DOE Hydrogen and Fuel Cells Program Record		
Record #: 5002	**Date:** March 27, 2006	
Title: Hydrogen Program Solicitation Awardee Announcements		
Originator: Elvin Yuzugullu		
Approved by: JoAnn Milliken	**Date:** March 28, 2006	

Item:

"Competitively selected approximately $529 million in projects ($779 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:"

References:

- "Selected 65 new hydrogen production and delivery projects ($107 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; $30 million for coal; and $2 million for nuclear-based hydrogen)."

U.S. Department of Energy, Press Release (October 19, 2004), "DOE Awards $75 Million in Research Grants in Support of President Bush's Hydrogen Fuel Initiative," retrieved January 9, 2006 from http://www.energy.gov/news/1525.htm.

For Immediate Release
October 19, 2004

DOE Awards $75 Million in Research Grants in Support of President Bush's Hydrogen Fuel Initiative

WASHINGTON, DC – Secretary of Energy Spencer Abraham today announced that the department has selected over $75 million in research projects to support the President's Hydrogen Fuel Initiative.

In last year's State of the Union address, President Bush communicated his vision that, "the first car driven by a child born today could be powered by hydrogen, and pollution-free." The research projects announced today address major technical and economic hurdles in renewable and distributed hydrogen production technologies that must be overcome to make the President's vision a reality.

"Hydrogen from diverse domestic resources has the long-term potential to deliver greater energy independence by reducing America's reliance on foreign sources of energy, Secretary Abraham said. "The projects we are announcing today highlight the emphasis that the department has placed on renewable and distributed production of hydrogen. They will move the nation toward advanced technologies to make and deliver safe, affordable hydrogen for fuel cell powered

vehicles."

The proposals selected are a key factor in moving forward and also address major recommendations from the recent National Research Council (NRC) Report "The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs," including the NRC's call for shifting more hydrogen production work towards more exploratory research on long-term sustainable, carbon-free pathways. Projects announced today include several renewable hydrogen production technologies powered by sun.

The projects selected also establish more robust programs in near-term distributed hydrogen generation appliances such as small-scale natural gas reformers and electrolyzers that can be sited at existing gasoline stations. This addresses another NRC recommendation to use already existing natural gas pipelines and electricity transmission and distribution systems which already exist. These small scale technologies can also make use of renewable resources to produce hydrogen such as bio-derived liquids and wind-based electricity.

Work resulting from the awards is expected to increase the United States' leadership in hydrogen technology. When private cost share is included, these projects come to a nearly $100 million investment in this second round of major hydrogen research funding. The projects involve 36 lead organizations and include over 80 teaming organizations. Selected organizations include academia, industry, and support by DOE national laboratories. Projects were chosen through a merit-review, competitive solicitation process.

Hydrogen Research Projects Selected for $75 Million in DOE Awards

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U.S. Department of Energy, Press Release, (March 16, 2005), "DOE Announces $62.4 Million in Clean Coal R&D Awards," retrieved January 9, 2006 from http://www.fe.doe.gov/news/techlines/2005/tl_coal_bbfa.html.

DOE - Fossil Energy Techline - Issued on: March 16, 2005

DOE Announces $62.4 Million in Clean Coal R&D Awards

Supports President Bush's Initiative to Make America More Energy Secure

Washington, DC — Secretary of Energy Samuel Bodman today announced the award of $62.4 million for 32 clean coal research projects to advance President George W. Bush's goal to develop a coal-fired zero emissions power plant. This initiative will also advance other energy-related policy initiatives in energy, climate and hydrogen, including the FutureGen zero-emissions power plant of the future.

"Coal is our most abundant fuel resource. It's important that we find ways to use it in a cleaner, more efficient way in order to provide the energy needed to continue our economic growth and job creation," Secretary Bodman said. "All of these projects are an investment in our Nation's energy and economic security, present and future."

Among the objectives of the research are:

Improved and new methods of producing pure hydrogen in coal gasification;
Hydrogen handling - safe storage of hydrogen, and on-board storage which will aid the commercialization of hydrogen fuel cell vehicles;
Improved and simplified removal of multiple pollutants in coal gasification;
Development of carbon dioxide capture technology that can be retrofit on existing coal-based powerplants;
Expansion of carbon sequestration technology to identify and accurately assess the CO2 storage capacity of geologic formations; and,
Development of new alloys to advance ultra-supercritical generation with pulverized coal, an emerging newer technology that can deliver power with ultra-low emissions and ultra-high efficiency.

The projects will be managed by the DOE Office of Fossil Energy's National Energy Technology Laboratory (NETL) and will support NETL's Coal and Power Research and Development (R&D) program in four program areas of interest: Carbon Sequestration; Power Systems Advanced Research; Coal Fuels and Hydrogen; and Advanced Gasification. The projects total nearly $62.4 million in government and contractor cost-shared funds, with DOE contributing approximately $48.7 million.

The Carbon Sequestration program area supports President Bush's Global Climate Change Initiative goal of reducing greenhouse gas intensity by 18 percent over the next 10 years by developing technologies to capture, store, and in some cases use greenhouse gases. The eight projects will focus on direct and indirect carbon dioxide (CO2) capture technologies; technologies for mitigating non-CO2 greenhouse gas emissions; and monitoring, verification and risk assessment for carbon sequestration options.

The overall goal of the Power Systems Advanced Research program area is to develop the scientific knowledge base for the development of revolutionary technologies and processes with substantial improvements and advances in power, environmental, and fuel systems. As part of the DOE effort to improve the Nation's energy infrastructure — which includes power plants, power transmission systems, and fuel production and transportation systems — eight projects will focus on developing novel high temperature materials for in situ sensing devices, materials for ultra supercritical steam (USC) turbines, and advanced power plant simulation.

The Coal Fuels and Hydrogen program sponsors coal-based research in development of processes to produce clean liquid transportation fuels and hydrogen, more efficient processes for manufacturing carbon products and chemicals, and advanced separation processes. Twelve projects will focus on hydrogen storage, production of high hydrogen content coal-derived liquids, process intensification, advanced water-gas shift membrane reactors, advanced solvents and solid sorbents-based separation systems, advanced fuels research, and advanced solid separation technologies.

Advanced Gasification research will focus on integrated sulfur, ammonia and chloride removal and integrated multiple contaminant removal of mercury, arsenic, selenium and cadmium. Four projects have been awarded in this area.

Awards in the four research areas are described in detail below:

Carbon Sequestration

Southern Research Institute (Birmingham, Ala.) — Oxygen-fired CO2-recycle combustion will be extensively investigated to develop a complete, fundamental understanding of the most effective methods of retrofitting this technology to existing air-blown coal-fired boilers with a minimum capital expenditure.

The detailed quantitative experimental map developed through the research will promote the commercialization of this technology and enable optimized implementation of oxy-fired CO2 recycle to obtain maximum benefit. Team members include BOC Gases, Murray Hill, N.J.; Maxon Corp., Muncie, Ind.; Reaction Engineering International, Salt Lake City, Utah; and FirstEnergy, Akron, Ohio. (DOE share: $863,724; Project duration: 36 months)

University of Michigan (Ann Arbor, Mich.) — A combination of laboratory and field experiments will be performed to develop effective, efficient and economic methodologies that will minimize microbial production of nitrous oxide and maximize microbial consumption of methane in landfill cover soils. This project will determine what suite of geochemical parameters should be provided to minimize the net emission of methane and nitrous oxide in situ. A matrix of soil microcosms will be constructed with landfill cover soils and exposed to a range of geochemical parameters that are known to affect methane and nitrous oxide production and consumption. Then, the suite of geochemical conditions noted to cause the greatest net reduction in greenhouse gases will be applied at a landfill in southern Michigan to verify that (1) such

conditions can be easily and inexpensively maintained using simple application strategies, and (2) that such treatments will reduce methane and nitrous oxide emissions over larger areas. (DOE share: $501,205; Project duration: 36 months)

University of Delaware (Newark, Del.) — Researchers will demonstrate the Intelligent Bioreactor Management Information System (IBM-IS) for the control of fugitive landfill gas emissions from an anaerobic bioreactor landfill. IBM-IS is a computer-controlled program that manages a network of automated sensors (e.g., gas pressure transducers) and control points (e.g., valves) to manage and control landfill gas extraction and liquid addition. The utility of the IBM-IS approach will also be evaluated for the control of an aerobic bioreactor landfill, where the objective is to maximize biodegradation and minimize the formation of methane by controlled injection of air and liquids. New in situ measurement techniques will be coupled with new and existing computer models of landfill processes in the demonstration of the IBM-IS. Team members include Yolo County, Calif., Planning and Public Works Department, Division of Integrated Waste Management, Woodland, Calif.; Institute for Environmental Management, Inc. (IEM), Palo Alto, Calif.; and Hydro Geo Chem, Inc., Tucson, Ariz.. (DOE share: $599,373; Project duration: 36 months)

