DOE Hydrogen Program Record	
Record #: 10004	**Date:** September 16, 2010
Title: Fuel Cell System Cost - 2010	
Update to: Record 9012	
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Approved by: Sunita Satyapal	**Date:** December 16, 2010

Item:

The cost of an 80-kW_{net} automotive polymer electrolyte membrane (PEM) fuel cell system based on 2010 technology and operating on direct hydrogen is projected to be \$51/kW when manufactured at a volume of 500,000 units/year.

Rationale:

In fiscal year 2010, TIAX LLC (TIAX) and Directed Technologies, Inc. (DTI) each updated their 2009 cost analyses of 80-kW_{net} direct hydrogen PEM automotive fuel cell systems based on 2010 technology and projected to manufacturing volumes of 500,000 units per year [1,2]. Both cost estimates are based on performance at beginning of life.

The model system used in the DTI 2010 analysis included state-of-the-art 3M nanostructured thin film (NSTF) ternary platinum-alloy catalyst layers with 20 micron reinforced perfluorosulfonic acid (PFSA) membranes. The platinum group metal (PGM) loading was 0.15 mg/cm^2, and the gross cell power density at rated power was 833 mW/cm^2 at a cell voltage of 0.676 V and operating pressure of 1.69 atm. The TIAX analysis, which was based on a fuel cell system model developed by Argonne National Laboratory, also assumed 20 micron reinforced PFSA membranes and NSTF catalysts at a PGM loading of 0.15 mg/cm^2, with a gross cell power density at rated power of 930 mW/cm^2 at a cell voltage of 0.622 V and operating pressure of 1.5 atm. Both the DTI and TIAX 2010 cost analysis models used 2010 dollars. The Pt commodity cost of \$1100 per troy ounce for the 2010 analysis was consistent with the Program's 2006-2009 analyses.

The DTI analysis resulted in a projected cost of \$51/kW for an 80-kW_{net} system manufactured at a volume of 500,000 units/year, and this value was selected by the DOE to represent the 2010 cost status. The TIAX analysis produced a preliminary projected cost of \$53/kW. Though preliminary, the TIAX analysis strongly supports the findings of the DTI analysis. Both analyses were reviewed by the DOE, in collaboration with the FreedomCAR and Fuel Partnership's Fuel Cell Technical Team (the Tech Team), and found to be credible.

The current status of \$51/kW represents a 30% decrease since 2008 and an 81% decrease since 2002, as depicted in Figure 1. The 30% decrease in projected cost since 2008 stems in part from a reduction in PGM loading and an increase in cell power density, allowing the design of smaller and less expensive stacks. Balance of plant (BOP) cost has also been reduced during this time. Major causes of the reduction in BOP cost include reconfiguration of the ejector system based on stakeholder input, redesign of the system controller, and reduction of the radiator size. The reduced radiator size was enabled by improvements in stack components, allowing a higher stack operating temperature.

Key assumptions of the cost analyses are summarized in Table 1, along with a cost breakdown for the years 2007 – 2010 [3-5].

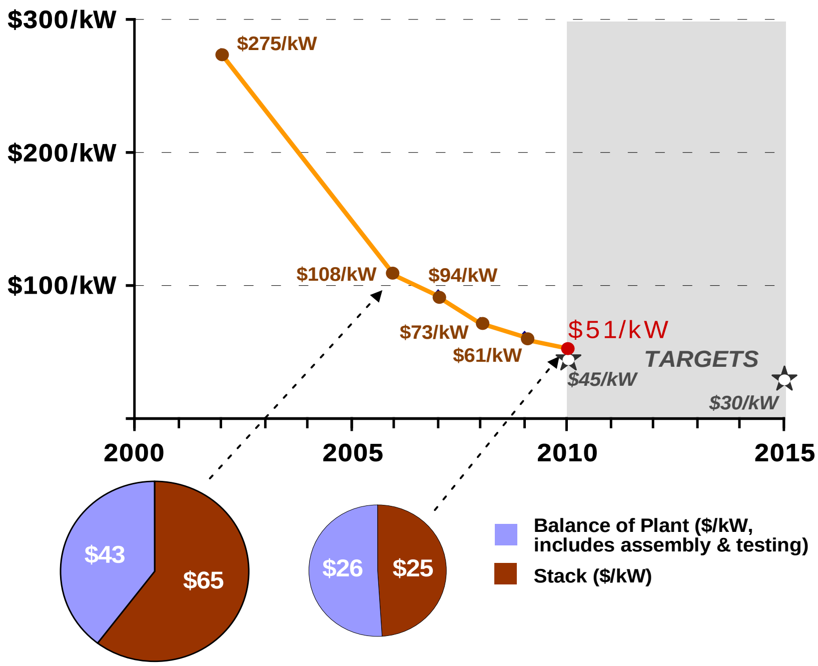

Figure 1. Modeled cost of an 80-kW$_{net}$ PEM fuel cell system based on projection to high-volume manufacturing (500,000 units/year). Cost targets are based on 2002 dollars. Cost status is based on dollars in the year of the analysis.

