Accelerating Acceptance of Fuel Cell Backup Power Systems

Donald F. Rohr
May 16, 2012
H2RA007

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

Project Overview

Timeline

- Start: June 1, 2009
- Finish: June 2013

Budget

- DOE: $2.7M
- Cost-share: $2.7M
- Spent $1.88M as of 2011 Q4
- Planned 2012 $0.52M
- Planned 2013 $0.30M

Barriers

- Cost
- Affordability
- System reliability
- Market volume

Partners

- Robins AFB
- Ft. Irwin, CA
- Construction Engineering Research Laboratory (CERL)
- IdaTech

Relevance

- Demonstrate market viability and increase market pull of fuel cell systems within our government customers/partners

- Maintain US jobs both within Plug Power and outside through collaborations with supply base
  - Plug Power — Engineering, Testing, Sales, Mktg, Mgmt
  - Supply Chain — DANA, BASF, 3M, SFO (India)
  - Services — Site installation support
  - Other Partners — IdaTech

- Deploy 20 GenSys low temperature PEM, LPG units (GenSys LT) that provide economically viable backup power in excess of 72 hours
  - Increase distributed power generation
  - Improve reliability and efficiency of mission critical backup power
  - Decrease fossil fuel dependencies for power generation

Approach

GenCore®

Backup Power

- Hydrogen fueled
- Start time < 1 minute
- Run time = 4 hours

GenSys™

Extended Backup Power

- LPG fueled
- Readily available backup
- Run time = indefinite

GenSys™

Continuous Power

- LPG fueled
- Start time = 3 hours
- Run time = indefinite

Program Status

- ✓ Task 1 Program Management and Reporting
- ✓ Task 2 Site Planning and Applications Engineering
- ✓ Task 3 Site Specific Engineering Development
- ✓ Task 4 RAFB Fleet Build Test Ship
- • Task 4 Ft Irwin Fleet Build Test Ship – 2011 Q2 Startup
- • Task 5 Fleet Operation and Managed Services – Ongoing operation
- • Task 6 Reporting – Ongoing
- • Task 7 Project Closeout – Anticipated 2013 Q2