University of North Carolina at Charlotte (Charlotte, N.C.) — The research objective is to design a tarp impregnated with immobilized methane oxidizing bacteria and then field test it for use as an alternative daily cover that can reduce methane emissions during the active life of a landfill. The project team will evaluate a number of methods for bacteria immobilization to identify suitable strategies for maintaining methane oxidizers in a tarp matrix; design the tarp, and investigate various matrix options to support and sustain the microbes in a material that can also serve as alternative daily landfill cover. The work will result in at least three promising prototypes which will be field tested, and the results of the field tests will be used to assess the prototypes and recommend one of the designs for further development and full-scale field testing. Team members include Landfills+ Inc., Wheaton, Ill.; Ten Cate Nicolon, Pendergrass, Ga.; and BFI CMS Landfill, Concord, N.C. (DOE share: $417,645; Project duration: 36 months)

Battelle Memorial Institute (Columbus, Ohio) — The overall objectives of this work are to develop an improved understanding of the geologic formations in the midwestern United States and, in the process, identify formations of interest for CO2 storage and determine the geologic patterns in their regional distribution. These formations may represent potential storage reservoirs or containment layers. The emphasis in developing this framework will be on obtaining information needed for quantitative assessment of geologic storage potential such as formation thickness, structural controls, permeability, and porosity data. Ultimately the comprehensive assessment of the compiled data along with knowledge of the sedimentary history of the area can be used to develop models and improve predictability of sequestration targets in this region. The project supports the DOE's overall goal of developing safe, effective, and low-cost geologic sequestration options and specifically helps with measurement and verification of the geologic storage potential in a critically important region that is heavily dependent on coal-based power generation. (DOE share: $1,819,700; Project duration: 36 months)

Geological Survey of Alabama (Tuscaloosa, Ala.) —The objectives of the project are to develop software for the assessment of risks associated with carbon sequestration in coal and to use that software to assess risks associated with carbon sequestration and enhanced coalbed methane recovery in the Black Warrior basin. The primary tasks of the project are software development, fracture analysis, and Discrete Fracture Network (DFN)/flow modeling. Fractures in outcrops and wireline cores from the Black Warrior basin will be analyzed to determine statistical scaling rules and to construct DFN models of coal-bearing strata. Short- and long-term leakage risks posed by carbon sequestration and enhanced coalbed methane recovery operations will then be analyzed on the basis of the DFN models and flow models.Team members include the University of Alabama, Tuscaloosa, Ala.; and Jim Walter Resources, Incorporated, Brookwood, Ala.. (DOE share: $399,889; Project duration: 36 months)

University of Kentucky Research Foundation (Lexington, Ky.) —Researchers will measure and document rates of surface gas flux and the composition of surface and shallow soil gases in areas overlying possible carbon sequestration sites in eastern Kentucky, providing (1) a database for interpreting the atmospheric, biologic, and geologic factors affecting gas flux prior to sequestration (2) a screening tool for selecting possible sequestration sites, and (3) a methodology for monitoring changes in surface and shallow gas flux and composition that might occur during a sequestration project. (DOE share: $276,232; Project duration: 24 months)

Winrock International (Morrilton, Ark.) — The overall objective of this project is to develop, test and apply new low-cost technologies and methods to detect carbon changes in mixed hardwood forests. The approach combines 3D terrain reconstruction with multiple ranging lasers and multispectral imagery to develop new techniques of canopy crown detection and automated delineation that currently do not exist, but are crucial in reducing costs in monitoring and estimating standing biomass in forests while maintaining known levels of

precision. American Electric Power, Gahanna, Ohio, is teaming with Winrock International to conduct the research. (DOE share: $398,720; Project duration: 24 months)

Power Systems Advanced Research

General Electric Global Research Center (Niskayuna, N.Y.) — GE will develop a novel distributed fiber-optic micro-sensor capable of detecting common fossil fuel gases in harsh environments. During the first year, the researchers will investigate, design, and synthesize materials to modify the cladding layer on a novel fiber-optic grating sensor suitable to operate at 500°C and beyond. In the second year, the team will develop and fabricate fiber-optic micro gas sensing devices to demonstrate gas sensing to selected gases and evaluate sensitivity, selectivity, and reliability, around and above 500°C. The final six months involve integrating and testing of multiple sensors on the same fiber to demonstrate its sensor fusion capability for a spatial-distributed sensing system. General Electric is teaming with Penn State University, University Park, Pa., for this project. (DOE share: $631,007; Project duration: 30 months)

New Mexico Institute of Mining and Technology (Soccorro, N.M.) — This project aims to develop new types of fiber-based optical sensors using doped-ceramic high temperature materials that may enable in situ monitoring of fossil fuel flue gases in high temperature (>500°C) and high pressure (~ 200 psi) environment. The research will primarily focus on fundamental issues including development of highly selective doped-ceramic materials, optimization of coating characteristics, and design of optical fiber structures. Performance of these newly created sensors will be tested in simulated application environments to establish the selectivity, sensitivity, and stability of the materials and sensor devices. A partner in this project is Dr. Jerry Y.S. Lin of Phoenix, Ariz.. (DOE share: $527,942; Project duration: 36 months)

University of Utah (Salt Lake City, Utah) — The objective is to develop novel microscale (MEMS) gas sensing devices suitable for application in exhaust gas streams of power plants. The researchers will use thin film gas sensitive layers in combination with SiC-based micro hotplate devices to develop the novel MEMS. The use of thin film sensing layers and MEMS hotplate technologies yield excellent prospects for high volume fabrication of gas sensor devices, making them inexpensive to produce and relatively easy to be added to existing and future power plants.

The researchers will investigate thin films based on two different sensing mechanisms: electrochemical thin films for sensing H2O and H2S, and metal oxide semi conductive sensors for H2, CO, CO2 NH3, NOX, HCs, and H2. They will also investigate the development of micro hotplates and integration of gas sensing layers. (DOE share: $461,490; Project duration: 36 months)

Virginia Polytechnic Institute and State University (Blacksburg, Va.) The objective is to develop novel modified fiber materials for high temperature gas sensors based on evanescent wave absorption in standing hole optical fibers. To overcome the response time limitation of currently available holey fibers (due to gas phase diffusion constraints), a novel process will be developed to produce holes perpendicular to the fiber axis. An investigation of the feasibility of upgrading the technology to single crystal sapphire by use of sol-gel processing and laser backside photochemical etching will be accomplished, thereby providing a quantum leap in temperature capability of the gas sensor. (DOE share: $599,479; Project duration: 36 months)

Energy Industries of Ohio (Independence, Ohio) — The objective is to contribute to the development of materials technology for use in USC pulverized coal power plant steam turbines capable of operating with steam conditions up to 760°C (1400°F), 35 MPa (5000 psi). The overall approach is to measure the level of properties that are achievable in candidate alloys and then arrive at appropriate alloys and design configurations. The project then branches into two parallel efforts for acquiring the bench-scale material properties: (1) rotors, buckets and bolting materials, and (2) valves and cylinder body casing materials. The effort on rotors is further divided into welded and mono block or solid rotors. Development of materials technology for USC steam turbines to match the USC boiler conditions is necessary to support commercialization of USC power plants. The work proposed here is a significant first step towards achieving this goal. Team members include Alstom, Windsor, Conn.; GE Energy, Schenectady, N.Y.; Siemens Westinghouse, Orlando, Fla.; Oak Ridge National Laboratory, Oak Ridge, Tenn.; and EPRI, Palo Alto, Calif.. (DOE share: $2,087,877; Project duration: 36 months)

Fluent, Inc. (Lebanon, N.H.) — Fluent, Inc. and partners will develop an integrated simulation capability by linking a hierarchy of plant- and equipment-level models that will have varying levels of fidelity and computational speed suitable for either preliminary conceptual design or detailed final design. A main objective of the project is to complete the development of an integrated steady-state simulator that will include computationally efficient reduced order models (ROM) and a 3D virtual reality walkthrough capability. A second objective is to develop a prototype dynamic simulator that integrates plant- and equipment-level models. The use of leading commercial, advanced capability software tools as the

backbone of the simulator infrastructure will ensure that the infrastructure will remain supported and available to the industry far into the future for simulating advanced power plants. Team members include ALSTOM Power, Inc., Windsor, Conn.; Aspen Technology, Inc., Cambridge, Mass.; and Carnegie Mellon University, Pittsburgh, Pa.. (DOE share: $1,883,320; Project duration: 36 months)

