EERE-PMC News

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NREL, in a joint project with Xcel Energy, uses wind energy to make hydrogen that generates electricity used at the National Wind Technology Center.

There is little doubt that hydrogen will be America's transportation fuel of the future. The question is, "what are we doing now to reach that future?"

PMC-News this month explores DOE's Hydrogen, Fuel Cells & Infrastructure Technologies Program and discovers some exciting answers.

The greatest challenge to putting hydrogen-fueled vehicles on our highways is cost reduction; lower cost hydrogen production, distribution and storage, and less expensive fuel cells.

To see some of the advances currently underway, take a look at an exciting video from Shell that shows hydrogen vehicles already at work in some of the world's major cities.

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News

DOE funds three Bioenergy Research Centers for $375 million

DOE will invest up to $375 million in three new Bioenergy Research Centers that will be located in Oak Ridge, Tenn.; Madison, Wis. and near Berkeley, Calif. The Centers are intended to accelerate basic research in the development of cellulosic ethanol and other biofuels. The Department plans to fund the Centers for the first five years of operation (fiscal years 2008-2013).

The goal is for the Centers to provide the transformational science needed to make cellulosic ethanol cost-competitive with gasoline by 2012, and to assist in reducing America's gasoline consumption by 20 percent in ten years.

Additional details

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Nearly $88 million released for home weatherization

DOE announced $88 million in July for weatherization grants to 20 states to make energy efficiency improvements in homes of low-income families. This funding is the second installment of the $200 million in total weatherization grants for fiscal year 2007. Thirty other states received funding in April. DOE expects to weatherize approximately 70,000 homes nationwide this year.

Funding details

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U.S. expands cooperation with Sweden on advanced vehicles

EERE Assistant Secretary Alexander Karsner and Swedish Deputy Prime Minister and Minister of Enterprise and Energy Maud Olofsson have signed an agreement to further expand cooperation on renewable energy and vehicle technologies, and to establish a bilateral working group to explore prospective projects. The agreement paves the way for trans-atlantic cooperation between DOE and Mack Trucks, a subsidiary of Volvo AB, to develop environmentally friendly commercial vehicle technologies.

Additional information

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Fuel cell seminar & exposition in San Antonio, Oct. 15-19

Researchers from across the country will meet in San Antonia to share information on making hydrogen a viable next generation fuel.

Over 2,300 participants and 175 exhibiting companies — representing over 36 different countries — are expected to attend the annual Fuel Cell Seminar & Exposition in San Antonio, Texas, October 15-19, making it the largest fuel cell meeting in the world. Participants include technical leaders, scientists, educators, researchers, developers, investors, students and manufacturers of fuel cell products.

Registration and seminar information

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New manufacturing R&D funding opportunity available

DOE is seeking to fund manufacturing research and development (R&D) for hydrogen and fuel cell systems. This funding opportunity announcement focuses primarily on technologies near commercialization; this includes the following areas:

- Alternative Electrode Deposition Processes
- Gas Diffusion Layer Fabrication
- Novel MEA Manufacturing
- Process Modeling for Fuel Cell Stacks
- Process and Device for Cost Effective Testing of Cell Stacks
- Manufacturing Technologies for High Pressure Composite Tanks Applications

Total estimated funding available is $38 million, pending Congressional appropriations, with an expectation of about 15 selected projects and an individual award ceiling of $4 million.

Application details

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Features

In the U.S. and elsewhere, constructing a functional hydrogen refueling infrastructure is a long-term challenge already underway.

Road to a hydrogen economy

Billions of dollars from government and private sources are being spent to help move the U.S. toward a hydrogen economy and away from petroleum. Fortunately, the money is being spent in a controlled, targeted manner and the investment goals make good sense:

- Reducing our dependence on foreign oil;
- Reducing emissions of greenhouse gases;
- Reducing pollutants that negatively impact our health and environment;
- Making better use of renewable energy resources and diversifying our national energy portfolio.

Hydrogen research areas targeted by DOE include:

- Production;
- Storage;
- Fuel Cells;
- Safety, and;
- Technology Validation.

Production:

Hydrogen is an energy carrier, not an energy source.

Hydrogen delivers energy in a usable form easily transported and stored. It can be produced from several sources: reformed from natural gas, gasified from coal or even produced from water by using electrolysis to split H2O into its basic components of hydrogen and oxygen.

Hydrogen and renewable energy sources can work hand in hand.

