XII.8 Accelerating Acceptance of Fuel Cell Backup Power Systems

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Objectives

- Quantify the performance of 20 low-temperature fuel cell systems at two locations
- Optimize the maintenance of the systems and data collection practices
- The project is intended to increase distributed power generation, improve reliability and efficiency of mission critical backup power and decrease fossil fuel dependencies for power generation

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

- This project sustained jobs for the companies involved through the work required during the installation of the fuel cell-powered systems, the engineering work to sustain system performance, and all third parties involved in building sub-components, shipping parts to on-site locations and managing/coordinating the project.
- Long-term: Advances were made to prove the durability and efficiency of fuel cell technologies for critical backup applications that will help power and fuel the long-term economic health of our nation.
- This project used 20 fuel cell-powered low-temperature systems that were built, installed, maintained and analyzed. The fuel cell manufacturer gained valuable reliability data/experience that will advance their ability to meet customer expectations in order to be a viable competitor to traditional technologies.

Technical Barriers

- The siting, installation and operation of 20 low-temperature fuel cell systems
- Eliminate the hydrogen start requirement

Technical Targets and Milestones

- Build 20 low-temperature fuel cell systems
- Operate the fuel cell systems for one year at two locations

Accomplishments

- Built 20 low-temperature fuel cell systems
- Sited and installed of 10 low-temperature fuel cell systems at Robins Air Force Base Georgia
- Sited and installed 10 low-temperature fuel cell systems at Ft. Irwin in California
- Implemented eight safety-related improvement recommended by the Hydrogen Safety Panel at Robins Air Force Base

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Introduction

The project uses low-temperature GenSys fuel cell systems to provide power in remote, off-grid systems or primary power where grid power is unreliable or nonexistent. Coupled with high-efficiency performance, low-temperature GenSys reduces operating costs making it an economical solution for prime power requirements.

Currently, field trials at telecommunication and industrial sites across the globe are proving the advantages of fuel cells—lower maintenance, fuel costs and emissions, as well as longer life—compared with traditional solutions. This project will enhance the experience and knowledge of all partners involved bringing another hydrogen-powered fuel cell product into commercialization.

Approach

The 20 low-temperature systems were built for use at two distinct locations with each location having an installation plan. The siting of the fuel cells at Robins Air

Force Base had to be undertaken while keeping disruption to compound operations and future fuel cell maintenance to a minimum.

In the process of gaining sign-off of the National Environmental Policy Act form, we experienced some minor site engineering changes. Ultimately, the National Environmental Policy Act forms were approved and submitted to the DOE.

Results

Tables 1-3 summarize the unit performance at Robins Air Force Base. Table 1 contains 2012 statistics, Table 2 summarizes the totalized statistics, and Table 3 illustrates the total MW-hrs of power generated by each system. As can be seen in each table, units 7, 8 and 9 are the poorest performers while units 2, 3, 4, 6, and 10 are collecting more operational hours.

For these systems, we have a total of 13,500 cumulative operating hours, 13,370 cumulative hours of stack operation and have generated about 39 MW-hrs of power. The average efficiency is ~23.7%.

Table 3 summarizes our top problem list for the Robins Air Force Base systems. The top three problems based on occurrence are anode tailgas oxidizer (ATO) ignition timeout, scanner communication loss, and loss of fuel flow. The ATO timeout problem occurs when the ATO does not light off fast enough. Scanner communication loss happens either in the disruption of the signal through the cable or through a scanner board issue. Loss of fuel flow seems to be caused by a software bug where the fuel control valve momentarily closes.

The amount of operating hours we have on our systems demonstrates our ability to increase distributed power generation, improve reliability and efficiency of mission critical backup power and decrease fossil fuel dependencies for power generation through the use of low-temperature fuel cell systems.

Plug Power continues advance the deployment of fuel cells in their material handling "GenDrive" product line. We have sold over, and installed close to, 3,000 fuel cells across the United States that continues to advance the commercialization of fuel cells.

Conclusions and Future Directions

- Continue to monitor, maintain and repair systems.
- Prepare and log service and maintenance records for the low temperature fuel cell systems.
- Continue open communication with all partners on the performance of the systems and continue analyzing the field data.
- The fleet at Robins Air Force Base will continue to run and collect data until the end of October 2012. Fort Irwin will continue to run and collect data until mid-September 2013. A final report will coincide with the decommissioning of the Ft. Irwin site.