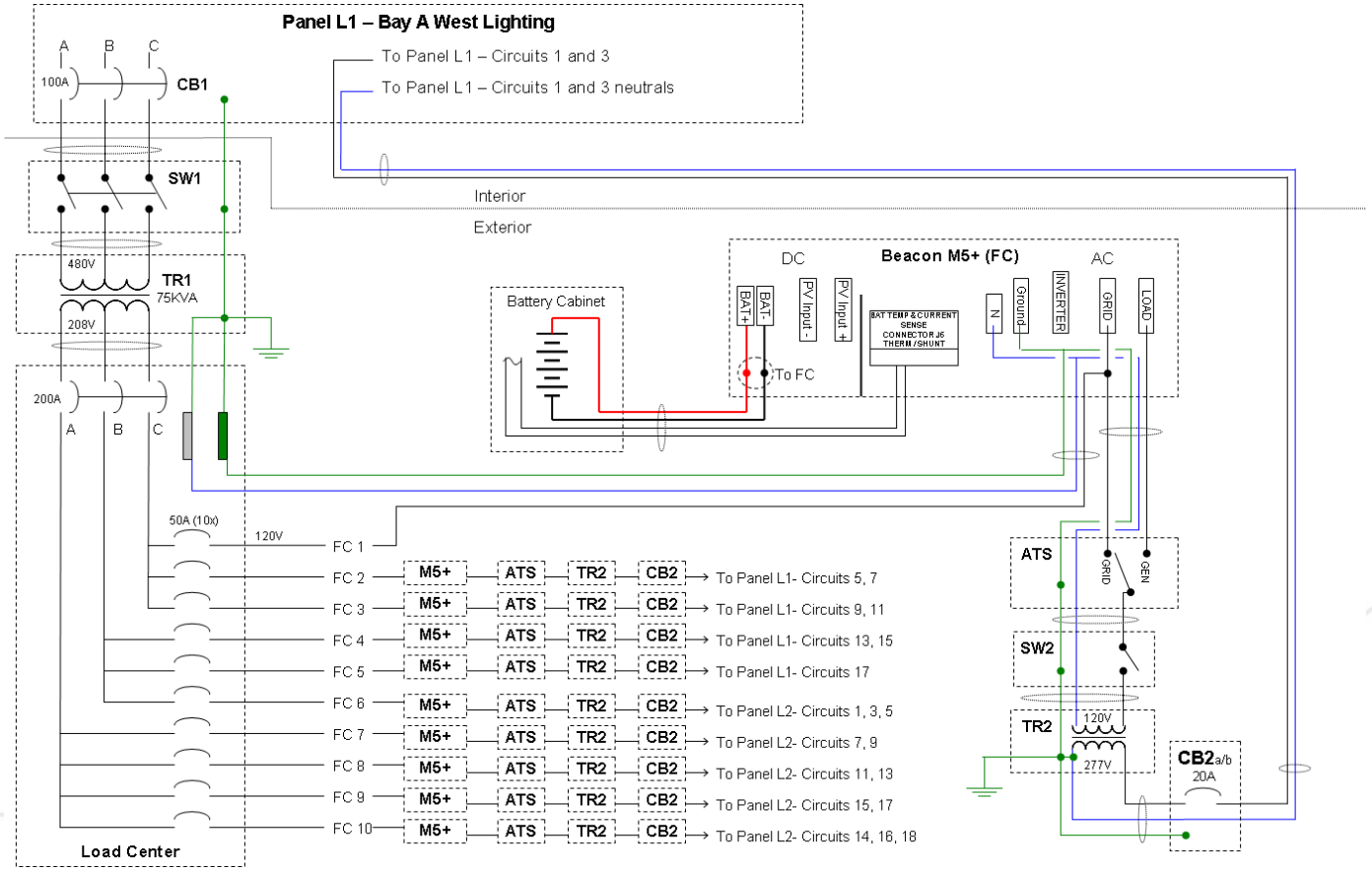
Collaboration: Plug Power-IdaTech

- Added IdaTech as a subcontractor
- Agreed on work scope and participation:
  - Site support
  - Data analysis
  - Ft. Irwin support
  - Additional spare parts
  - Participate in communication calls
- Excellent collaboration
- Project learning is contributing into next designs

Task 2: RAFB Site Application

- The team visited the Defense Distribution Depot - Robins AFB (DDWG), Georgia for detailed site analysis for installation of Fleet 1
- Ten GenSys LT systems will back up the lighting at the Air Logistics Center

