

# Accelerating Acceptance of Fuel Cell Backup Power Systems



Project ID: H2RA007  
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May 13, 2011

# Project Overview

## ■ Timeline

- Start: August 31, 2009
- Finish: August 31, 2011
- 35% complete

## ■ Budget

- DOE: \$2.7 MM
- Cost-share: \$2.7 MM

## ■ Barriers

- Cost
- Affordability
- System reliability
- Market volume

## ■ DOD Partners

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

# Objectives

- 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

- Hydrogen and LPG fueled
- Start time < 1 minute
- Run time = indefinite

**GenSys™**

## Continuous Power

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

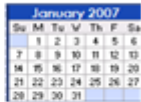









# Approach

■ <b>Cost Analysis and Commercialization Study</b>	<b>Complete</b>
■ <b>Site Planning and Applications Engineering</b>	<b>50% complete</b>
■ <b>Site Specific Engineering Development</b>	<b>20% complete</b>
■ <b>Systems Builds and Factory Testing</b>	<b>95% complete</b>
<p><b>Go/No Go:</b> After 20 simulated extended run power outage profiles, the system must be able to produce 6kW of DC power at a combined efficiency of &gt;24% using propane available at Plug Power's Latham facility</p>	
■ <b>Fleet Operation and Managed Services</b>	<b>0% complete</b>
■ <b>Project Closeout</b>	<b>0% complete</b>
■ <b>Program Management</b>	<b>35% complete</b>

# Cost Analysis

- The GenSys LT offers economic as well as environmental benefits over the incumbent diesel generator technology
- Near threefold advantage in system life with only 20-25% higher maintenance costs than a diesel generator
- The GenSys LT offers the customer a 20 to 30% decrease in power generation expense

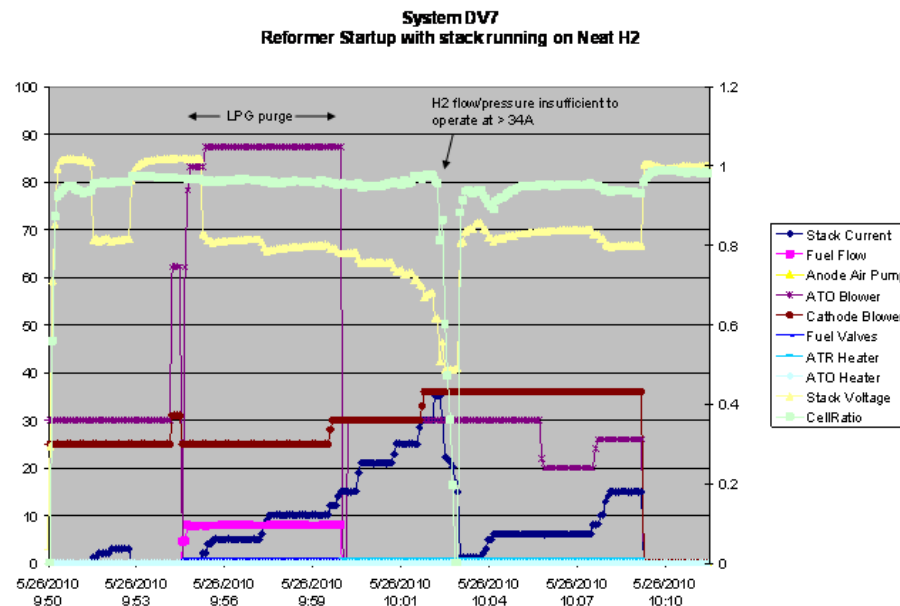
Telecom Cell Tower Application Comparison (4.5 kW Case)		
GenSys System	Features	Diesel Generator
<b>43,800 Hours (5 Years)</b>	System Life 	<b>15,000 Hours (1.71 Years)</b>
<b>System, Inverter, Batteries 2.4% less</b>	5-Year Capital Costs 	<b>3 Generators, AMF Panel, PIU, SMPS, Batteries 2.4% more</b>
<b>Range: 20% to 32% 4.5 kW Point: 29.1% (BOL)</b>	Efficiency $\frac{P_{out}}{P_{in}}$	<b>Range: 7% to 21% 4.5 kW Point: 18.5% (BOL)</b>
<b>LPG, potential to run on a range of hydrocarbons</b>	Fuel Type 	<b>Diesel</b>
<b>75-85% less fuel expense than diesel generator</b>	5-Year Fuel Costs 	<b>75-85% more fuel expense than fuel cell</b>
<b>Comparable maintenance 20-25% more than DG</b>	5-Year Maintenance Costs 	<b>Comparable maintenance 20-25% less than FC</b>
<b>&gt;99%</b>	Reliability / Availability 	<b>&gt;99%</b>
<b>7.0 metric tons of C, 0.4 g of NO<sub>x</sub>, 0.06 g of SO<sub>x</sub>, 0.51 g of CO annually</b>	Emissions to Environment 	<b>14.4 metric tons of C, 743 g of NO<sub>x</sub>, 49 g of SO<sub>x</sub>, 160 g of CO annually</b>
<b>65 dBA at 3 m</b>	Noise Level 	<b>75 dBA sheltered 92 dBA unsheltered</b>

