U.S. Department of Energy Hydrogen Program

Helping to achieve our national energy goals by developing critical technologies and paving the way for their commercialization.

Hydrogen and fuel cells are an important part of the DOE's comprehensive and balanced energy technology portfolio addressing the nation's critical energy challenges—significantly reducing CO_2 emissions and ending our dependence on imported oil.

Hydrogen is an energy carrier that can be produced from domestic resources that are clean, diverse, and abundant; fuel cells provide a technology to use this energy in a highly efficient way, in numerous applications, with only water and heat as byproducts. Together, hydrogen and fuel cells represent a radically different approach to energy conversion that could replace conventional power generators like internal combustion engines, turbines, and batteries. Widespread adoption could greatly expand the growth of the green job market with up to 675,000 new jobs associated with manufacturing fuel cells and related hydrogen technologies, fuel cell maintenance and support systems, and hydrogen production.[1]

Green Jobs Potential

- Projected increase in U.S. employment up to 675,000 jobs
- Job gains distributed across 41 industries
- Workforce skills mainly in vehicle manufacturing and service sectors
- U.S. competitive leadership in critical technology sector strengthened

The DOE Hydrogen Program—a cooperative effort involving the Offices of Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, and Science—works with industry, national laboratories, universities, government agencies, and other partners to overcome the barriers to the widespread use of hydrogen and fuel cells. The Program includes a research and development (R&D) effort focused on advancing the performance and reducing the cost of these technologies, in conjunction with a market transformation element dedicated to facilitating hydrogen and fuel cell adoption. To promote market acceptance, the Program also conducts a range of activities to address essential non-technological issues such as codes and standards, the cost-effectiveness of establishing a delivery infrastructure, growth of a domestic manufacturing and supplier base, and public awareness of the technologies.

Accomplishments

A sustained R&D effort has helped hydrogen and fuel cells evolve into commercially viable technologies in a growing market. Since the Program was accelerated in 2004, its efforts have advanced these technologies and achieved several significant accomplishments. DOE-supported activities have:

- Significantly reduced the cost of automotive fuel cells (from $275/kW in 2002 to $73/kW in 2008, based on projections of high-volume manufacturing costs);
- Doubled the durability of fuel cell systems in vehicles operating under real-world conditions (data in 2006 showed 950-hour durability—today, this number is 1900 hours, equivalent to approximately 57,000 miles of driving);
- Reduced the cost of producing hydrogen from both renewable resources and natural gas (hydrogen can now be produced by distributed reforming of natural gas at a projected high-volume cost of $3.00/gallon gasoline equivalent—a cost competitive with gasoline);

[1] *Effects of a Transition to a Hydrogen Economy on Employment in the United States Report to Congress, U.S. Department of Energy, July 2008, http://www.hydrogen.energy.gov/pdfs/epact1820_employment_study.pdf.*

The State of the Industry…
Where Are We Today?

Fuel Cells for Stationary Power, Specialty-Vehicles, and Portable Power

Rapidly growing markets for fuel cells today are in stationary power, specialty-vehicles, and portable power.

- More than 50 commercially available fuel cell products
- 52,000 fuel cells have been shipped worldwide
- 18,000 fuel cells were shipped in 2008 (a 50 percent increase from 2007)

Fuel cells can be a cost-competitive option for critical-load facilities, backup power, and forklifts.

These early markets will help to achieve major reductions in cost through economies of scale, and they will help to establish the manufacturing and supplier base.

- Developed and demonstrated technologies at laboratory-scale for producing hydrogen from nuclear energy and coal to enable increased efficiency and reduced cost;
- Identified several new materials that show an improvement of more than 50 percent in on-board hydrogen storage capacity;
- Established a robust basic science effort to develop a fundamental understanding of catalysts, membranes, and innovative approaches in close coordination with applied R&D;
- Validated the status of the technologies by demonstrating 122 fuel cell vehicles and 16 refueling stations nationwide;
- Developed a coordinated national agenda for hydrogen codes and standards through a collaborative effort with industry and codes and standards development organizations;
- Developed resources to help disseminate information about hydrogen for general educational purposes, for the use of first responders, and to facilitate the process of permitting hydrogen installations;
- Established the International Partnership for the Hydrogen Economy (IPHE) among 16 countries and the European Commission to foster international cooperation on R&D, common codes and standards, and information sharing on infrastructure development through 30 collaborative projects;
- Established the Hydrogen and Fuel Cell Interagency Task Force to coordinate federal adoption of hydrogen and fuel cell technology to support commercialization and industry growth; notable deployments include 100 forklifts, more than 40 backup power systems, and several fuel cell vehicles located in federal facilities across the nation.

The Way Forward

The Hydrogen Program will continue to build on its progress through a comprehensive program of R&D and market transformation. Accelerating the use of stationary, specialty vehicle, and portable fuel cell applications through market transformation efforts will create economies of scale that can further reduce cost, build a domestic manufacturing and supplier base, and greatly expand growth of the green job market.

R&D efforts will continue to advance hydrogen and fuel cell technologies for the expanded commercialization of stationary, portable, and transportation applications. For light duty vehicles, the Program aims to reduce the cost of fuel cells to $30/kW, develop an automotive fuel cell with 5,000-hour (150,000-mile) durability, and develop on-board hydrogen storage technologies to enable more than 300-mile driving range across all vehicle platforms by 2015. For stationary fuel cells, the Program seeks to reduce the cost of fuel cells to $750/kW and develop a distributed generation polymer electrolyte membrane fuel cell system with 40,000 hours durability and 40% electrical efficiency by 2011.

DOE will continue to work with its partners in industry, academia, and government to advance R&D needed to overcome technical challenges; support the development of uniform codes and standards and associated training for code officials and first responders; validate and demonstrate hydrogen and fuel cell technologies in real-world conditions; facilitate technology adoption to support the growth of early markets and meet federal goals for energy efficiency, renewable energy use, greenhouse gas reductions; and track and communicate project results to encourage broader adoption of the technologies in the public and private sectors.

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Where Are We Today?

Hydrogen & Fuel Cells for Transportation (in the U.S.)

- 200 fuel cell vehicles
- 20 hydrogen-fueled buses
- 60 fueling stations

Several carmakers (including Honda, Daimler, GM) have announced plans for increased deployments in the next few years.

Production & Delivery of Hydrogen

In the U.S., there are currently:

- 9 million metric tons of hydrogen produced (mostly used in industrial and manufacturing processes
- 1200 miles of hydrogen pipelines

Independent analysis by the National Academies found that the cost to government of supporting hydrogen infrastructure development will be less than the cost of ethanol subsidies—this is consistent with other analyses, including a recent study by Oak Ridge National Laboratory.

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