Task 3: RAFB Backup Power Grid



Systems provide backup to multiple load circuits

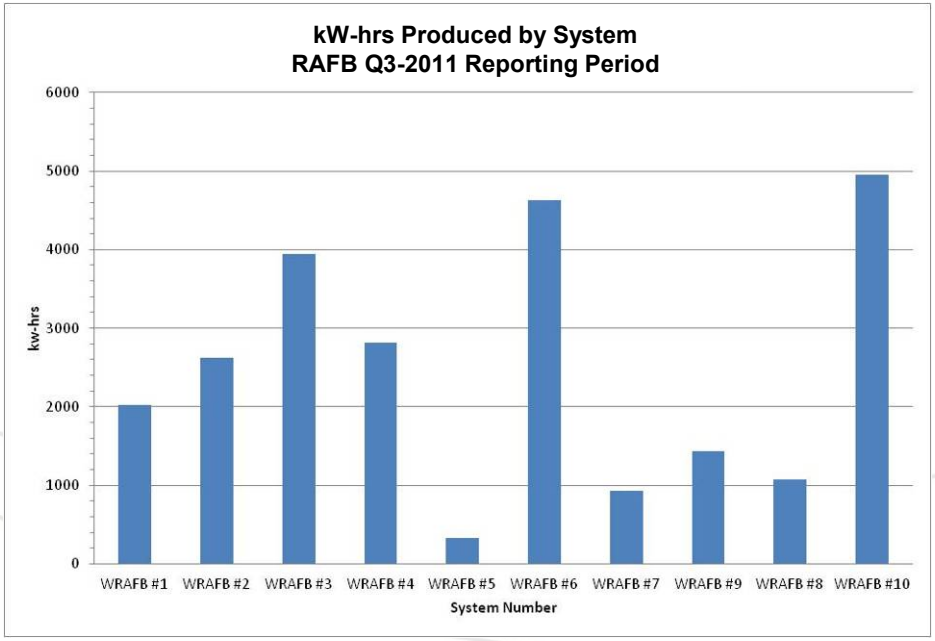
Task 4: RAFB Installation

Site prepared and systems installed

Task 5: RAFB System Operation

Robins AFB Fleet Metrics

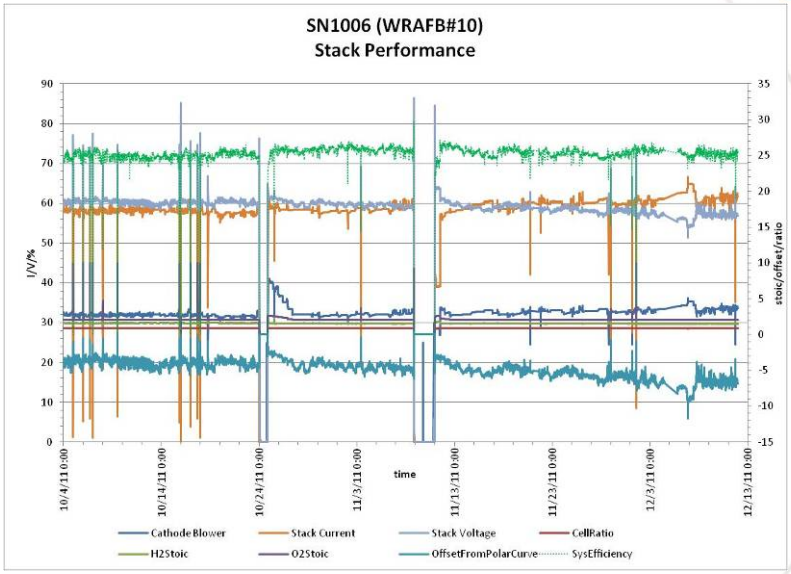
	1	2	3	4	5	6	7	8	9	10
Serial Number	1028	1022	1033	1009	0005	1001	1019	1002	1016	1006
Cumulative System Hours	659	914	1280	922	251	1511	497	475	492	1607
System Uptime	39.4%	58.5%	76.2%	55.9%	11.3%	91.3%	30.8%	29.3%	45.5%	95.7%
System kW-hrs produced	2020	2627	3943	2820	330	4633	931	1440	1075	4950
System Electrical Efficiency@3kW	24.9%	25.3%	24.9%	24.2%	24.2%	23.3%	24.4%	24.5%	21.7%	25.4%
Cum Stack Hours	661	912	1276	918	128	1505	497	474	491	1607
Degradation Rate(μV/hr)	-15.06	-54.68	-31.20	-42.50	N/A	-18.83	-16.64	-8.02	-25.28	-22.02
Estimated Hrs to 48v	9572	2776	4323	3518	N/A	7978	10613	16567	5933	6219



Robins Air Force Base

Systems were being brought online in 2011Q3

Task 5: RAFB Trended Data



- System variables tracked
- Trouble-shooting can be accomplished through remote login
- If degradation occurs, leading indicators can be determined