BOL= Beginning of Life



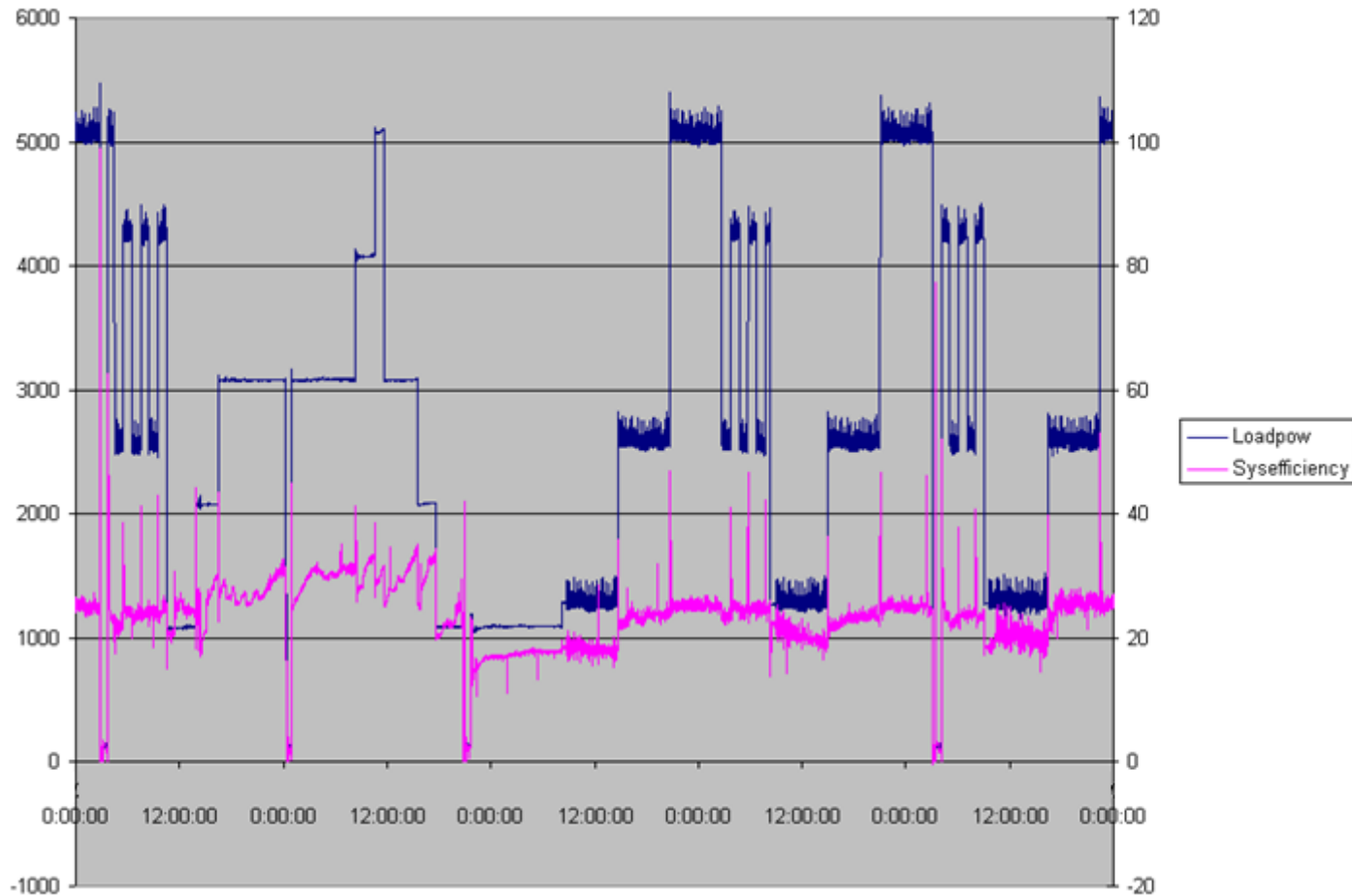
# Technical Accomplishments – Hydrogen Startup