Reaction Engineering International (Salt Lake City, Utah) — Reaction Engineering International (REI) proposes to develop a virtual engineering based software framework to support static and dynamic plant engineering simulations, which will be used to assess and evaluate the performance of advanced power generation systems. A software system that supports virtual engineering functionality will be used to create the framework, and financial models will be used to implement plant economics. The VE Suite Virtual Engineering Framework (VEF) will include a hierarchy of models and visualization tools to construct, perform and interrogate simulation results for component models and overall plant performance at multiple levels of detail within a three-dimensional (3-D), user-centered, interactive environment. The VEF will enable researchers to better understand the interactions of different equipment components, identify weaknesses and processes needing improvement and thereby allowing more efficient, less expensive plants to be developed and brought on line faster and in a more cost-effective manner. Team members include American Electric Power (AEP), Columbus, Ohio; AmerenUE, St. Louis, Mo.; Praxair, Tonawanda, N.Y.; MIT, Belmont, Mass.; EPRI, Palo Alto, Calif.; Iowa State University, Ames, Iowa; Carnegie Mellon University, Pittsburgh, Penn.; Cooperative Research Centre For Coal in Sustainable Development, Newcastle, Australia; and Enertechnix, Maple Valley, Wash.. (DOE share: $440,998; Project duration: 24 months)

Texas A&M University (College Station, Texas) — A method will be developed that will drastically reduce the computational effort required to model multiphase flow reactors such as circulating fluidized-bed combustors and fluid catalytic cracking risers. This reduction will be accomplished by developing a low order model based on the proper orthogonal decomposition (POD) method. In this project, a reduced order model for multiphase flow reactors previously developed by the investigator will be enhanced to better capture the flow physics, to reduce the computational time and to provide interfaces that allow for integration with power plant simulations. The development of the reduced order model will significantly impact the design of new reactors by improving the understanding of multiphase flow and chemical reactions. (DOE share: $298,974; Project duration: 36 months)

Coal Fuels and Hydrogen

Advanced Materials Corporation (Pittsburgh, Pa.) — In keeping with the overall goal of this research—to develop tailored sorbent materials for use in on-board hydrogen storage systems—the researchers propose to design, synthesize, and study a new class of lightweight, thermally stable, microporous metal organic materials (MMOMs). A subset of the general family of metal organic frameworks (MOFs), these microporous crystalline materials are composed of various metals which form the internal surfaces of the pores. The adsorption mechanism and interaction energies of hydrogen on these novel microporous materials will be performed, and the adsorption energies and binding character of hydrogen interacting with all parts of the MMOM sorbents will be studied. Detailed potential models will then be developed that will allow the investigators to perform statistical mechanical simulations to study the uptake of hydrogen as a function of temperature and pressure. Team members include Rutgers, The State University of New Jersey, New Brunswick, N.J.; and the University of Pittsburgh, Pittsburgh, Pa.. (DOE share: $544,103; Project duration: 24 months)

University of Michigan (Ann Arbor, Mich.) — Porous metal-organic frameworks (MOFs) will be designed to concentrate hydrogen in a practical volume at room temperature and reasonably safe pressures. To help meet the DOE guidelines for use of hydrogen as a fuel, the research will focus on increasing the uptake capacity of MOFs. The researchers will undertake the synthesis and structural characterization of MOFs and apply high throughput sorption measurements to test existing MOFs and to produce tailor-made MOFs. In addition, they will use Raman spectroscopy to examine the mechanism of hydrogen uptake and elucidation of hydrogen sorption sites. (DOE share: $618,871; Project duration: 24 months)

Headwaters Technology Innovation Group (Lawrenceville, N.J.)
This proposal covers bench-scale and pilot-scale process development unit (PDU) testing of high and medium-alpha iron-based catalysts to produce high-hydrogen content Fischer-Tropsch (FT) liquids. Barrel-quantity of FT liquid products will be delivered to NETL for various end-use tests. These research programs will confirm and provide scale-up data for commercial applications. Based on analysis of bench-scale results, the catalyst with superior commercial potential for high hydrogen content liquids production will be chosen for pilot-scale testing. Experimentation will also be performed on novel wax/catalyst separation methods, FT product upgrading, gas cleanup, and reformer performance. The potential benefit of this research is a more reliable, economic, and efficient coal-based system for producing FT liquids that will meet the DOE hydrogen program goals. Team members include Gas Technology Institute (GTI), Des

Plaines, Ill. Nexant, Inc., San Francisco, Calif.; Rentech, Inc., Denver, Colo.; UOP, Des Plaines, Ill.; Pall Corporation, East Hills, N.Y.; Air Force Research Laboratory, Dayton, Ohio; Argonne National Laboratory, Argonne, Ill.; and FT Solutions, South Jordan, Utah. (DOE share: $3,000,000; Project duration: 24 months)

Integrated Concepts and Research Corporation (Sterling Heights, Mich.) — Integrated Concepts and Research Corporation, with its partner, Syntroleum Corporation of Tulsa, Oklahoma, will evaluate commercially available coal gasification and synthesis gas (syngas) cleanup technologies and the integration of these processes with a cobalt catalyst based Fischer-Tropsch (FT) technology. The results of this work will provide a foundation for the development of a coal-to-liquids plant based on a cobalt catalyst FT technology. Additionally, engineering and economic analysis will be utilized to evaluate the commercial feasibility of a plant in a coal producing state. A field evaluation of 6,000 gallons of ultra-clean FT #2 diesel fuel will be performed in a coal producing state to introduce the value of these ultra-clean fuels and gain market awareness and acceptance. These fuels will be produced as part of DOE's ultra-clean fuel demonstration plant. (DOE share: $4,500,000; Project duration: 24 months)

Gas Technology Institute (Des Plaines, Ill.) — Gas Technology Institute and Arizona State University will develop a novel membrane reactor process that combines hydrogen sulfide removal, water-gas shift reaction, hydrogen separation and carbon dioxide separation in a single membrane configuration. The CO conversion of the water-gas-shift reaction from the coal-derived syngas stream is enhanced by the complementary use of two membranes within a single reactor to separate hydrogen and carbon dioxide. Consequently, hydrogen production efficiency is increased. The single membrane reactor configuration produces two products, one pure H2 stream and a second pure CO2 stream that is ready for sequestration. In addition, sulfur is removed by a front-end membrane section of the single module. (DOE share: $386,420; Project duration: 24 months)

General Electric (Niskayuna, N.Y.) — GE will develop a detailed design for a single, high-temperature syngas-cleanup module to produce a pure stream of H2 from a coal-based system and develop new high temperature membrane materials at the core of the design. The novel "one box" process combines shift reactors with a high temperature CO2-selective membrane to convert CO to CO2, remove sulfur compounds, and remove CO2 in a simple, compact, fully integrated system. (DOE share: $499,924; Project duration: 24 months)

Aspen Products Group (Marlborough, Mass.)—The objective of this project is to develop a low-cost, robust water gas shift (WGS) membrane reactor that can be used to produce high-purity hydrogen from coal-derived syngas. WGS is the reaction of water and carbon monoxide to produce hydrogen and carbon dioxide. The WGS membrane reactor will utilize a highly active, contaminant-tolerant WGS catalyst and a novel, highly selective hydrogen membrane structure that is also contaminant-tolerant. (DOE share: $498,227; Project duration: 24 months)

United Technologies Corporation (East Hartford, Conn.) — The objective of this work is to develop necessary technology for the production of 99.96% pure H2 from coal-derived synthesis gas by combining water gas shift reaction (CO and H2O react to form CO2 and H2) with simultaneous selective separation of H2 though a palladium (Pd) alloy membrane. This membrane reactor technology has the advantages of maximizing H2 productivity; eliminating complex, energy intensive processes like pressure swing adsorption to purify the H2; and producing a CO2 rich stream, that, after drying and a simple catalytic treatment to remove trace contaminants, is ready for compression and sequestration. United Technologies Corporation will be joined by QuesTek Innovations, LLC, Evanston, Ill., to conduct the research. (DOE share: $848,962; Project duration: 24 months)