Wind energy, for example, can be used as the basic energy source to reform hydrogen from feedstocks such as natural gas or even water. Wind energy, through the medium of hydrogen, can be converted into a transportable fuel that can be stored and transported for use anywhere, any time, not just when the wind blows.

Wind-produced hydrogen will represent a major breakthrough in the flexibility of harvesting and using wind energy in new ways other than just as an intermittent producer of electricity.

Hydrogen as a transportation fuel, particularly when produced from renewable energy sources, will carry very little negative environmental impact. Even when the feedstocks for hydrogen production are fossil fuels, the environmental impact can be significantly reduced over directly burning those fuels as we currently do.

Producing hydrogen is nothing new; the U.S. already formulates over 9 million tons of hydrogen annually, mostly for use in petroleum refining and fertilizer production; or, to put it another way, we produce enough hydrogen today to fuel 34 million automobiles.

DOE research is targeted to diversify and improve hydrogen production efficiency and to also drive down the cost. To be used as transportation fuel, hydrogen must become cost-competitive with conventional fuels and technologies on a per-mile basis. In today's market that means that hydrogen, including the cost of delivery and before taxes, must be priced at $2-3 per gallon gasoline equivalent (GGE).

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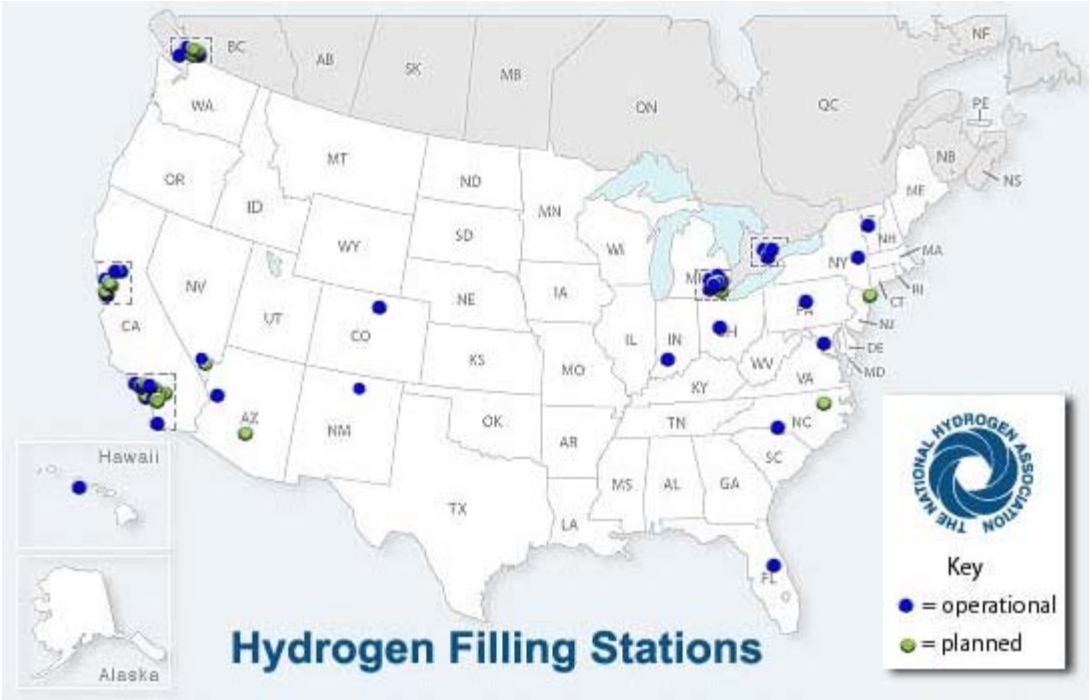
Storage:

Developing safe, reliable, compact and cost-effective hydrogen storage technologies is one of the barriers to its widespread use as a transportation fuel. To be competitive with conventional vehicles, hydrogen-powered cars must be able to travel more than 300 miles between fills. This presents a major challenge. Hydrogen is difficult to store in large quantities without taking up a significant amount of space. Using current storage technologies, the hydrogen fuel tank would be larger than the typical trunk of most automobiles.



California currently leads the way with number of hydrogen filling stations with 24 now opertional and 15 more planned, though other states such as Wash. and Mich. are also bring multiple stations online.