- An economically viable path to 72 hours worth of backup power with a pure hydrogen solution was not determined
- Focus shifted to backup power/grid assurance with LPG



Hydrogen startup demonstrated in the lab

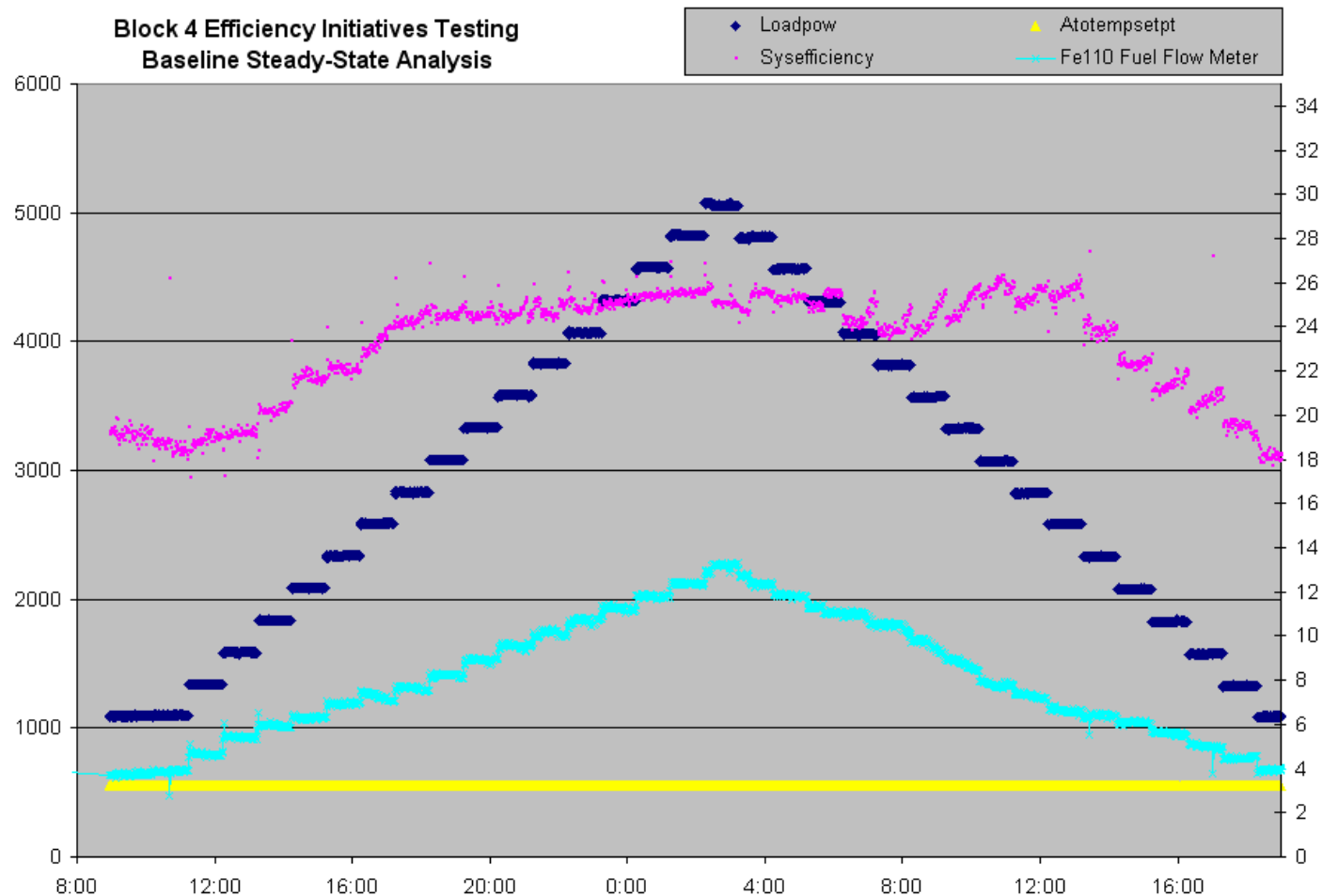
# Technical Accomplishments – System Operation



