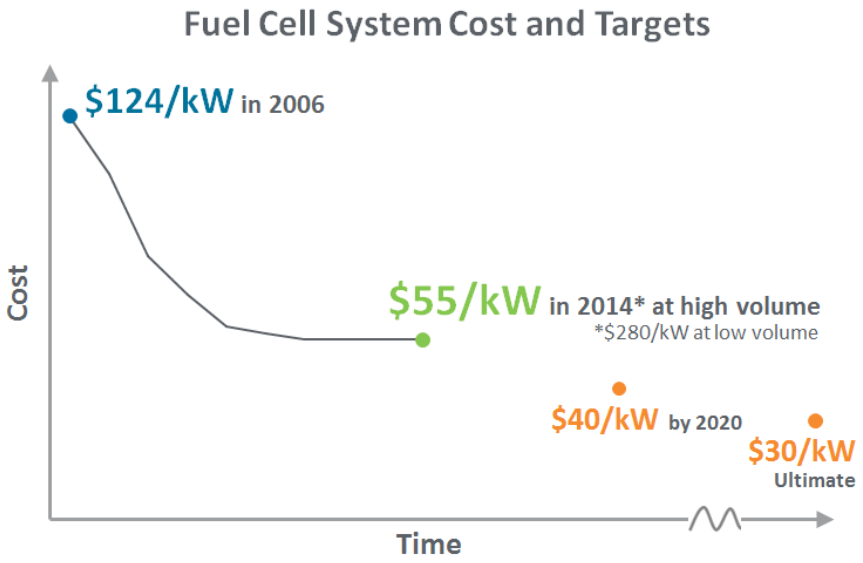
Progress and Accomplishments in Hydrogen and Fuel Cells

The U.S. Department of Energy's (DOE's) efforts have advanced the state of the art of hydrogen and fuel cell technologies—making significant progress toward overcoming key challenges to widespread commercialization.



Reducing Cost and Improving Durability and Performance of Fuel Cells

✓ **Reduced automotive fuel cell cost by more than 50% since 2006 and more than 30% since 2008 (based on projections to high-volume manufacturing).[1]**

Cost reductions reflect numerous individual advances in key areas, including a fivefold reduction in the platinum content of fuel cell catalysts and the development of durable membrane electrode assemblies with low platinum group metal content.[2] Today fuel cells can be manufactured at low volume for around $280/kW. If fuel cells were manufactured at high volume with the latest advanced materials and components demonstrated in the lab, the cost would be around $55/kW.

✓ **Doubled durability since 2006.** Demonstrated more than 2,500 - hour (75,000 miles) durability of fuel cell systems in vehicles operating under real-world conditions with only 10% degradation. This is more than double the maximum durability of 950 hours demonstrated in 2006.[3]

Improving Technologies for Producing, Delivering, and Storing Hydrogen

✓ **Reduced the cost of producing hydrogen from natural gas.** Projected costs of hydrogen (assuming high-volume production and widespread deployment) have been reduced to ~$2.00 per gallon of gasoline equivalent (gge) produced (<$4.50/gge produced, delivered, and dispensed for 700 bar fueling), cost competitive with gasoline.[4]

✓ **Reduced the cost of producing hydrogen from renewables.** The cost of electrolyzers has been reduced by 80% since 2002.

✓ **Reduced the cost of delivering hydrogen to the end-user.** Since 2011, composite tube trailers have demonstrated that they can carry 30% more hydrogen (~810 kg) at a high volume cost of ~$3.00/kg.[5]

✓ **Developed advanced materials-based hydrogen storage technologies and reduced cost of advanced compressed hydrogen storage systems.** The DOE has, through the three Hydrogen Storage Materials Centers of Excellence and independent projects, prepared and characterized hundreds of novel hydrogen storage materials.[6] An online database, with 3,000 unique entries, has been established with key material properties.[7]

Safety, Codes & Standards

✓ **Trained more than 30,000 first-responders and code officials** through online and in-classroom courses. In addition, **released a first-of-its-kind iPad/iPhone app** to enhance utility and integration of the safety knowledge tools with other safety planning resources.

