X.2 Highly Efficient, 5-kW CHP Fuel Cells Demonstrating Durability and Economic Value in Residential and Light Commercial Applications

Jim Petrecky
Plug Power
968 Albany-Shaker Road
Latham, NY 12110
Phone: (518) 817-9124
Email: James_Petrecky@plugpower.com

DOE Manager
Reginald Tyler
Phone: (720) 356-1805
Email: Reginald.Tyler@go.doe.gov

Subcontractor:
ClearEdge Power, Sunnyvale, CA

Project Start Date: June 2009
Project End Date: September 2013

Objectives

- Create new jobs as well as save existing ones; spur economic activity
- Invest in long-term economic growth
- Accelerate the commercialization and deployment of fuel cells, fuel cell manufacturing, installation, maintenance, and support services

Relevance to the American Recovery and Reinvestment Act (ARRA) of 2009 Goals

- Jobs created at Plug Power including engineering, testing, sales, marketing, program management
- Improved reliability and efficiency of hydrogen fuel cell systems
- Decreased fossil fuel dependencies for power generation
- Used demonstrations to overcome the fuel cell development hurdles of durability, cost, system complexity, and temperature
- Substantiated the durability of Plug Power's 5 kW stationary proton exchange membrane fuel cell system and verify its commercial readiness for the marketplace:
  - Task 1 - internal fleet testing
  - Task 2 - external customer demos in real-world locations in California

Technical Barriers

- Stack Quality Issues
  - GenSys Blue membrane electrode assembly production was moved to another manufacturing process
  - Hydrogen tests looked strong
  - Reformate test: cell-to-cell variability
  - Stacks would have multiple weak cells

Technical Targets and Milestones

See Table 1.

Accomplishments

- Design Improvements
  - Efficiency: 89% total peak to 94%

TABLE 1. Performance Targets and Results

6A Target Performance and Go/No-Go Decision Chart					
Characteristic	**Units**	**Goal**	**1st GO - 2Q10**	**1st GO Actual**	**2nd GO - 2Q11**
Electrical efficiency at rated power	%	40	>30	32%	>30
CHP efficiency at rated power	%	90	>80	90%	>80
Cost (qnty < 15)	$/kWe	10,000	20,000	10,400	20,000
Durability at < 10% rated power degradation	hr	10,000	2,000	3,000	8,700
Noise	dB(A)	<55 at 10m	<55 at 10m	55 at 1m	<55 at 10m
Emissions (combined NOx, CO, SOx, hydrocarbon, particulates)	g/MWhr	< 1.5	< 1.5	< 1.5	< 1.5
				GO	NO GO

CHP - combined heat and power.

  - Manufacturing: Build reduced from >120 to <50 hr
  - Direct Material Cost Reduction: ~$90k to $53k in volumes <20
- Fleet of six GenSys combined heat and power (CHP) units at: 31k+ run hours; 53 MW-hrs electric, 633 MW-hrs heat

INTRODUCTION

This demonstration project is intended to test multiple units of high-temperature, proton exchange membrane fuel cell systems in residential and light commercial micro-combined heat and power (μ-CHP) applications in California. The specific objective of the demonstration project is to substantiate the durability of GenSys Blue, and, thereby, verify its technology and commercial readiness for the marketplace. Plug Power is working with the University of California, Irvine (UCI), Sempra, and ClearEdge during this project.

APPROACH

From 2009 to 2012, Plug Power led the development through internal customer acceptance testing. However, in May of 2010, Plug Power announced that the Company would "focus commercial activity on material handling market." In 2012, Plug Power subcontracted ClearEdge to demo ClearEdge CHP units in California.

RESULTS

See Figure 1 and Table 2.

FIGURE 1. ClearEdge Unit Performance

TABLE 2. Plug Power CHP System Performance Metrics

Plug Power CHP System Performance Metrics (Through December 2011)								
System S/N	E8	E9	E10	F2	F3	F4	Totals	Average
Commissioned Date	Jan-10	Jan-10	Apr-10	Jan-10	Mar-10	Jun-10		
System Runtime (Hours)	7,823	4,381	1,777	8,977	5,011	3,249	31,219	5,203
Current Stack Runtime	6,058	3,802	1,777	1,651	3,098	3,249	19,635	3,273
Burner Runtime	11,443	9,910	8,344	7,958	11,191	8,264	57,109	9,518
Electrical kWh	15,247	7,349	2,520	15,109	6,679	6,002	52,905	8,818
Thermal kWh	117,862	101,859	95,252	112,070	122,348	83,607	632,998	105,500
Startup Reliability	60.0%	70.0%	71.4%	64.0%	56.3%	54.5%		62.7%
Heat Operational	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		100.0%
CHP Operational	71.9%	39.2%	55.7%	70.4%	53.8%	46.9%		56.3%

CONCLUSIONS AND FUTURE DIRECTIONS

The continuity of supply for the high-temperature stacks needs to remain a focus of this market to meet and continue to improve the stack life requirements for this technology to be competitive with incumbent technology.

FY 2013 PUBLICATIONS/PRESENTATIONS

1. H2RA003_PETRECKY_2013_o (Annual Merit Review)