University of Wyoming Research Corporation (Laramie, Wyo.) — With improved efficiency in hydrogen production as the goal, this project will undertake three steps in the improvement of the hydrogen production system. These steps include (1) development of an improved monolithic water gas shift catalyst that provides efficient conversion of carbon monoxide and structural support for a stacked assembly of membranes; (2) an improved vanadium alloy hydrogen transport membrane suitable for the chemical and physical environment of the coal-derived synthesis gas stream; and (3) an integrated stacked catalyst and membrane assembly scalable for commercial devices and economically designed for mass production. The structural water gas shift catalyst will have a formulation that will eliminate the friable nature of current iron oxide-based pellets. The shape of the catalyst will be important in the structure. WRI will partner with the Department of Chemical and Petroleum Engineering at the University of Wyoming to conduct the research. (DOE share: $500,000; Project duration: 24 months)

Lehigh University (Bethlehem, Pa.) — The research to be undertaken deals with a concept called Thermal Swing Sorption Enhanced Reaction (TSSER) process, which simultaneously carries out the water gas shift (WGS) reaction (carbon monoxide and water react to form carbon dioxide and hydrogen) and the separation of carbon dioxide as a single unit operation in a sorber-reactor. The process will potentially reduce the cost

of production of hydrogen by coal gasification as well as provide a carbon dioxide byproduct at gasification pressure for sequestration without large recompression costs, or for its sale as a chemical agent. It will also open up the possible use of a new genre of chemisorbents as separation agents at elevated temperatures without predrying the feed gas. Industrial participation will be solicited for future scale-up of this concept after successful completion of the proposed phase of the project. (DOE share: $403,892; Project duration: 24 months)

University of Kentucky Research Foundation (Lexington, Ky.) — The Consortium for Fossil Fuel Science (CFFS), a multi-university research consortium, will conduct a research program focused on (1) developing novel processes for the production of hydrogen using C1 chemistry; (2) developing novel hydrogen storage materials; and (3) synthesis and dehydrogenation of hydrogen-rich carrier liquids. The CFFS will conduct research on these feedstocks: synthesis gas derived from coal, gaseous and liquid hydrocarbons produced from coal-derived syngas, coalbed methane, and natural gas. The research will emphasize development of a continuous reactor for the dehydrogenation of light alkanes to produce hydrogen and carbon nanotubes. The research is divided into three main categories: production of hydrogen, hydrogen storage, and advanced characterization of the catalysts and reaction products that are developed. Team members are West Virginia University, Morgantown, W.Va.; University of Pittsburgh, Pittsburgh, Pa.; Auburn University, Auburn, Ala.; and University of Utah, Salt Lake City, Utah. (DOE share: $6,000,000; Project duration: 36 months)

Virginia Polytechnic Institute and State University (Blacksburg, Va.)
A consortium of seven universities will conduct broad-based research at the Center for Advanced Separation Technologies (CAST) to develop advanced technologies in physical separation, chemical/biological separation, and environmental control, which have crosscutting applications in the mining industry. The advanced separation technologies developed in the proposed work can be used for producing high-quality solid fuels with maximum recovery without adversely impacting the environment. Some of the technologies can also be used for extracting values from low-grade ores and cleaning up the environment. The new technologies and information generated from the proposed work will help the U.S. mining industry provide low-cost energy and mineral resources in a sustainable manner. The university members include Virginia Polytechnic Institute and State University; West Virginia University; Montana Tech of the University of Montana; New Mexico Institute of Technology; University of Nevada, Reno; University of Utah; and University of Kentucky. (DOE share: $12,000,000; Project duration: 36 months)

Advanced Gasification

Gas Technology Institute (Des Plaines, Ill.) — The project will undertake the development of an integrated multi-contaminant removal process in which hydrogen sulfide (H2S), ammonia (NH3), hydrogen chloride (HCl) and heavy metals including mercury (Hg), arsenic (As), selenium (Se) and cadmium (Cd) present in coal-derived syngas will be removed to specified levels in a single process step. To accomplish this, a novel process called high pressure University of California Sulfur Recovery Process (UCSRP-HP) that directly converts H2S into elemental sulfur at 285°F to 300°F will be developed for coal-derived syngas. Other contaminates such as NH3, HCl and other trace contaminants will be removed in separate sections of the same reactor column. The preliminary process concept has been verified using a batch reactor at the Gas Technology Institute (GTI) and the results have been found to be very promising. The proposed process is tightly integrated and is expected to be significantly more economical both in terms of capital and operating costs because it could replace with one single unit the multi-unit processes used in conventional schemes. This study will be conducted by a team led by GTI and consisting of the University of California at Berkley, IP owners of this technology, and ConocoPhillips, with industrial expertise in coal-gasification for power generation. (DOE share: $359,957; Project duration: 18 months)

Research Triangle Institute (Research Triangle Park, N.C.) — One of the major costs of integrated gasification combined cycle (IGCC) technology is cleaning the syngas to near zero levels at temperatures and pressures matching the existing gasification and syngas utilization systems. Removal of the contaminants contained in syngas in a cost-effective way is critical for cost reduction of the IGCC technology, while maintaining or improving the thermal efficiency of the overall IGCC system. The researchers proposed to address this need by breaking the syngas cleaning task into bulk and polishing removal stages. Bulk removal will be accomplished with a transport reactor system to reduce H2S, COS, NH3 and HCl down to low ppm to sub-ppm concentrations using a multifunctional sorbent. The polishing removal stage will be accomplished using a fixed-bed system with a multifunctional sorbent designed to achieve near zero levels with materials containing active chemical sites for H2S, COS, NH3, HCl, and the heavy metals. Suitable selection of the composition of these multifunctional sorbents will make this process capable of handling the significant variations in bulk syngas contaminant concentrations and the contaminant removal required for various syngas utilization requirements. Team members are Eastman

Chemical Company, Kingsport, Tenn.; Nexant, San Francisco, Calif.; SRI, Menlo Park, Calif.; Sud Chemie, Louisville, Ky.; and URS Corporation, Austin, Texas. (DOE share: $1,032,654; Project duration: 72 months)

TDA Research, Incorporated (Wheat Ridge, Colo.) — This project will develop a novel gas cleaning technology for removing multiple trace metals (particularly mercury, arsenic, selenium and cadmium) from coal-derived synthesis gas at high temperature. The new sorbent-based trace metal removal process, when combined with warm or hot gaseous pollutant removal, will enable the efficient integration of all types of coal gasification technologies with downstream processes such as a gas turbine combined cycle, fuel cells and chemical generation, and will meet anticipated near-zero emissions control requirements. (DOE share: $300,000; Project duration: 12 months)

University of North Dakota (Grand Forks, N.D.) — This project will develop an impregnated monolith for contaminant control under oxygen-blown operation on a suite of low-rank coals including both North Dakota and Texas lignite. The monolith developed by Corning Inc. is a fixed honeycomb-like structure that will force the contaminant-laden syngas to travel through multiple small channels in the monolith. The surfaces inside the monolith will be impregnated with a sorbent developed by the University of North Dakota Energy Environmental Research Center (UNDEERC). The monolith structure is expected to result in high syngas-sorbent contacting, low pressure drop and a long sorbent life, all of which could result in substantial cost savings over the more common particulate sorbent approach for gas cleanup.

UNDEERC is the cooperative agreement recipient, with Corning as a substantial partner, both in terms of technical development and cost share. (DOE share: $4,993,179; Project duration: 60 months)

U.S. Department of Energy, Press Release, (December 23, 2004), "Department of Energy Announces the Award of 35 Cooperative Agreements with U.S. Universities Totaling About $21 Million," retrieved January 9, 2006 from http://www.ne.doe.gov/home/12-23-04.html.

Department of Energy Announces the Award of 35 Cooperative Agreements with U.S. Universities Totaling About $21 Million

December 23, 2004

WASHINGTON, DC – Secretary of Energy Spencer Abraham today announced 35 research awards to U.S. universities totaling $21 million over three years to engage students and professors in the Department of Energy's (DOE) major nuclear energy research and development programs, including the Advanced Fuel Cycle Initiative, the Generation IV Nuclear Energy Systems Initiative and the Nuclear Hydrogen Initiative.

The Energy Department has restructured its Nuclear Energy Research Initiative to provide U.S. universities with the opportunity to participate directly in the agency's priority efforts to develop the nuclear technologies that could pave the way to an economy that relies less on imported fossil fuels and will allow the Nation to meet its long-term environmental goals. The awards announced today are the first to benefit from this new approach to peer-reviewed nuclear technology research and development.

