

Hydrogen & Fuel Cell Technologies develops fuel cells to be cost-competitive in diverse applications, including light-duty vehicles (at \$30/kW) and stationary power (at less than \$1,500/kW), and renewable hydrogen (from diverse resources) to be cost-competitive with gasoline (\$2 to \$4 per gallon gasoline equivalent [gge], delivered and dispensed).

What We Do

To achieve its goals, Hydrogen & Fuel Cell Technologies employs a comprehensive strategy that addresses both technical and non-technical barriers to commercialization and aims to catalyze domestic growth in this emerging industry:

- ✓ **Research and Development:** Investing in R&D to increase the durability and reduce the cost of fuel cells, reduce the cost of producing hydrogen from renewable resources, and reduce the costs of delivering and storing hydrogen.
- ✓ **Technology Validation:** Demonstrating hydrogen and fuel cell systems under real-world conditions and collecting and analyzing data to provide critical feedback to R&D efforts.
- ✓ **Addressing Market Barriers:** Developing information resources to address safety issues, providing critical information needed for the development of technically sound codes and standards, and providing financial and technical assistance to catalyze and transform early markets.

Program Goals/Metrics

- Reduce automotive fuel cell system cost to \$30/kW at modeled high-volume production (equivalent to the cost of gasoline internal combustion engines) and improve

durability to 5,000 hours (equivalent to 150,000 miles of driving) by 2017.

- Reduce the cost of combined heat and power (CHP) fuel cell systems operating on to \$1,500/kW and enable 60,000-hour durability by 2020.
- Reduce the cost of renewably produced hydrogen to \$2 to \$4/gge by 2020 (delivered, dispensed, and un-taxed).

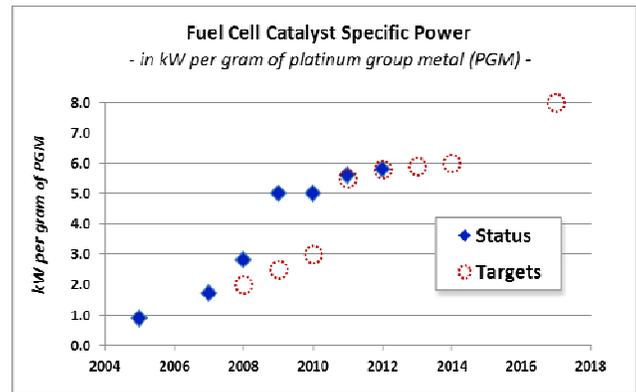
FY 2014 Priorities

- **Fuel Cell R&D** will continue to reduce cost and improve durability (e.g., by increasing PEM fuel cell power output per gram of platinum-group catalyst to 6.0 kW/g in 2014 and 8.0 kW/g by 2017, from 2.8 kW/g in 2008).
- **Hydrogen Fuel R&D** will reduce the cost of producing hydrogen from renewable resources (e.g., renewable electrolysis and direct solar water splitting), reduce the cost of delivering and dispensing hydrogen, and reduce the cost and improve the capacity of hydrogen storage systems. For example, in FY 2014, these efforts will reduce renewable hydrogen cost by 10 percent from the FY 2011 baseline of \$8/gge and reduce hydrogen storage costs by more than 10 percent, to \$15/kWh.
- **Manufacturing R&D** will continue to develop fabrication processes and technologies for fuel cell components to enable an automotive fuel cell cost of \$30/kW in 2017.
- **Technology Validation** will gather and analyze data from fuel cell electric vehicles and hydrogen fueling stations—providing critical feedback to R&D efforts.
- **Safety, Codes and Standards** will quantify the impact of fuel contaminants (for the revision of fuel quality standards) and the impact of fast fueling (SAE J2601).