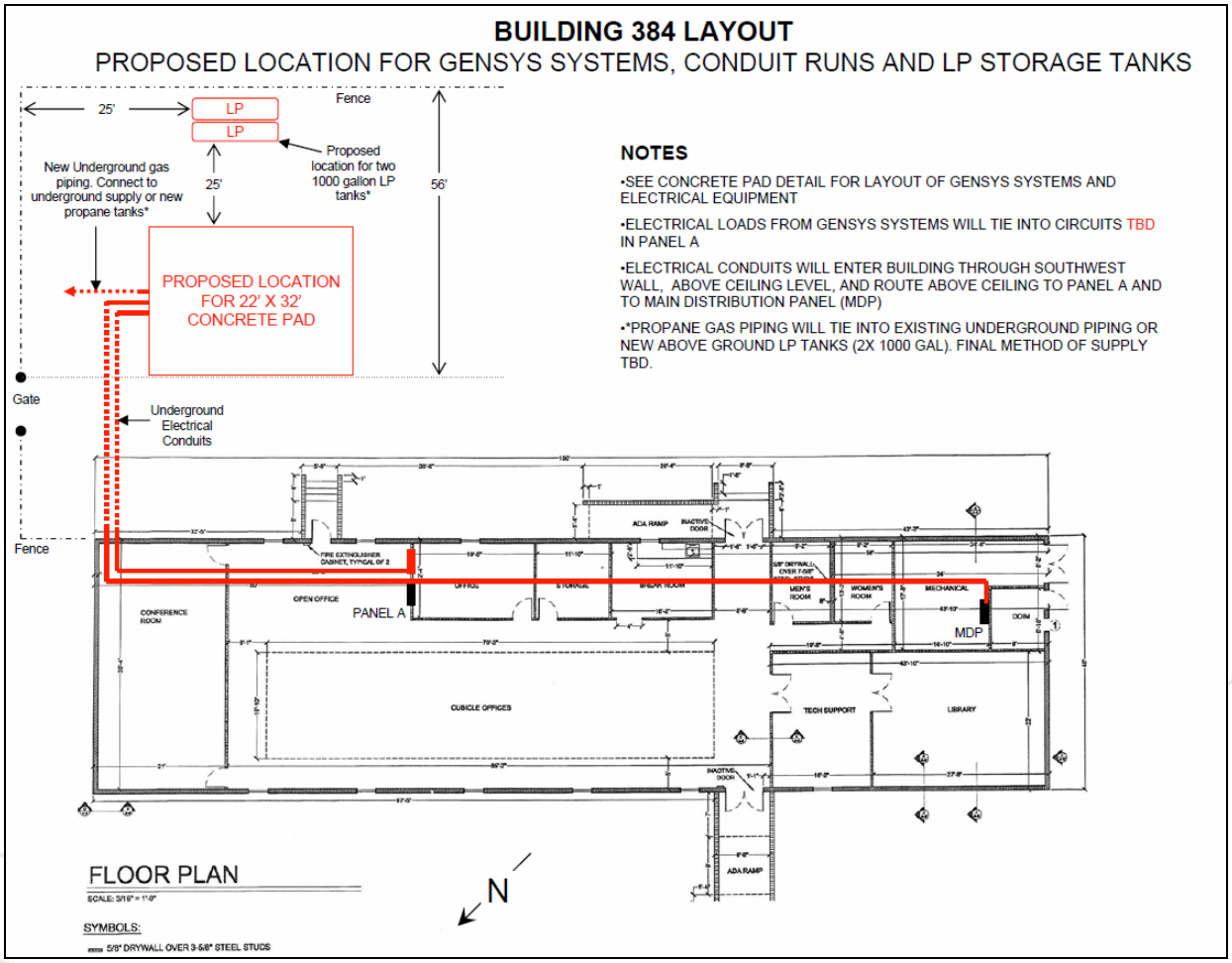
More consistent operation in 2011Q4

Task 2: Ft Irwin Site

Engineering Bldg
High efficiency lighting
Solar light pipes
Interest in reduced environmental footprint

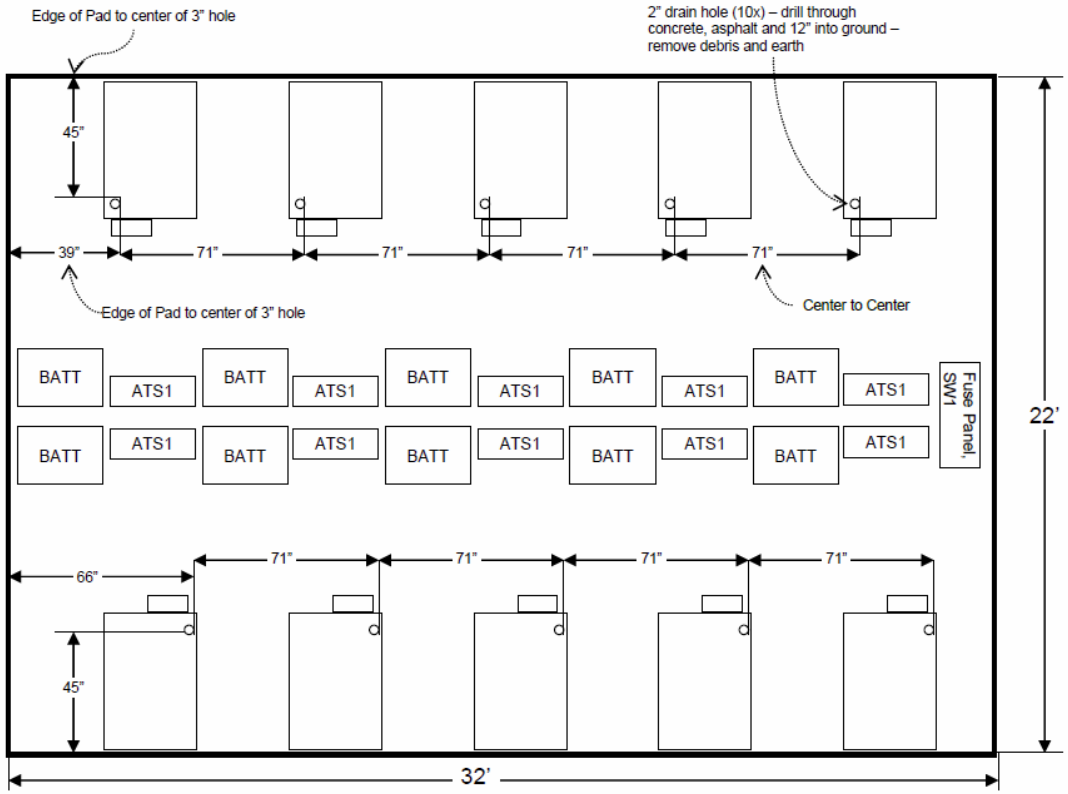
DOE requested site relocation; Moved to engineering Bldg

