen storage R&D at three Centers of Excellence, and $64 million in funding over three years in the Office of Science for basic research in nanoscale catalysts, novel materials for hydrogen storage and conversion, and hydrogen production from solar energy and biological processes.

Federal funding for hydrogen research is producing results. Technology development funded by DOE and industry has reduced the estimated cost of automotive fuel cells purchased in high-volume by 25% (from $275 per kilowatt to $200 per kilowatt) over the past three years. Development efforts have also reduced the estimated cost of delivered, natural gas-based hydrogen production from $5.00 per gasoline gallon equivalent in 2003 to $3.60 today. While this progress is encouraging, additional research is needed to make these technologies commercially viable. DOE's 2015 cost target for fuel cells is $30 per kilowatt, and the target for delivered, untaxed hydrogen is $2 – $3 per gasoline gallon equivalent. These goals are challenging. Other technical goals for the Hydrogen Fuel Initiative, such as energy density requirements for on-board hydrogen storage, will also require major technology advances. DOE has established a close collaboration among the Federal government, State governments, industry, academia, and the national laboratories to focus on the basic and applied research necessary to achieve these goals.

The overall Federal R&D effort has also been engaged to address these challenges. For the past several years, at the President's direction, the Directors of OSTP and the Office of Management and Budget have identified hydrogen R&D as an interagency budget priority. While DOE provides the leadership and most of the funding for the Hydrogen Fuel Initiative, other Federal agencies are also funding hydrogen-related research and development projects and demonstrations. The interests of each agency in hydrogen vary according to individual missions, but in general, these activities are relevant and complementary to the President's Hydrogen Fuel Initiative.

To encourage collaboration among the Federal agencies, OSTP has established an Interagency Task Force on Hydrogen R&D ("Hydrogen Task Force"). By working together, agencies can better accomplish their own missions as well as contribute to overall progress toward the goals of the President's initiative. The work of this group also ties in with interagency coordination efforts in nanotechnology, networking and information technology, and manufacturing, which are organized by OSTP through the National Science and Technology Council (NSTC) Committee on Technology.

The Hydrogen Task Force has developed an extensive taxonomy of hydrogen research activities and has identified key areas for interagency collaboration. For each priority, agency leads and participants have been designated to develop and implement interagency coordination plans. The Hydrogen Task Force has also developed a public website, hydrogen.gov; organized a conference workshop on funding opportunities provided by the Small Business Innovation Research and Small Business Technology Transfer programs; and initiated plans for a public forum to highlight nanotechnology breakthroughs that could enable the hydrogen economy.

The Hydrogen Task Force has identified 22 focused R&D priorities for interagency collaboration. In the area of fundamental research, these include the investigation of high-performance, low-cost catalysts for hydrogen production and fuel cells; novel materials for hydrogen storage; robust and cost-effective membrane materials; and the molecular interactions of hydrogen and materials. These topics serve as focal points for collaboration among agencies funding basic research, including DOE, the National Science Foundation (NSF), the Department of Defense (DOD), the National Institute of Standards and Technology (NIST) in the Department of Commerce (DOC), and the Research and Innovative Technology Administration in the Department of Transportation (DOT).

With its ability to yield insights into structures and materials at the molecular level, nanotechnology holds the key to understanding and solving many of these basic challenges. To identify specific opportunities in this area, the Nanoscale Science, Engineering and Technology Subcommittee of the NSTC organized an interagency workshop in March 2004 on "Nanoscience Research for Energy Needs." This and other topical workshops contributed to development of the Strategic Plan of the National Nanotechnology Initiative, published in December 2004, which outlines the major areas for interagency investment, including nanomaterials, nanoscale processes, and next-generation instrumentation. Research in these areas could enable significant advances in hydrogen production, storage, and fuel cells.

Similarly, high-end computing R&D, which is coordinated within the interagency Networking and Information Technology R&D Program, is a valuable tool that can provide insight into highly complex processes associated with hydrogen production, storage, and conversion. Complex computational simulations for solid-oxide fuel cells and proton exchange membrane fuel cells are being developed by Sandia National Laboratories. High-performance clusters or supercomputers will be used to model and analyze the operation (fluid flow and multi-dimensional transients) of fuel cell stacks at a detailed level. High-end computing can also be used to model microbial systems that might be modified for more efficient production of hydrogen through photosynthesis.

In addition to fundamental research, the Hydrogen Task Force coordinates activities associated with hydrogen pipelines and refueling, hydrogen turbines and internal combustion engines, solid-oxide fuel cells, safety, codes and standards, and several exploratory approaches to hydrogen production. For each of these topics, which are intentionally limited to areas of multi-agency interest, the Hydrogen Task Force serves as a forum for information sharing and collaboration on program plans, research projects, solicitations, and demonstrations. For example, DOE and the Environmental Protection Agency (EPA) have collaborated to improve their simulation and modeling tools. DOE, DOT, EPA, NIST, and NASA collaborate on hydrogen safety, codes and standards, and regulatory issues. DOE, DOT, NASA, NIST, and NSF are sharing data and planning research to better understand hydrogen embrittlement of pipelines and storage vessels. Several agencies are funding fuel cell vehicle and hydrogen fueling demonstrations, including DOE, DOT, DOD, EPA, and the US Postal Service, and these organizations provide updates about their progress and test results to the interagency group.

Additionally, we have recently begun a coordination group within the Hydrogen Task Force devoted to workforce issues, with expected participation from NSF, NIST, DOD, DOE, DOT,

NASA, and the Department of Labor (DOL). This group will discuss agency efforts such as the NSF Advanced Technological Education Program, DOL programs associated with the President's High Growth Job Training Initiative, and other workforce education initiatives. Within the framework of these programs, we plan to develop a performance-based, hands-on apprenticeship pilot program for technicians and engineers to receive training with fuel cell manufacturers.

Manufacturing R&D will be critical to transferring technology successes from the laboratory to the market, potentially leading to new jobs, new investments, and a competitive U.S. supplier base in a global economy. For this purpose, the NSTC Interagency Working Group on Manufacturing R&D, chaired by DOC, has selected hydrogen manufacturing, along with nanomanufacturing and intelligent and integrated manufacturing systems, as its top priorities. DOE and other agency participants recently organized a workshop for government, industry, and university stakeholders to develop a roadmap specifically for hydrogen and fuel cell manufacturing technologies. The roadmap will help to coordinate the Federal Government research agenda with industry and to guide future budget requests.

There are other coordination groups involving Federal agencies in the hydrogen arena, including the U.S.-initiated International Partnership for the Hydrogen Economy, which includes DOE, DOT, DOC, State Department, USAID, and representatives from 16 other nations that collaborate on hydrogen research and global codes and standards. Another significant group is the California Fuel Cell Partnership, which includes DOE, DOT, and EPA, along with eight automakers, four energy companies, and several State and local government agencies.

The hydrogen vision is ambitious, but through the President's Hydrogen Fuel Initiative, together with related activities across the federal government, we can make substantial progress towards the vital national goals of energy security and environmental stewardship.

I would be happy to answer any questions you may have.