National Hydrogen Association map

Possible approaches to storing hydrogen include:

- Physical storage of compressed hydrogen in high pressure tanks (up to 10,000 pounds per square inch);
- Physical storage of cryogenic liquid hydrogen (cooled to -253 degrees C) in insulated tanks, and;
- Storage in advanced materials -- within the structure on the surface of certain materials, as well as in the form of chemical precursors that undergo a chemical reaction to release hydrogen.

Researchers are developing and evaluating light-weight, safe, composite materials that can reduce the weight and volume of compressed gas storage systems. They are also studying a hybrid tank concept that can store high-pressure hydrogen gas under cryogenic conditions (cooled to around -120 to -196 degrees C). These “cryo-compressed” tanks would allow relatively lighter weight, more compact storage.

Another storage possibility is to develop space-conformable high-pressure hydrogen tanks that could better fit into the nooks and crannies of a car’s structure, much as today’s gasoline tanks do. Ford Motor Company, for example, has developed an all-new fuel cell Explorer featuring a center-mounted hydrogen tank that delivers more miles on a single fill-up while maintaining ample space for six passengers and cargo.

Hydrogen storage within materials, to be released when needed, holds great promise, but more research is needed to better understand how to accomplish this under practical operating conditions, and to overcome challenges related to capacity, hydrogen uptake and release, management of heat during refueling, cost and life-cycle impacts.

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Hydrogen fuel cells:

Many researchers working to make hydrogen-powered cars a reality believe that the key component needed for success will be a reasonably priced fuel cell capable of competing on a cost basis with the internal combustion engine. Current fuel cells are just too expensive to be practical in day-to-day automotive applications. (The term “fuel cell” is often used to refer to the entire stack of cells, as well as the individual cell.)
Fuel cell primer

Developing a cost-competitive fuel cell-powered vehicle is well worth the effort; clean power gained by directly

converting the chemical energy in hydrogen to electricity, with pure water and potentially useful heat as the only byproducts. Additionally, hydrogen fuel cell vehicles are much more energy efficient than traditional vehicles, using 40-60 percent of the fuel's energy, compared to the 20-percent range typical of a conventional vehicle using a gasoline-powered internal combustion engine.

Improving fuel cell durability, as well as reducing cost, is the most significant challenge needed to advance fuel cell technology into the marketplace. Current research focuses on identifying and developing new materials that will reduce the cost and extend the life of fuel cell stack components including membranes, catalysts, bipolar plates and membrane-electrode assemblies. Eventually, low cost, high volume manufacturing processes will also help make fuel cell systems cost competitive with traditional technologies.
Online fuel cell information resource library

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Hydrogen Safety:

Hydrogen is easily transportable from a central production plant to remote filling stations.

Like gasoline, diesel and natural gas, hydrogen must be handled appropriately. Whenever the widespread use of hydrogen as a transportation fuel is discussed, it is not long before the subject of safety arises.

The basic facts of safely handling, storing and burning hydrogen as a transportation fuel are straight-forward:

- Hydrogen is much lighter than air and rises at a speed of almost 20 meters per second – two times faster than helium and six times faster than natural gas. This means it disperses quickly when released from confinement.

- Hydrogen burns very quickly under optimal combustion conditions, however, at low concentrations of hydrogen fuel in air, the energy required to initiate combustion is similar to that of other commonly used fuels.

- Because hydrogen flames have low radiant heat, compared to a hydrocarbon fire, the risk of secondary fires being started is lower.

- Combustion cannot occur in a tank or container that contains only hydrogen; an oxidizer, such as oxygen, must be present.

- Hydrogen is odorless, colorless and tasteless and it is difficult to add an odorant, such as is used with natural gas, because no known odorant is light enough to "travel with" hydrogen, and at the same dispersion rate. Also, currently known odorants contaminate fuel cells.

- As with any gas other than oxygen, high concentrations of hydrogen can cause asphyxiation. But because it disperses so rapidly it is unlikely to be confined in conditions where asphyxiation might otherwise occur.

- Hydrogen is non-toxic and non-poisonous. It will not contaminate groundwater and it is not a known contributor to atmospheric pollution.

Researchers in government, industry and academia are currently working to:

- Further analyze critical **hydrogen behavior data**;

- Develop reliable, inexpensive hydrogen **sensor and leak detection technologies**,and;

- Identify **tools and methodologies** to support the development of hydrogen codes and standards.