"This vitally important research will benefit both our advanced technology development efforts and our academic system to have America's best and brightest students and professors work with us to conduct this challenging research," Secretary Abraham said. "The awards we announce today will bring us a step closer to a better, more secure energy future and also help develop the scientists and engineers that will keep the United States at the forefront of technology well into the future."

The 35 projects announced today were selected in a rigorous peer review of 160 proposals from universities all over the United States. The selected projects will be conducted at 25 U.S. universities in

22 different states. Many of the participants represent institutions that have not participated in DOE nuclear technology programs in recent years.

Most of the awards are for a three year period. The total funding for the awards over the three year period ranges from $299,000 to $914,000. There is also one award with a duration of approximately one year; this award is for $116,000. The research projects and additional information on other DOE nuclear science and engineering educational initiatives that are sponsored by the Office of Nuclear Energy, Science and Technology are available at **www.nuclear.gov**.

DOE will now enter into negotiations with the 25 universities selected to reach final cooperative agreement terms including award dates.

Media contact: Hope Williams, 202/586-5806

- DOE -

Release No. R-04-376

- "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. The focus of these efforts, which include over 35 universities, 14 Federal laboratories, and 13 industry partners, is to develop high capacity materials and low-pressure storage technologies."

U.S. Department of Energy, Press Release, (April 27, 2004), "Secretary of Energy Abraham Announces NREL, Los Alamos and Sandia Hydrogen Storage 'Centers of Excellence,'" retrieved January 9, 2006 from http://www.energy.gov/news/1331.htm.

For Immediate Release
April 27, 2004

Secretary of Energy Abraham Announces NREL, Los Alamos and Sandia Hydrogen Storage "Centers of Excellence"

GOLDEN, COLORADO-- Secretary of Energy Spencer Abraham announced today that the Department of Energy (DOE) has selected over $150 million in hydrogen storage research projects to support President Bush's Hydrogen Fuel Initiative.

The awards include the formation of three "Centers of Excellence," at the National Renewable Energy Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories, integrating the expertise of the DOE National Laboratories in partnership with industry and academia

"In last year's State of the Union address, President Bush communicated his vision that the first car driven by a child born today could be fueled by hydrogen and pollution free," Secretary Abraham said. "The research projects announced today address the key technical and economic

hurdle of hydrogen storage that must be overcome to make the President's vision a reality."

Each "Center of Excellence" will include a DOE national laboratory lead and several university and industry partners. Responding to DOE's "Grand Challenge" solicitation, these centers will address the major technical barrier to on-board hydrogen storage - storing enough hydrogen to enable greater than 300 mile driving range without impacting cargo or passenger space. In addition, individual universities, research institutes, and small businesses will explore new materials for hydrogen storage.

One of the key recommendations of the recent National Academies report "The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs," is that DOE should partner with a broader range of academic and industrial organizations to greatly increase the probability of success in bringing the United States to a hydrogen economy.

Earlier today, Secretary Abraham announced other awards in support of President Bush's Hydrogen Fuel Initiative. Combined, today's announcements total over $350 million in hydrogen research projects. When private cost share is included, the total amount of awards, which still need to be negotiated, may be over $575 million.

Hydrogen Storage Grand Challenge

Centers of Excellence		
LANL/PNNL	**SNL**	**NREL**
Chemical Hydrogen Center	**Metal Hydride Center**	**Carbon Center**
Los Alamos National Laboratory (Los Alamos, NM)	Sandia National Laboratories (Livermore, CA)	National Renewable Energy Laboratory (Golden, CO)
Pacific Northwest National Laboratory (Richland, WA)	Stanford University (Stanford, CA)	California Institute of Technology (Pasadena, CA)
University of Pennsylvania (Philadelphia, PA)	General Electric (Niskayuna, NY)	Duke University (Durham, NC)
UCLA (Los Angeles, CA)	University of Hawaii (Honolulu, HI)	Penn State University (University Park, PA)
UC-Davis (Davis, CA)	California Institute of Technology (Pasadena, CA)	Rice University (Houston, TX)
Penn State University (University Park, PA)	Jet Propulsion Laboratory (Pasadena, CA)	University of Michigan (Ann Arbor, MI)
University of Washington (Seattle, WA)	HRL Laboratories (Malibu, CA)	University of North Carolina (Chapel Hill, NC)
University of Alabama (Tuscaloosa, AL)	University of Illinois (Champaign, IL)	University of Pennsylvania (Philadelphia, PA)
Rohm and Haas (Philadelphia, PA)	Univ. of Pittsburgh/Carnegie Mellon Univ. (Pittsburgh, PA)	Oak Ridge National Laboratory (Oak Ridge, TN)
Millennium Cell (Eatontown,	NIST (Gaithersburg, MD)	Lawrence Livermore National

NJ)		Laboratory (Livermore, CA)
Intematix (Moraga, CA)	University of Nevada-Reno (Reno, NV)	NIST (Gaithersburg, MD)
US Borax (Boron, CA)	Oak Ridge National Laboratory (Oak Ridge, TN)	Air Products (Allentown, PA)
	University of Utah (Salt Lake City, UT)	
	Intematix Corporation (Moraga, CA)	
	Brookhaven National Laboratory (Brookhaven, NY)	
Individual Projects		
Prime	Partners	Research Area
TIAX LLC (Cambridge, MA)	Gas Technology Institute (IL) Yale University (CT) University of Oklahoma (OK)	Lifecycle and cost analysis
University of Missouri (St. Louis, MO)	Pacific Northwest National Laboratory (WA)	New materials
University of Connecticut (Storrs, CT)	Pacific Northwest National Laboratory (WA)	New materials
Michigan Technological University (Houghton, MI)	None	Chemical hydrides
Gas Technology Institute (2 projects) (Chicago, IL)	Superior Graphite Co. (IL) NEXGEN Fueling (MN)	Carbon Off-board storage
Alfred University (Alfred, NY)	Savannah River Technology Center (SC)Mo-Sci Corporation (MO) CERALINK (NY)	New processes
Carnegie Institute of Washington (Washington, DC)	None	New materials
Research Triangle Institute (Research Triangle Park, NC)	State Scientific Research Institute (Moscow, Russia) ATK/Thiokol Propulsion (UT)	Chemical hydrides
State University of New York (Syracuse, NY)	PoroGen, LLC (MA)	Carbon
TOFTEC, Inc. (Gainesville, FL)	University of Florida, Gainesville (FL)	New processes
University of Michigan (Ann Arbor, MI)	Northwestern University (IL) Los Alamos National Laboratory (NM)	New materials

University of Pennsylvania (Philadelphia, PA)	Drexel University (PA) NIST (MD)	Carbon
University of California-Berkeley (Berkeley, CA)	Lawrence Berkeley National Laboratory (CA)	New materials
University of California-Santa Barbara (Santa Barbara, CA)	Los Alamos National Laboratory (NM)	New materials

Media contact: Tom Welch, 202/586-5806

U.S. Department of Energy, Press Release, (May 25, 2005), "Department of Energy Announces $64 Million in Hydrogen Research & Development Projects," retrieved January 9, 2006 from http://www.energy.gov/news/1639.htm.

For Immediate Release
May 25, 2005

Department of Energy Announces $64 Million in Hydrogen Research & Development Projects

WASHINGTON, DC – Secretary of Energy Samuel W. Bodman today announced the selection of over $64 million in research and development projects aimed at making hydrogen fuel cell vehicles and refueling stations available, practical and affordable for American consumers by 2020.

"Since President Bush first laid out his vision for a hydrogen economy, we've witnessed incredible innovation and tremendous advancement," Secretary of Energy Samuel Bodman said. "We hope that through our ingenuity, investment and effort, hydrogen vehicles will someday be as commonplace as the cars we drive today."

A total of 70 hydrogen research projects have been selected to focus on fundamental science and enable revolutionary breakthroughs in hydrogen production, and storage in addition to new fuel cell technologies. Participants in the projects include more than 50 research organizations in 25 states. The organizations include academic institutions, industry, and national laboratories (see attached list).

The initiatives announced today are part of a comprehensive, balanced portfolio of basic and applied research, technology development, and learning demonstration projects aimed to significantly advance President Bush's Hydrogen Fuel Initiative. The projects were selected through an open, merit-reviewed, competitive solicitation process. A total of $64 million over three years will be provided by the Department to these entities, subject to Congressional appropriations.