> 25% average electrical efficiency over a wide range of operation

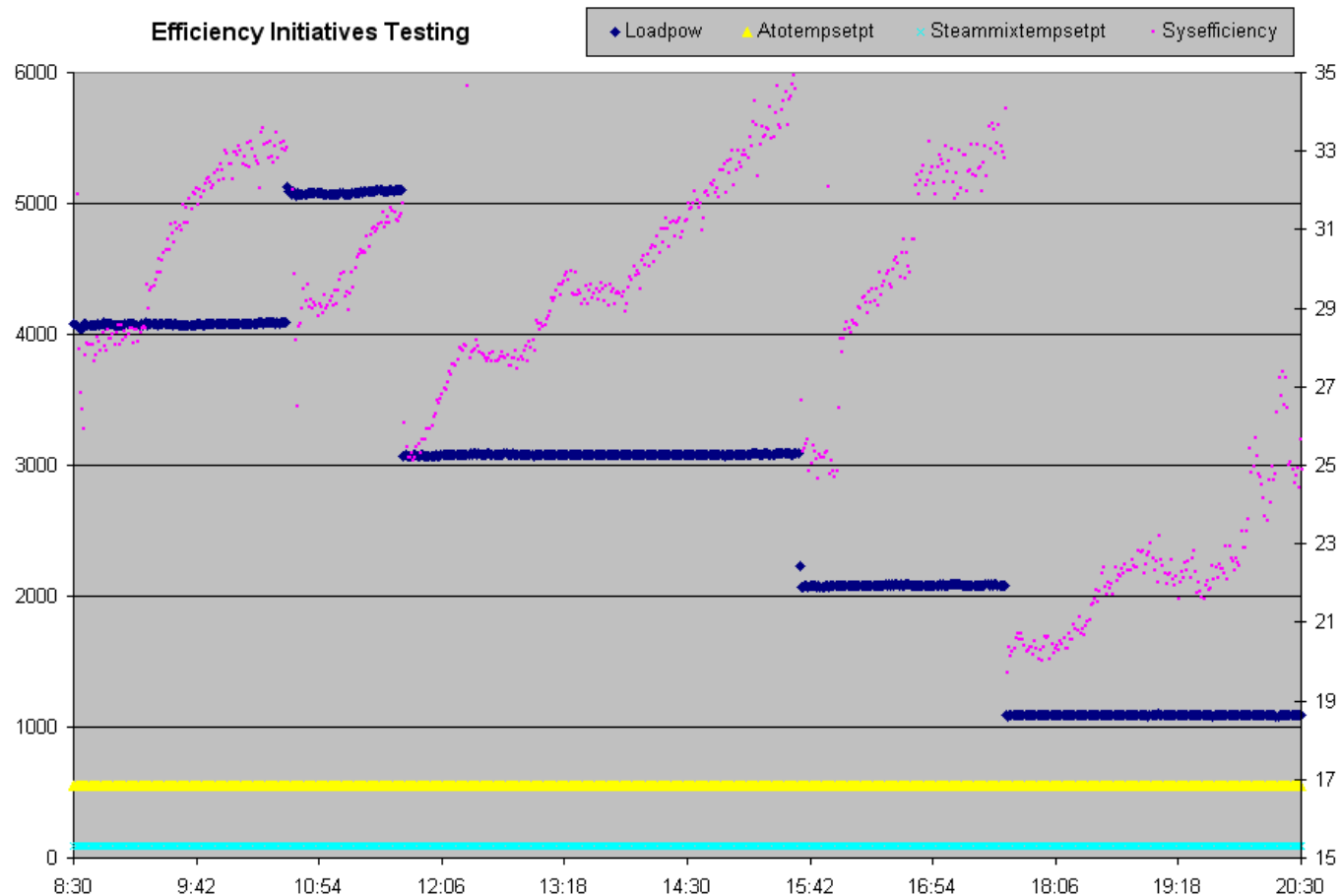