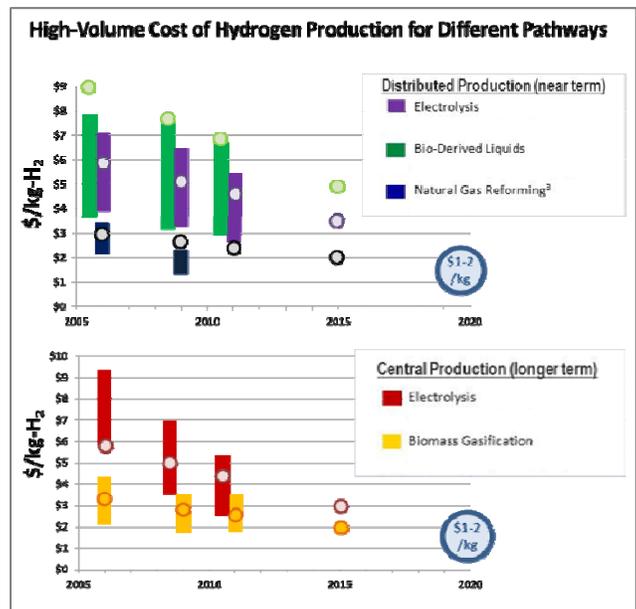
(Dollars in Thousands)	FY 2012 Current	FY 2013 Request	FY 2013 Annualized CR*	FY 2014 Request
Fuel Cells R&D	43,634	38,000	—	37,500
Hydrogen Fuel R&D	33,824	27,000	—	38,500
Manufacturing R&D	1,944	2,000	—	4,000
Systems Analysis	3,000	3,000	—	3,000
Technology Validation	8,986	5,000	—	6,000
Safety, Codes and Standards (HFCT Total)	6,938	5,000	—	7,000
Market Transformation	3,000	0	—	3,000
NREL Site Wide Facility Support	0	0	-	1,000
Total, Hydrogen and Fuel Cell Technologies	101,326	80,000	104,258	100,000
*FY 2013 amounts shown to reflect the P.L. 112 175 continuing resolution level annualized to a full year.				

Key Accomplishments

- **Reduced the cost of automotive fuel cell systems** to \$47/kW in 2012 (projected to high volume manufacturing), a >35 percent reduction since 2008 and >80 percent reduction since 2002—and well on the way to achieving the 2017 target of \$30/kW.
- **More than doubled the durability of automotive fuel cell systems** operating under real-world conditions, with durability of >2,500 hours (about 75,000 miles) demonstrated on the road with < 10 percent degradation in performance (improved from 950 hours in 2006).
- **Reduced platinum content of fuel cells** by more than doubling catalyst specific power from the 2008 baseline of 2.8 kW/g of platinum group metal (PGM) to 5.8 kW/g in 2012. Current catalyst specific power is approaching the 2017 target of 8.0 kW/g, and it reflects more than 80 percent reduction in PGM content since 2005.
- **Reduced the capital cost of electrolyzer stacks** by 80 percent since 2002, which will help to achieve a cost of \$2.00–\$4.00/gge for renewable hydrogen by 2020.
- **Validated vehicles with more than 250-mile driving range** (and one vehicle capable of up to 430 miles on a single fill of hydrogen) and a **refueling time of less than 5 minutes** for about 4 kg of hydrogen—enough fuel for about 250 miles of driving.
- **Demonstrated the world’s first tri-generation fuel cell system (capable of providing electricity, heat, and hydrogen fuel)**, validating combined efficiency of 54 percent for co-producing hydrogen and electricity.
- **Spurred commercialization of fuel cells** in key early markets—R&D funding by this office has led to more than 360 patents, 35 commercial technologies, and more than 65 “emerging” technologies (commercial in 3-5 years).
- **Achieved substantial impact on the marketplace** through strategic deployments of early-market fuel cells, in which DOE-supported deployment of about 1,400 fuel cells has directly led to more than 5,000 additional industry orders of fuel cell powered forklifts and backup power fuel cells—with no additional DOE funding.



Status and targets for fuel cell catalyst specific power, showing reduced need for platinum group metals.¹



Status and targets for hydrogen production cost (assuming high production volumes).² Hydrogen cost status is shown in vertical bars, reflecting values based on a range of assumptions, and targets are shown in circles.

¹ Sources: DOE Hydrogen & Fuel Cells Program Record #9018, http://hydrogen.energy.gov/program_records.html; M. Debe, “Advanced Cathode Catalysts and Supports for PEM Fuel Cells,” 2011 Annual Merit Review Proceedings, www.hydrogen.energy.gov/pdfs/review11/fc001_debe_2011_o.pdf; and M. Debe, “Advanced Cathode Catalysts and Supports for PEM Fuel Cells,” 2012 Annual Merit Review Proceedings, http://www.hydrogen.energy.gov/pdfs/review12/fc001_debe_2012_o.pdf.

² Source: DOE Hydrogen & Fuel Cells Program Record #12002, http://www.hydrogen.energy.gov/pdfs/12002_h2_prod_status_cost_plots.pdf (For consistency in cost basis and techno-economic assumptions, the targets indicated in the plots for years prior to 2015 are consistent projections back along the trajectories established by the 2015 and 2020 targets (which incorporate updated H2A analysis and cost bases).