The following projects address the five technical focus areas identified during the Department of

Energy's May, 2003 workshop on "Basic Research Needs for the Hydrogen Economy":

Novel Materials for Hydrogen Storage (17 projects, $19.8 million over three years)
On-board hydrogen storage has been identified by both the National Academy Sciences and the DOE as a key technology for the successful implementation of a hydrogen economy. However, significant scientific challenges remain, highlighting the need for further basic research. Within the hydrogen storage topic, 17 projects will be awarded to10 universities and 6 national laboratories. A broad range of research in hydrogen storage is covered by these selected projects, including complex hydrides; nanostructured and novel materials; theory, modeling, and simulation; and state-of-the-art analytical and characterization tools to develop novel storage materials and methods.

Membranes for Separation, Purification, and Ion Transport (16 projects, $12.3 million over three years)
Novel membranes are needed to selectively transport atomic, molecular, or ionic hydrogen and oxygen for hydrogen production and fuel cell applications. The 16 projects selected, which include 13 universities and 3 national laboratories, address integrated nanoscale architectures; fuel cell membranes; and theory, modeling, and simulation of membranes and fuel cells.

Catalyst Design at the Nanoscale (18 projects, $15.8 million over three years)
Catalysis plays a vital role in hydrogen production, storage and use. Specifically, catalysts are needed for converting solar energy to chemical energy, producing hydrogen from water or carbon-containing fuels such as coal and biomass, increasing efficiency in hydrogen storage kinetics, and producing electricity from hydrogen in fuel cells. Nanoscale catalyst designs will be explored through18 projects involving 12 universities and 5 national laboratories. Research areas include innovative synthetic techniques; novel characterization techniques; and theory, modeling, and simulation of catalytic pathways.

Solar Hydrogen Production (13 projects, $10 million over three years)
Efficient and cost-effective conversion of sunlight to hydrogen by splitting water is a major enabling technology for a viable hydrogen economy. Hydrogen production via solar energy conversion will be studied through 13 projects at 8 universities, 1 industry company, and 3 national laboratories. The projects address nanoscale structures; organic semiconductors and other high performance materials; and theory, modeling, and simulation of photochemical processes.

Bio-inspired Materials and Processes (6 projects, $7 million over three years)
Fundamental research into the molecular mechanisms underlying biological hydrogen production is the key to our ability to adapt, exploit, and extend what nature has accomplished for our own renewable energy needs. Bio-inspired materials and processes for hydrogen production will be investigated through 6 projects at 5 universities and 1 national laboratory. Research includes enzyme catalysis; bio-hybrid energy coupled systems; and theory, modeling, and nanostructure design.

A list of selected projects

Media contacts:
Mike Waldron, 202/586-4940

Tom Welch, 202/586-5806

- "Selected five projects that address critical fuel cell cost and durability issues for consumer electronics and other applications ($13 million over three years)."

U.S. Department of Energy, Press Release, (April 27, 2004), "Energy Secretary Spencer Abraham Announces $350 Million in Hydrogen Research Projects," retrieved January 9, 2006 from http://www.energy.gov/news/1330.htm.

For Immediate Release
April 27, 2004

Energy Secretary Spencer Abraham Announces $350 Million In Hydrogen Research Projects

DETROIT, MICH. – President George W. Bush's Hydrogen Research Initiative took center stage in Detroit today with Secretary of Energy Spencer Abraham announcing $350 million in nationwide funding for science and research projects to establish a hydrogen economy.

Abraham will make additional stops in Golden, Colorado and Los Angeles, California. There, he will speak to the National Hydrogen Association's meeting.

The $350 million represents nearly one-third of the President's $1.2 billion commitment in research funding to bring hydrogen and fuel cell technology from the laboratory to the showroom.

Selected through a merit-reviewed, competitive process, the projects involve 30 lead organizations and include over 100 partners. Recipients include academia, industry and DOE national laboratories. President Bush has proposed a multi-year research funding effort for program like FreedomCAR and the Hydrogen fuel initiative, to enable America to lead the world in developing clean, hydrogen-powered automobiles that would free the U.S. from dependence on foreign petroleum.

"President Bush's Administration recognizes that a hydrogen economy has the long-term potential to deliver greater energy independence by reducing America's dependence on foreign sources of energy," said Energy Secretary Abraham.

"It offers immense environmental benefits that current energy technologies cannot meet. This multi-million dollar commitment to research is a down payment on a more energy and environmentally secure future."

Key research areas include:

Hydrogen Storage

"Centers of Excellence" for exploratory research in hydrogen storage. Each center includes a DOE national laboratory lead and several university and industry partners. Responding to DOE's "Grand Challenge" solicitation, these centers will address the major technical barrier to on-board hydrogen storage - storing enough hydrogen to enable greater than 300 mile driving range without impacting cargo or passenger space. In addition, individual universities, research institutes, and small businesses will explore new materials for hydrogen storage. The DOE share for this National Hydrogen Storage Project is $150 million over 5 years with an additional private cost share of approximately $20 million.

Vehicle and Infrastructure "Learning" Demonstrations

"Learning demonstrations" that will provide important data to focus research efforts. The use of hydrogen as a transportation fuel and the development of fuel-cell vehicles will require extensive research and an implementation strategy. Automakers and energy companies will work together with their teams under this project to demonstrate integrated and complete system solutions operating in real world environments. These demonstrations will assess the research program's progress toward meeting the goal of making a commercialization decision by 2015. The expected DOE share is $190 million over 5 years with an additional private cost share of approximately $190 million.

Fuel Cell Research

Fuel cell research projects that address critical fuel cell cost and durability issues for consumer electronics and other applications. The DOE share is $13 million dollars over 3 years with an additional private cost share of approximately $10 million. These selections are in addition to the $75 million in fuel cell awards announced by Secretary Abraham last year.

Hydrogen Education

Hydrogen technology education projects include middle school and high school curricula and teacher professional development. These projects pair hydrogen technology experts with professional educators and experienced curriculum developers to create hands-on activities and lessons to engage students in the developing hydrogen economy. Teacher professional development is an essential component, as teachers nationwide will not only learn how to use the materials but also receive the training they need to build their

expertise and enhance their ability to educate students. The hydrogen education projects also include the development of materials suitable for a general audience. These materials will help introduce the public to the hydrogen vision, as well as provide a better understanding of how fuel cells work; how hydrogen is produced, delivered, and stored; and the facts about hydrogen safety.

Secretary Abraham added, "The financial commitment of the private sector dramatically increases the probability of success that we will overcome the technology challenges in this important endeavor and achieve the President's vision."

Hydrogen Storage Grand Challenge

	Centers of Excellence	
LANL/PNNL	**SNL**	**NREL**
Chemical Hydrogen Center	**Metal Hydride Center**	**Carbon Center**
Los Alamos National Laboratory (Los Alamos, NM)	Sandia National Laboratories (Livermore, CA)	National Renewable Energy Laboratory (Golden, CO)
Pacific Northwest National Laboratory (Richland, WA)	Stanford University (Stanford, CA)	California Institute of Technology (Pasadena, CA)
University of Pennsylvania (Philadelphia, PA	General Electric (Niskayuna, NY)	Duke University (Durham, NC)
UCLA (Los Angeles, CA)	University of Hawaii (Honolulu, HI)	Penn State University (University Park, PA)
UC-Davis (Davis, CA)	California Institute of Technology (Pasadena, CA)	Rice University (Houston, TX)
Penn State University (University Park, PA)	Jet Propulsion Laboratory (Pasadena, CA)	University of Michigan (Ann Arbor, MI)
University of Washington (Seattle, WA)	HRL Laboratories (Malibu, CA)	University of North Carolina (Chapel Hill, NC)
University of Alabama (Tuscaloosa, AL)	University of Illinois (Champaign, IL)	University of Pennsylvania (Philadelphia, PA)
Rohm and Haas (Philadelphia, PA)	Univ. of Pittsburgh/Carnegie Mellon Univ. (Pittsburgh, PA)	Oak Ridge National Laboratory (Oak Ridge, TN)
Millennium Cell (Eatontown, NJ)	NIST (Gaithersburg, MD)	Lawrence Livermore National Laboratory (Livermore, CA)
Intematix (Moraga, CA)	University of Nevada-Reno (Reno, NV)	NIST (Gaithersburg, MD)
US Borax (Boron, CA)	Oak Ridge National Laboratory (Oak Ridge, TN)	Air Products (Allentown, PA)
	University of Utah (Salt Lake City, UT)	
	Intematix Corporation (Moraga, CA)	
	Brookhaven National Laboratory (Brookhaven, NY)	
	Individual Projects	
Prime	Partners	Research Area
TIAX LLC (Cambridge, MA)	Gas Technology Institute (IL)	Lifecycle and cost analysis