# Technical Accomplishments – Efficiency Improvements



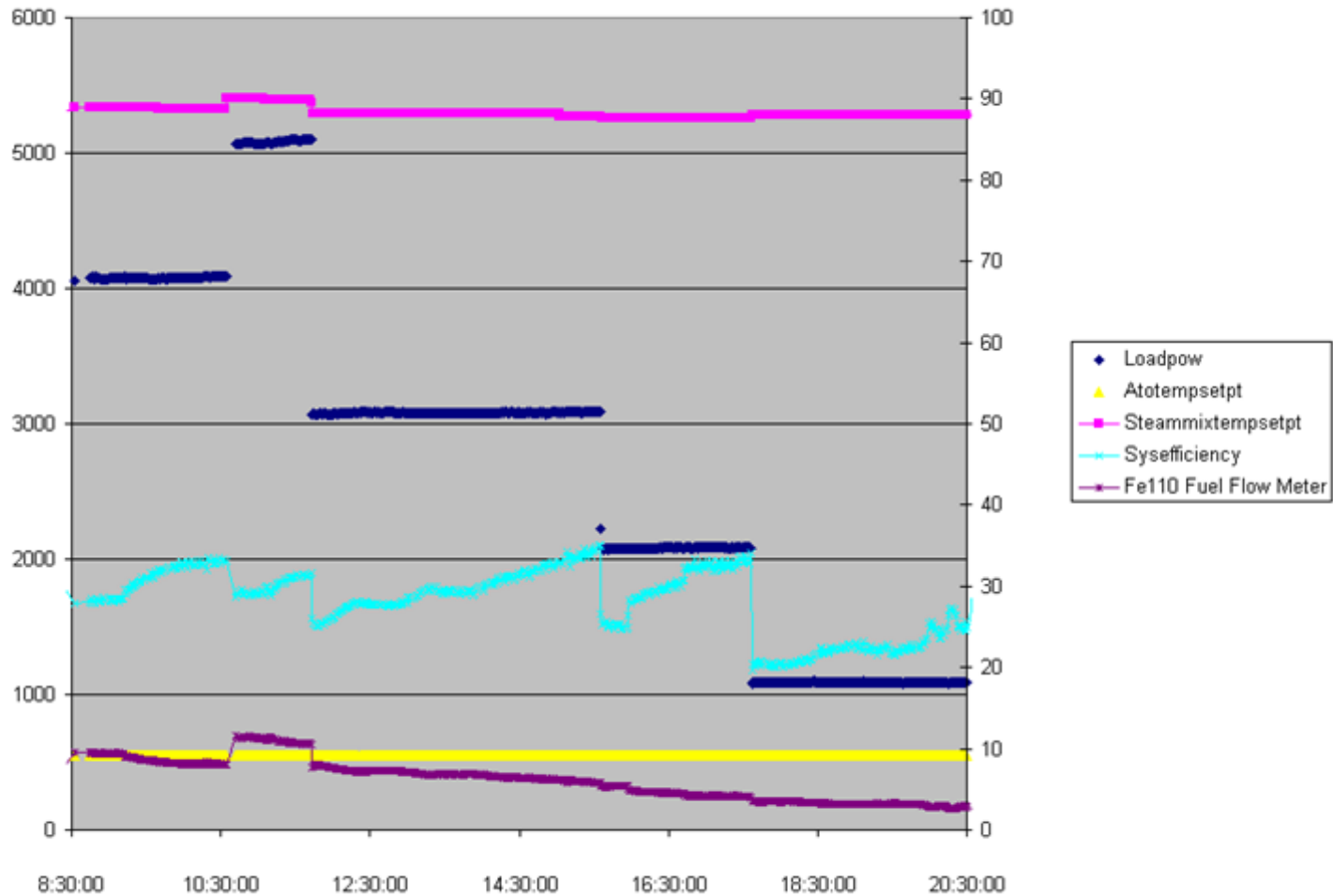
Baseline test showing efficiency vs. power levels