Task 3: Ft Irwin Site Layout



Site layout developed and agreed upon

Task 3: Ft Irwin Pad Layout

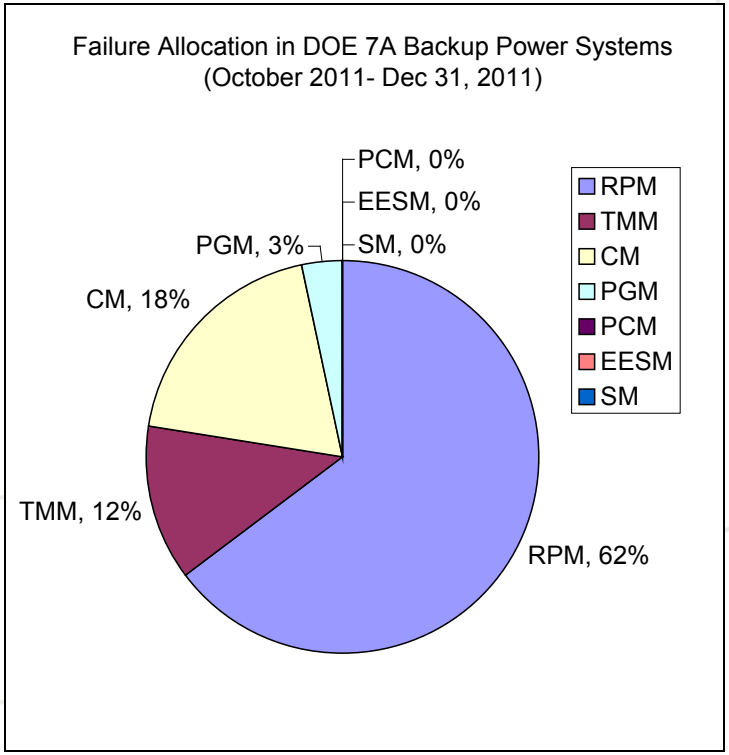


Similar application to RAFB, more aggressive environment

Task 5: Top Problems

- RPM: ATO timeout waiting for catalyst activation
- CM: Electronic board failures, some possible connection to software.
- RPM: Loss of fuel flow (related to flow meter/valve issues)
- TMM: Coolant Leak, loss of coolant
- RPM: Anode Air Pump failed to start, known issue
- RPM: Gas leak during commissioning
- CM: Unknown, attributed to electronic boards
- RPM: Fuel Flow, issue with occasional dropout or flow spikes
- PGM: Max Low Cell Trips, stack protection due to either CO or cell performance
- RPM: Desulfurization needed excessive time for conditioning/equilibration.
- CM: Firmware update and boot failure

Module Acronyms	
RPM	Reactive Processing
TMM	Thermal Management
CM	Controls & Electronics
PGM	Power Generation
PCM	Power Controls
EESM	Electrical Energy Storage
SM	Structure



Task 5: Lessons Learned

- Replaced a lot of boards, perhaps prematurely
  - IdaTech has shared with us that some board failures may be linked with software
- Highly interconnected system: troubleshooting is sometimes difficult with minimal instrumentation
  - Keep diagnostic ports & capability
  - Low-cost portable GC
  - Low-cost portable sulfur detector
- Stack manifold leaks
  - May contribute to coolant loss
  - Possible cross-leaks for anode
- Still need low cost components
  - Stack, Stack manifold
  - Pumps, blowers, boards
- Weld cracks seen in 3 reactors
  - Pressure test ahead of installation
  - An in-situ leak test procedure would help
- Learning from program will help IdaTech's next design

Future Work

- Steps to Program Completion

7A Backup Power Reliability Testing Remaining Tasks	
Task	Completion Date
Continue running 10 systems at Robins Air Force Base, including service and reporting	-
Install and commission 10 systems at Ft Irwin. Carry out service activities in coordination with IdaTech	1-May-12
Quarterly Report - Q1 2012	10-Apr-12
Quarterly Report - Q2 2012	10-Jul-12
Quarterly Report - Q3 2012	10-Oct-12
Decommission 10 systems at Robins Air Force Base. Send catalysts & reformers to IdaTech for post mortem analysis.	1-Nov-12
Quarterly Report - Q4 2012	10-Jan-13
Quarterly Report - Q1 2013	10-Apr-13
Decommission 10 systems at Ft Irwin. Send catalysts & reformers to IdaTech for post mortem analysis.	1-May-13
Quarterly Report - Q2 2013	10-Jul-13
Program Management Conclusion	30-Jul-13

POWERAHEAD

968 Albany Shaker Road
Latham, New York 12110

518.782.7700
www.plugpower.com