	Yale University (CT) University of Oklahoma (OK)	
University of Missouri (St. Louis, MO)	Pacific Northwest National Laboratory (WA)	New materials
University of Connecticut (Storrs, CT)	Pacific Northwest National Laboratory (WA)	New materials
Michigan Technological University (Houghton, MI)	None	Chemical hydrides
Gas Technology Institute (2 projects) (Chicago, IL)	Superior Graphite Co. (IL) NEXGEN Fueling (MN)	Carbon Off-board storage
Alfred University (Alfred, NY)	Savannah River Technology Center (SC) Mo-Sci Corporation (MO) CERALINK (NY)	New processes
Carnegie Institute of Washington (Washington, DC)	None	New materials
Research Triangle Institute (Research Triangle Park, NC)	State Scientific Research Institute (Moscow, Russia) ATK/Thiokol Propulsion (UT)	Chemical hydrides
State University of New York (Syracuse, NY)	PoroGen, LLC (MA)	Carbon
TOFTEC, Inc. (Gainesville, FL)	University of Florida, Gainesville (FL)	New processes
University of Michigan (Ann Arbor, MI)	Northwestern University (IL) Los Alamos National Laboratory (NM)	New materials
University of Pennsylvania (Philadelphia, PA)	Drexel University (PA) NIST (MD)	Carbon
University of California-Berkeley (Berkeley, CA)	Lawrence Berkeley National Laboratory (CA)	New materials
University of California-Santa Barbara (Santa Barbara, CA)	Los Alamos National Laboratory (NM)	New materials

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Energy and Automotive Company Partners	Additional team members
Air Products and Chemicals, Inc. (Prime)	

(Allentown, PA)	
- Toyota Motor Sales (Torrance, CA)	UTC Fuel Cells (South Windsor, CT)
- Nissan North America (Gardena, CA)	Proton Energy Systems (Wallingford, CT)
- American Honda Motors (Marysville, OH)	University of California, Davis (Davis, CA)
- ConocoPhillips (Bartlesville, OK)	Southern California Edison (Rosemead, CA)
- BMW (Woodcliff Lake, NJ)	California Energy Commission (Sacramento, CA)
	California Air Resources Board (Sacramento, CA)
	South Coast Air Quality Management District (Diamond Bar, CA)
	Sacramento Metropolitan Air Quality Management District (Sacramento, CA)
DaimlerChrysler Corp. (Prime) (Auburn Hills, MI)	
- BP America (Warrenville, IL)	DTE Energy (Detroit, MI)
	SAIC (San Diego, CA)
	SRI International (Palo Alto, CA)
	Ballard (Vancover, BC)
	NextEnergy (Detroit, MI)
	California Fuel Cell Partnership (Sacramento, CA)
	National Hydrogen Association (Washington DC)
Ford Motor Co. (Prime) (Dearborn, MI)	
- BP America (Warrenville, IL)	Ballard (Vancover, BC)
	NextEnergy (Detroit, MI)
	Environmental Protection Agency (Ann Arbor, MI)
	H2Systems
	Sacramento Municipal Utility District (Sacramento, CA)
	California Energy Commission (Sacramento, CA)

	California Air Resources Board (Sacramento, CA)
	Progress Energy (Orlando, FL)
General Motors Corp. (Prime) (Warren, MI)	
- Shell Oil Products (Houston, TX)	Air Products and Chemicals, Inc. (Allentown, PA)
	Praxair (Tonawanda, NY)
	GE Global Research (Niskayuna, NY)
	NextEnergy (Detroit, MI)
	Viewpoint Systems, Inc. (NY)
	Strat@comm Inc. (Washington DC)
	Department of the Army (Ft. Belvoir, VA)
	Port of Los Angeles (Los Angeles, CA)
	Maryland Energy Office (Annapolis, MD)
	New York State Energy Research and Development Authority (Albany, NY)
Texaco Energy Systems LLC (Prime) (Houston, TX)	
- Hyundai Motor Co. (Chino, CA)	UTC Fuel Cells (South Windsor, CT)
	University of California, Davis (Davis, CA)
	AC Transit (Oakland, CA)
	Southern California Edison (Rosemead, CA)
	South Coast Air Quality Management District (Diamond Bar, CA)
	California Energy Commission (Sacramento, CA)
	California Air Resources Board (Sacramento, CA)
	New York State Electric and Gas/Rochester Gas and Electric (Apalachin, NY)

Fuel Cell Research Projects

Prime	Sub-contractors
Fuel Cells for Consumer Electronics Devices	
Poly Fuel Inc. (Mountain View, CA)	Intel Corporation (Santa Clara, CA)
MTI MicroFuel Cells Inc. (Albany, NY)	Flextronics (San Jose, CA)
	Methanol Foundation (Washington DC)
	Dupont Fuel Cells (Wilmington, DE)
Fuel Cells for Auxiliary Power Generation	
Cummins Power Generation (Minneapolis, MN)	International Truck & Engine Corporation (Fort Wayne, IN)
	SOFC Holding LLC (Alliance, OH
Delphi Automotive Systems, LLC (Troy, MI)	Volvo Trucks North America (Greensboro, NC)
	PACCAR (Mount Vernon, WA)
	Electricore, Inc. (Indianapolis, IN)
Off-Road Fuel Cell Applications	
Ida Tech, LLC (Bend, OR)	Donaldson Company (Bloomington, MN)
	The Toro Company (Bloomington, MN)
	University California, Davis (Cavis, CA)
	3M Company (St.Paul, MN)

Hydrogen Education Development

Prime	Partners	Project
University of California, Berkeley (Center for Curriculum Innovation of the Lawrence Hall of Science)	Schatz Energy Research Center at Humbolt State University; Chabot Space and Science Center; Alameda-Contra Costa Transit; Lab-Aids, Inc.; National Hydrogen Association	Curricula and teacher professional development
National Energy Education Development (NEED) Project	Sentech, Inc; Los Alamos National Laboratory; National Association of State Energy Officials; National Hydrogen Association; U.S. Fuel Cell Council	Curricula and teacher professional development
Andersen Creative Group	Argonne National Laboratory, NuZoo Media, Inc.	Educational materials

Energy International, Inc.	H2Nation, Breakthrough Technologies, Inc.	Educational materials

Media contacts:
Joe Davis, 202/586-4940
Thomas Welch, 202/586-5806

- "Selected 12 new projects ($19 million over five years) for research on polymer electrolyte-type membranes with improved performance at higher temperatures and lower humidity."

U.S. Department of Energy, Press Release, (January 24, 2006), "Energy Secretary Bodman Announces $119 Million in Funding and Roadmap to Advance Hydrogen Fuel Cell Vehicles," retrieved March 27, 2006, from http://www.energy.gov/news/3098.htm.

News Media Contact(s):
Mike Waldron, 202-586-4940

For Immediate Release
January 24, 2006

Energy Secretary Bodman Announces $119 Million in Funding and Roadmap to Advance Hydrogen Fuel Cell Vehicles

WASHINGTON, DC – Energy Secretary Samuel W. Bodman today kicked off the Washington Auto Show with the announcement of $119 million in funding and a research "roadmap" aimed at identifying and overcoming the technical and manufacturing challenges associated with the further development of commercially available hydrogen fuel cell vehicles. The goal of developing clean, hydrogen fuel vehicles is part of the Bush Administration's ongoing effort to reduce America's dependence on foreign oil.

"Investments in fuel cell and hydrogen research today will enable America to lead the world in developing clean, hydrogen-powered automobiles that will reduce our dependence on imported oil," said Secretary Bodman. "This funding will help overcome technical barriers and bring hydrogen and fuel cell technology from the laboratory to the showroom."

Secretary Bodman announced that the Department of Energy (DOE) will provide up to **$100 million** over four years for research projects seeking to improve fuel cell membranes, water transport within the stack, advanced cathode catalysts and supports, cell hardware, innovative fuel cell concepts, and effects of impurities on fuel cell performance and durability. Through this investment, DOE seeks to improve performance and to lower cost of these technologies by 2010. Further information, research specifications, and application information for interested nonprofit and for-profit private entities, institutes of higher education and state and local governments and government laboratories are available at: http://www.hydrogen.energy.gov/.