TABLE 1. 2012 Unit Statistics at Robins Air Force Base

	WRAFB #1	WRAFB #2	WRAFB #3	WRAFB #4	WRAFB #5	WRAFB #6	WRAFB #7	WRAFB #8	WRAFB #9	WRAFB #10
Serial Number>>	1028	1022	1033	1009	0005	1001	1019	1016	1002	1006
Cumulative System Hours	275	659	474	743	624	626	58	427	45	969
System Uptime	25.2%	30.2%	21.7%	34.0%	28.6%	28.6%	2.6%	19.6%	4.3%	44.4%
System kW-hrs produced	840	1770	1467	2298	1931	1931	141	929	131	2865
System Electrical Efficiency@3kW	23.3%	23.2%	24.0%	23.6%	22.4%	21.7%	26.2%	22.2%	20.9%	23.7%
Cum Stack Hours	275	659	474	743	624	626	58	427	45	969
Degradation Rate(µV/hr) @3kW	47.81	-38.88	23.17	24.22	2.61	-3.89	N/A	N/A	-29.26	22.22
Estimated Hrs to 48v	N/A	2578	N/A	N/A	N/A	31626	N/A	N/A	4583	N/A

TABLE 2. Exported Power Performance

	WRAFB #1	WRAFB #2	WRAFB #3	WRAFB #4	WRAFB #5	WRAFB #6	WRAFB #7	WRAFB #8	WRAFB #9	WRAFB #10	
Serial Number>>	1028	1022	1033	1009	0005	1001	1019	1016	1002	1006	Totals
Cumulative System Hours	934	1573	1754	1665	875	2136	555	920	520	2576	13506
System Uptime	33.8%	42.0%	45.4%	43.4%	19.9%	55.6%	14.6%	28.2%	19.5%	66.7%	36.9%
System MW-hrs produced	2.86	4.40	5.41	5.12	2.26	6.56	1.07	2.00	1.57	7.81	39.07
System Electrical Efficiency@3kW*	24.4%	24.4%	24.6%	23.9%	22.9%	22.9%	24.6%	21.9%	24.2%	24.8%	23.9%
Cum Stack Hours	936	1571	1750	1661	752	2131	554	919	519	2577	13369
* Hourly Weighted Average											

TABLE 3. Failure Modes

Summary of Top Failures		
Failure	**# of occurrences**	**Description**
ATO Preheat Timeout	15	ATO did not reach ignition temperature before a hard coded timer expired.
Scanner Comm Loss	26	Communication link between cell scanner and controller is lost
Loss of Fuel Flow	22	A bug in the control system causes a momentary cycling of the fuel inlet solenoid valve, fuel flow decreases to 0 and the system shuts down
Coolant Leak	4	Coolant level decreasing over time
Anode Air Pump failed to start	13	The anode air pump fails to start during system startup - the electrical connection to the pump needs to be physically disconnected and reconnected; or the system needs to be manually shut down and the controller rebooted.
Gas Leak	13	All leaks were detected during system startups and corrected prior to commissioning. No leaks were detected during normal operation
Unknown	7	
Fuel Flow Too High	5	Fuel flow meter failures or fuel proportional valve failures cause increased fuel flow readings inducing a system shutdown
Max Low Cell Trips	5	Usually a result of high CO levels in the reformate stream
FAD desulf cond timeout	4	During system startup, a hard coded timer expires when fuel flow is not detected
Firmware Update, Boot failure	4	
Anode Air Pump	2	Anode Air Pump failed and was replaced
ATO Can	2	ATO Can failed and was replaced
ATO MCB	2	ATO Blower Motor Control Board failed and was replaced
ATR In Temp High	1	Steam Temp did not rise during system startup causing a system shut down; caused by ATO Preheat timeout
Cathode Blower	2	Cathode Blower failed and was replaced
EIB Reset	3	
EIB/Sphere	3	EIB and/or Sphere Controller failed and was replaced
Exhaust Rad Fan	2	Exhaust Radiator Fan failed and was replaced
Float Cup	3	Float Cup failed and was repaired
Fuel Prop Valve	3	Fuel Proportional Valve failed and was replaced

ATO – anode tailgas oxidizer; FAD – fuel/air delivery; MCB – motor control board; EIB – electronic interface board