Table 1: Key Assumptions of Cost Analyses and Resulting Cost

Characteristic	**Units**	**2007**	**2008**	**2009**	**2010**
Stack power	kW_{gross}	90	90	88	88
System power	kW_{net}	80	80	80	80
Cell power density	mW_{gross}/cm^2	583	715	833	833
Peak stack temperature	°C	70-90	80	80	90
PGM loading	mg/cm^2	0.35	0.25	0.15	0.15
PGM total content	g/kW_{gross}	0.6	0.35	0.18	0.18
PGM total content	g/kW_{net}	0.68	0.39	0.20	0.20
Pt cost	$/troz. [a]	1100	1100	1100	1100
Stack cost	$\$/kW_{net}$ [a]	50	34	27	25
Balance of plant cost	$\$/kW_{net}$ [a]	42	37	33	25
System Assembly and Testing	$\$/kW_{net}$ [a]	2	2	2	1
System cost	$\$/kW_{net}$ [a]	94	73	61	51

[a] Dollars are in year of analysis.

Production of 80-kW_{net} transportation fuel cell systems for early market applications would occur at volumes lower than 500,000 units/year, and therefore would be more costly. Cost estimates prepared by DTI for manufacturing volumes of 1,000, 30,000, 80,000, 130,000, and 500,000 units/year are shown in Figure 2.

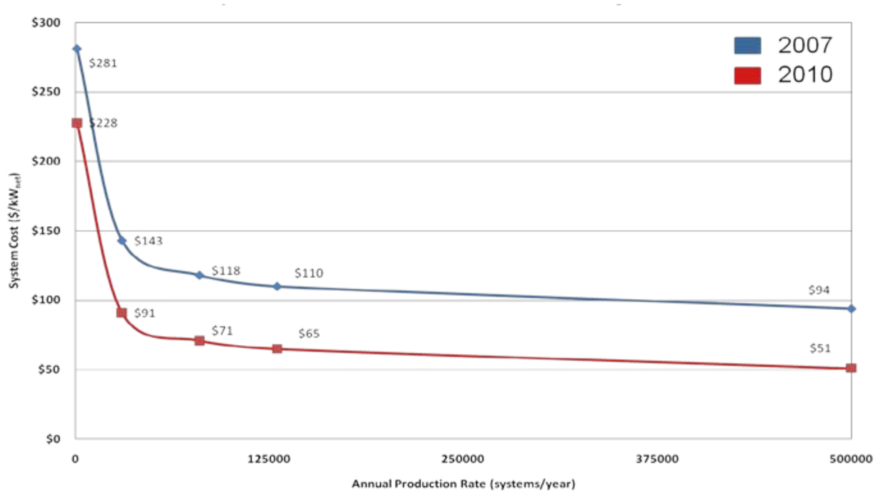

Figure 2. Projected cost of 80-kW_{net} transportation fuel cell systems at 1,000, 30,000, 80,000, 130,000, and 500,000 units/year.

For comparison to the DOE targets developed in 2002 and quoted in 2002 dollars ($45/kW by 2010 and $30/kW by 2015), the 2010 high-volume cost status of $51/kW in 2010 dollars equates to $42/kW in 2002 dollars [6].

References

[1] Brian James et al., "Mass Production Cost Estimation for Direct H_2 PEM Fuel Cell Systems for Automotive Applications: 2010 Update," report to the DOE Fuel Cell Technologies Program, September 30, 2010. http://www1.eere.energy.gov/hydrogenandfuelcells/fc_publications.html.

[2] Jayanti Sinha, et al., "Direct Hydrogen PEMFC Manufacturing Cost Estimation for Automotive Applications," Presentation to the Fuel Cell Tech Team, August 18, 2010.

[3] U.S. Department of Energy (Hydrogen Program), "Record 8002: Fuel Cell System Cost - 2007," http://www.hydrogen.energy.gov/program_records.html

[4] U.S. Department of Energy (Hydrogen Program), "Record 8019: Fuel Cell System Cost - 2008," http://www.hydrogen.energy.gov/program_records.html

[5] U.S. Department of Energy (Hydrogen Program), "Record 9012: Fuel Cell System Cost - 2009," http://www.hydrogen.energy.gov/program_records.html

[6] Bureau of Labor Statistics CPI Inflation Calculator, http://www.bls.gov/data/inflation_calculator.htm