In addition, Secretary Bodman announced the selection of 12 competitively awarded, cost-shared

projects that will receive **$19 million** in federal funding over five years for polymer membrane research ($19 million in federal funding; $4.75 million in applicant cost sharing). The membrane is an integral part of a hydrogen fuel cell system and is important in using hydrogen to create electricity that can power a vehicle. The goal of this research is to advance membrane durability and extend shelf-life, while simultaneously bringing down the cost.

Selected organizations include: Colorado School of Mines, Golden, CO; Pennsylvania State University, University Park, PA; Virginia Tech, Blacksburg, VA; Giner Electrochemical Systems, Newton, MA; University of Tennessee, Knoxville, TN; Case Western Reserve University (two projects), Cleveland, OH; FuelCell Energy, Danbury, CT; Clemson University, Clemson, SC; General Electric (GE Global Research), Niskayuna, NY; Arizona State University, Tempe, AZ; and University of Central Florida, Orlando, FL.

To identify the research and development (R&D) challenges that must be further addressed, Secretary Bodman also unveiled DOE's ***Roadmap on Manufacturing R&D for the Hydrogen Economy***. The 80-page document addresses challenges to manufacturing, storage and production of fuel cell technologies and proposes R&D solutions to overcome such challenges, focusing primarily on near commercial technologies. The *Roadmap* is based on the results of a July, 2005 hydrogen workshop made up of hydrogen and fuel cell experts from industry, universities, and national laboratories.

While hydrogen fuel cell technology has the potential to dramatically reduce vehicle emissions as well as America's dependence on foreign oil, barriers to commercialization continue to exist. Namely, hydrogen fuel cell technologies are significantly more expensive than traditional combustion engines and face challenges in energy storage and durability. Both the *Roadmap* and $119 million in funding announced today seek to address these challenges over the next ten years with the goal of making vehicles powered by hydrogen available in showrooms by 2020.

Today's announcement is part of the $1.2 billion Hydrogen Fuel Initiative announced by President Bush, in the 2003 State of the Union Address. This initiative has the potential to reverse America's growing dependence on foreign oil by developing the technology needed for commercially viable hydrogen-powered fuel cells - a way to power cars, trucks, homes, and businesses that produces no pollution and no greenhouse gases. Through partnerships with the private sector, DOE's Hydrogen Program is working to develop hydrogen, fuel cell, and infrastructure technologies needed to make it practical and cost-effective for large numbers of Americans to choose to use fuel cell vehicles by 2020.

U.S. Department of Energy, Office of Public Affairs, Washington, D.C.

- "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."

U.S. Department of Energy, Press Release, (April 27, 2004), "Energy Secretary Spencer Abraham Announces $350 Million in Hydrogen Research Projects," retrieved January 9, 2006 from http://www.energy.gov/news/1330.htm.

(See page 15 for the article.)

- "Selected 70 projects ($64 million over three years) in basic research to address the fundamental science underpinning hydrogen production, storage, and use."

U.S. Department of Energy, Press Release, (May 25, 2005), "Department of Energy Announces $64 Million in Hydrogen Research & Development Projects," retrieved January 9, 2006 from http://www.energy.gov/news/1639.htm.

(See page 13 for the article.)

- "Created three Hydrogen Technology Learning Centers ($1.6 million over three years), 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)."

U.S. Department of Energy, Press Release, (April 27, 2004), "Energy Secretary Spencer Abraham Announces $350 Million in Hydrogen Research Projects," retrieved January 9, 2006 from http://www.energy.gov/news/1330.htm.

(See page 15 for the article.)

State Technologies Advancement Collaborative, Press Release, (March 12, 2004), "STAC Selects Three Hydrogen Technology Learning Center Proposals for Federal Funding," retrieved January 9, 2006 from http://stacenergy.org/news/2004_03_12.pdf.

State Technologies Advancement Collaborative (STAC)
DOE – ASERTTI – NASEO

March 12, 2004 Contact: Robert Kripowicz, 301-620-2377

STAC Selects Three Hydrogen Technology Learning Center Proposals for Federal Funding

– Diverse Projects Involve Participants from Nine States –
WASHINGTON, DC (March 12, 2004)—The State Technologies Advancement Collaborative (STAC) today announced the results of its solicitation for the creation of hydrogen technology learning centers. The STAC Executive Committee approved funding for three projects valued at $446,595, with out year commitments of $1,150,886 from the U.S. Department of Energy subject to the availability of appropriations, based upon a determination that these projects represent the best of the proposals submitted. Of the total project costs of $2,131,097, more than $533,616 of the value represents implementation costs to be shared by non-federal government entities in addition to the approximately $1,597,481 in funding from the STAC program.

The projects selected seek to educate students, potential end-users, and the public about the vision of a hydrogen economy and hydrogen technologies—activities that contribute to both the President's Hydrogen Fuel Initiative and the National Energy Policy recommendation for a public education campaign about hydrogen technology.

"Combining state and federal efforts toward one of the President's energy initiatives is an exciting prospect and a new formula for addressing the energy challenges of this nation" said David Garman, Assistant Secretary for Energy Efficiency and Renewable Energy. "The collaborative is proving extremely successful in other areas and we look forward to positive results from these new awards."

Robert S. Kripowicz, STAC Program Director, announced the results of the solicitation review. "I'm extraordinarily pleased with the quality and diversity of the selected proposals. These projects involve participants from nine states. This cooperative effort with the Department of Energy's Hydrogen Fuel Cells and Infrastructure Technologies program, within the Office of Energy Efficiency and Renewable Energy, demonstrates the success and efficiency of combining federal and state energy efforts."

Final project awards are contingent on achieving the mandatory requirements of the solicitation in the contract negotiation process, which STAC expects to complete during the next four weeks.
The proposals selected for award are summarized below:

Hydrogen Technology Learning Centers for California, Florida, and New York
This 18-month effort will establish learning centers in the three named states. The project participants will develop interactive displays and exhibits, set up a website, produce information publications, and conduct a national conference.

Total project cost: $1,000,000
Funding request: $750,000
Project Lead: University of Central Florida-Florida Solar Energy Center
Project Participants: San Diego Miramar College University of California (Davis), Rochester Institute of Technology, New York State Energy Research and Development Authority (NYSERDA), and the California Energy Commission.

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Virginia-Maryland Hydrogen Technology Education Center (H2TEC)
This three-year project will establish a new undergraduate course in hydrogen technology in the two states, as well as graduate study in the hydrogen area. Short courses and seminars for professionals will be offered. In addition, presentations for non-technical audiences will be developed and K-12 outreach is also included.

Total project cost: $666,293
Funding request: $498,879
Project Lead: Virginia Polytechnic Institute and State University (Alexandria Research Institute)
Project Participants: University of Maryland at College Park, Breakthrough Technologies Institute, Hampton Roads Clean cities Coalition

Development of a Regional Hydrogen Technology Education Consortium (HyTEC)
This three-year effort led by a consortium of four universities from four states will provide education and training for students, professionals, and the public. The consortium will establish centers at each university, develop courses, workshops, establish a quarterly electronic newsletter, and develop and disseminate K - 12 outreach materials.

Total project cost: $464,804
Funding request: $348,602
Project Lead: North Carolina A&T University
Project Participants: University of South Carolina, University of Georgia, University of Florida

In all, there were 61 proposals received under the first STAC solicitation (including hydrogen proposals and other program areas) valued at approximately $68 million. More than $40 million of the proposals' value was cost-share. Thirteen proposals valued at $16, 806,000, including $9,793,000 in cost-sharing by non-Federal entities were announced on January 30, 2004.

The solicitation, which closed in September, is being administered by the National Association of State Energy Officials (NASEO) on behalf of the STAC Executive Committee. The solicitation supports joint energy research, development, demonstration and deployment of technologies where common Federal and State objectives exist. The program and the solicitation emphasize the wide dissemination of results from projects and the transfer of technologies for broad application and impact.
STAC is a five-year pilot program funded by the U.S. Department of Energy and directed by an Executive Committee that includes representatives of the Association of State Energy Research and Technology Transfer Institutions (ASERTTI), NASEO, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) and Office of Fossil Energy (FE), and an independent member. To learn more about STAC, please visit www.naseo.org/stac. For more information about EERE's Hydrogen Fuel Cells and Infrastructure Technologies Program, please visit www.eere.energy.gov/hydrogenandfuelcells.