# Technical Accomplishments – Efficiency Improvements



Effect of lowering steam mixing temp on efficiency

# Technical Accomplishments – Efficiency Improvements



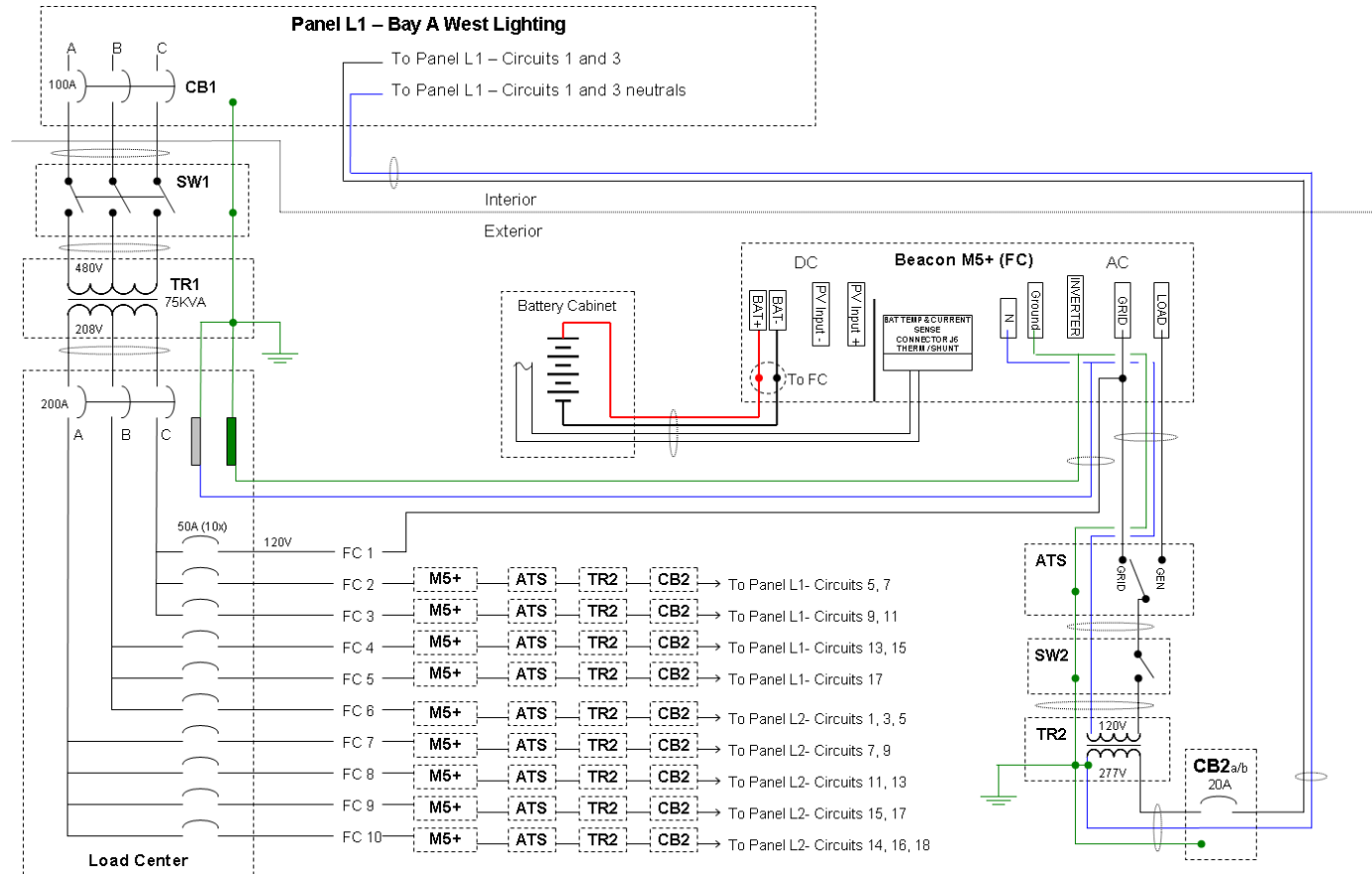
Optimization of operational parameters brings efficiency over 35%

# Technical Accomplishments - Site Selection



- The team visited the Defense Distribution Depot - Warner 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 at Warner Robbins