Infrastructure Partnership

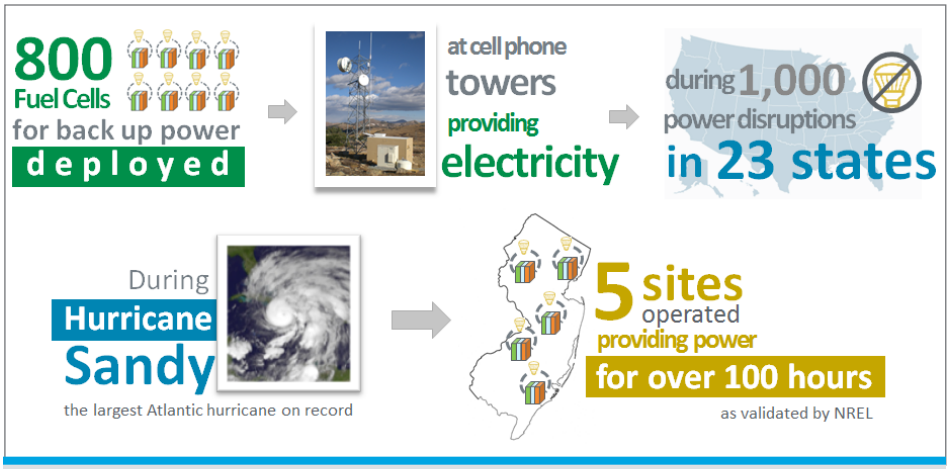
H_2USA

In 2013, DOE and other stakeholders launched H2USA, a public private partnership focused on the widespread commercialization of fuel cell electric vehicles. Members include federal agencies, the fuel cell trade association, automakers, hydrogen providers, fuel cell developers, national laboratories, and additional stakeholders.

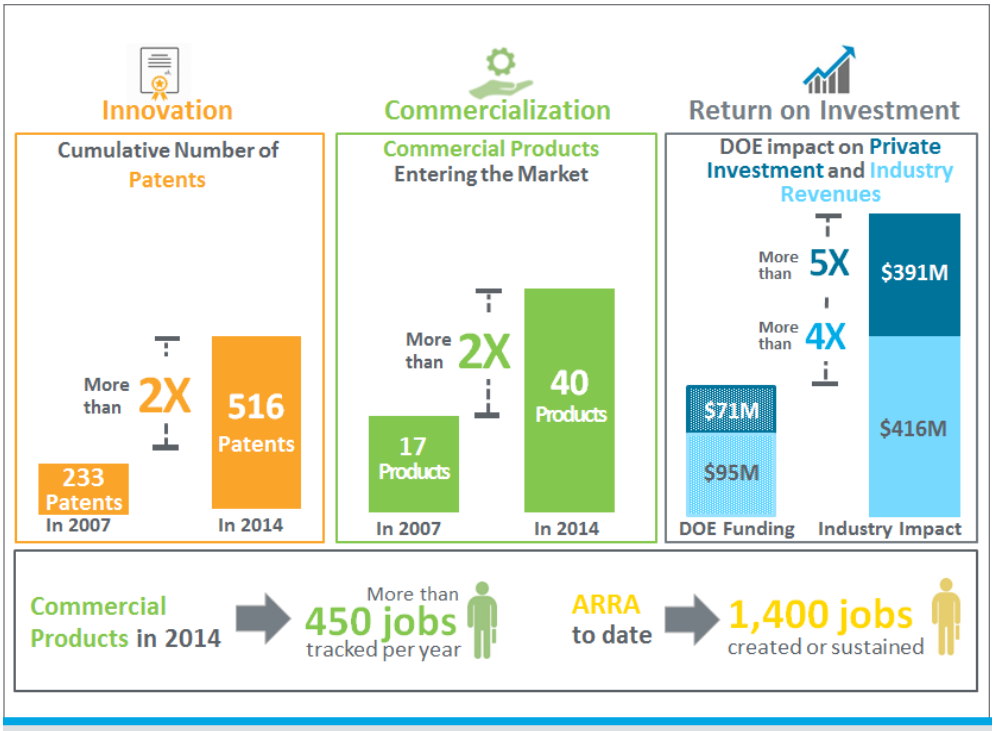
Real-World Demonstrations and Technology Validation

- ✓ **Completed the world's largest fuel cell electric vehicle validation project** of its kind with automakers, more than 180 vehicles traveling more than 3.5 million miles in more than 500,000 trips and 25 stations completing more than 33,000 refuelings.
- ✓ **Demonstrated the world's first "tri-generation" station** (capable of co-producing hydrogen, heat, and power) at the Fountain Valley wastewater treatment facility in California. The station has co-produced electricity and hydrogen with 54% efficiency and provides up to 100 kg of hydrogen a day, enough to fuel 25 to 50 vehicles.

FCTO-funded efforts have deployed more than 800 fuel cells for backup power at cell phone towers, successfully providing electricity during more than 1,000 unscheduled system or power disruptions across 23 states since 2010. During Hurricane Sandy, the largest Atlantic hurricane on record, 5 sites operated providing power for more than 100 hours as validated by NREL.



Validated the operation of fuel cells for backup power during Hurricane Sandy and in power disruptions across states.



DOE funding has led to >500 patents, 45 commercial technologies, and >65 emerging technologies.[8]

Encouraging a Growing Market

- ✓ **Deployed 700 DOE-funded fuel cell forklifts** that led to an additional 7,500 on order or in use with no DOE funding.
- ✓ **Deployed 900 DOE-funded emergency backup power projects** that led to an additional 4,000 with no DOE funding.
- ✓ **Invested $95M** in specific hydrogen and fuel cell projects that led to more than $410M in revenue.
- ✓ **Invested $70M** in specific projects that led to nearly $390M in additional private investment.

For More Information

More information on the Fuel Cell Technologies Office is available at http://www.hydrogenandfuelcells.energy.gov.

References

For specific information and references, visit the Fuel Cell Technologies web site at http://www1.eere.energy.gov/hydrogenandfuelcells/accomplishments.html.

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