Hydrogen safety and codes information

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Hydrogen Technology Validation

Fuel cell-powered vehicles make a lot of sense but are a long way from mass commercialization. Research is making steady progress, but most hydrogen, fuel cell and infrastructure technologies still require significant testing in real-world situations before they will be ready to compete in the marketplace.

This is where DOE's technology validation comes in – once a technology is shown to work in a laboratory, it needs to be evaluated as part of an integrated system such as a hydrogen fueling station or hydrogen fuel cell-powered vehicle.

Technology validation helps manage research and development activities, keeping them clearly focused on the ultimate goal of developing a national, hydrogen-based transportation system. It gives program directors and researchers real world feedback on factors such as vehicle fuel economy, fuel cell efficiency/durability, freeze start ability, hydrogen cost and vehicle operating range.

Technology validation will also give DOE the data necessary to communicate progress as well as risk to the public and Congress about how hydrogen and fuel cell technologies can begin to fit into our national energy choices.

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DOE, automakers, energy companies join to test hydrogen

Initiated in 2003, DOE's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project is a project to validate vehicle/infrastructure systems using hydrogen as a transportation fuel for light-duty vehicles.

The projects will help DOE and industry gain real-time knowledge of on-the-road operation of hydrogen fuel cell vehicles, building a hydrogen fueling infrastructure and developing necessary codes and safety standards. The program will also seek to educate consumers about the potential of driving hydrogen-fueled vehicles.

Four teams consisting of Chevron and Hyundia-Kia, DaimlerChrysler and BP, Ford Motor Company and BP, and General Motors and Shell will ultimately support more than 130 fuel cell vehicles. These vehicles will be used to validate actual on-road performance and safety as well as support the development of 20 hydrogen refueling stations across the U.S. It is estimated DOE will invest about $170 million in the project with cost-share from industry.

Here's what the teams are working on:

ChevronTexaco Hydrogen Co. will build up to six hydrogen energy stations; most will be located in California. The stations will demonstrate and validate safe, practical hydrogen technologies in real-world settings. ChevronTexaco, Hyundai and UTC Fuel Cells are members of the California Fuel Cell Partnership, which operates a hydrogen demonstration station in Sacramento, Calif.

The first Chevron hydrogen fuel station opened in Chino, Calif. in 2005. In 2006, Chevron inaugurated its second hydrogen fueling station in Oakland, in partnership with DOE, Alameda-Contra Costa Transit, Hyundai-Kia Motors and UTC Power. The station powers a fleet of hybrid fuel cell buses in the San Francisco Bay Area. Chevron also began construction on three additional hydrogen stations in Michigan, Florida and Rosemead, Calif.

BP is working with DOE and partners DaimlerChrysler and Ford to develop hydrogen fuel stations in several US cities. BP and project partners dedicated the first hydrogen fuel station on the West Coast at Los Angeles International Airport in October 2004.

BP also is involved in refueling infrastructure to support fuel cell buses and cars in a number of cities across the world, including Barcelona, Spain; Stuttgart and Hamburg in Germany; London, UK; Porto, Portugal; and Perth, Australia. Earlier this year, in Singapore, BP opened the world's first hydrogen facility added into an existing retail site.

Shell is concentrating on the manufacturing of hydrogen, including its production, delivery and storage, to reduce cost – the number one challenge with hydrogen -- and making it safe to use. The company is testing hydrogen

production onsite at filling stations and at centralized production sites that will rely on subsequent delivery of the hydrogen by tanker to filling stations. The goal is to overcome existing challenges to establishing a hydrogen retail, refueling infrastructure that can be online by the year 2015.

Parallel with fueling infrastructure development and testing, a number of hydrogen powered vehicles are also being tested and validated.

Chevron and Hyundia–Kia:

Hyundia-Kia fuel cell vehicles are being tested to evaluate performance, including greater vehicle range (almost 200 miles), power (80kw) and how the vehicle performs in colder climates.

DaimlerChrysler and BP:

DaimlerChrysler is testing over 100 fuel cell vehicles under varying weather and traffic conditions and driving styles in locations worldwide.

Ford Motor Company and BP:

Ford has a fleet of 30 hydrogen-powered Focus fuel cell vehicles on the road as part of a worldwide, seven-city program to conduct real-world testing of fuel cell technology. The fleet has accumulated more than 300,000 miles since its inception.

General Motors and Shell:

General Motors has an agreement in place to build a fleet of 40 HydroGen 3 vehicles that will help advance the technology. Vehicles will be tested throughout Washington, D.C., New York, California and Michigan.

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