# Technical Accomplishments - Site Selection



The team is working with the base to develop the site design

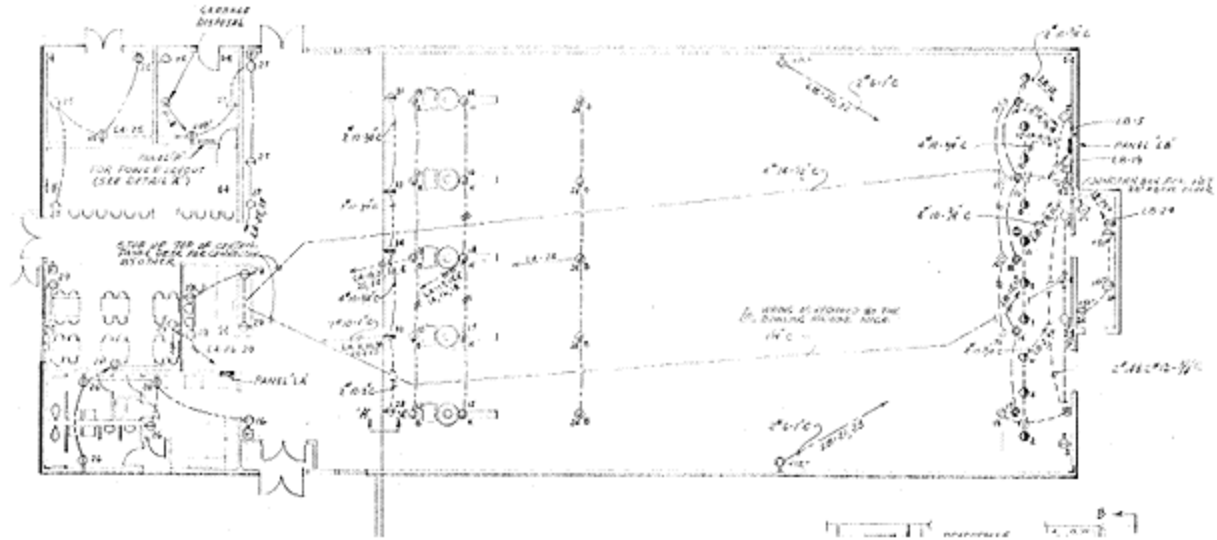
# Technical Accomplishments - Site Selection Ft Irwin



- The team visited Ft Irwin, CA 1Q11 for site analysis of Fleet 2 installation
- Ten GenSys LT systems will back up the lighting at the Strike Zone Center at Ft Irwin



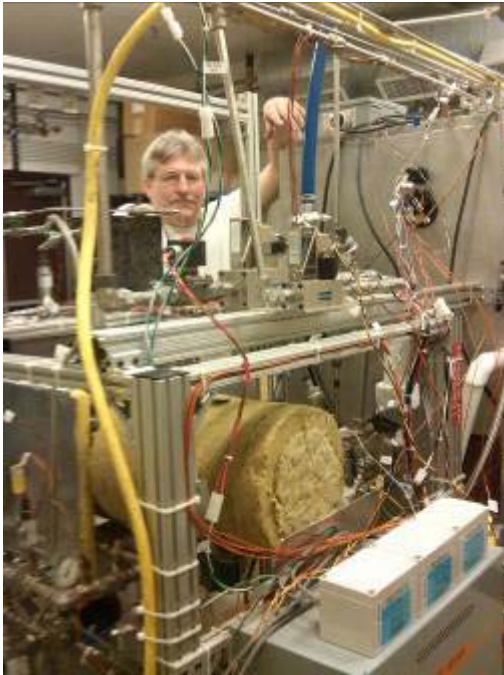
## Technical Accomplishments - Site Configuration



# Power plan of building

The team is developing the site inverter interconnect design

# Technical Accomplishments - System Build



Reformer Qualification Testing



Stack Qualification Testing



GenSys LT systems prepped for shipment to sites spare parts allocated.

Systems for the program are built, tested and being prepped for shipment

# Technical Accomplishments - System Installation & Field Tests

- Developed interface plan between GenSys converter and local grid on both bases.
- Installed trial grid topology at Plug Power and performed simulated power outages to confirm proposed interconnect strategy.
- Early results show promise, still working with systems controls and battery buffers to improve reliability.



Translate Field Tests to FT Irwin and WRAB

# Future Work

- ✓ Select sites for Fleet 2 at FT Irwin, CA 1Q11
- Perform site engineering work at FT Irwin and WRAB 2Q11
- Install and commission Fleet 1 at WRAFB 2Q11
- Install and commission Fleet 2 at FT Irwin 3Q11



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