

PEM Fuel Cell Systems Providing Backup Power to Commercial Cellular Towers and an Electric Utility Communications Network

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Project ID: H2RA006

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Timeline

- Start: August 2009
- End: December 2011
- 95% Complete

Barriers

- Site Selection
- Site Acquisition
- Fueling Infrastructure

Budget

Total Project Funding

- DOE: \$8,458,431
- Contractor: \$10,800,719

Partners

- AT&T
 - Host Sites / End-user
- PG&E
 - Host Sites / End-user
- Air Products and Chemicals, Inc.
 - Fueling Storage and Supply

- The goal of this project is to install and operate hydrogen fuel cells as critical emergency reserve power for cell sites operated by AT&T and as back-up power equipment for communications sites in use by Pacific Gas & Electric (PG&E), a California utility. Up to 189 sites will be served.
- The goals of the most recent year were to complete site acquisition, accelerate deployments, expand and cultivate the bulk refueling, and collect operating data.
- This project's relevance to the goals of ARRA:
 - the manufacture and installation of up to 189 fuel cell systems creates and retains direct and indirect jobs at ReliOn and indirect jobs through the service supply chain, and develops growth in new service industries to install and refuel these systems.
 - Air Products has developed a new fueling vehicle, and a new Hydrogen Storage Module (HSM)
 - The vehicle allows access to more sites, expanding the potential served market for compressed hydrogen; multiple outlet pressures serve multiple markets
 - The HSM is being leveraging as an alternative storage solution for other compressed gas applications
 - Multiple sub-contractors have gained experience installing fuel cells, increasing their product offerings
 - Advertising Fuel Cell Installation expertise

- This project's relevance to U.S. DOE goals:
 - by stimulating wider deployments, the benefits of fuel cells as a back-up solution has higher visibility within the industry, builds a critical mass for advanced refueling infrastructure using compressed hydrogen, and provides broad experience to installers and jurisdictions, reducing barriers to siting.
 - A parallel ARRA program is deploying additional fuel cells in a different carrier's network
 - Deployments outside of any DOE-funded program are in planning phases with multiple carriers
 - Product development in parallel has integrated lessons learned into new systems being deployed commercially in 2012.
 - Cost reduction, architecture simplification, >2x power density, 10% fuel efficiency improvements
 - HSM and bulk refueling are integral product offerings for applications previously un-served due to limitations of cylinder-exchange
 - Reduced operational cost of delivered hydrogen and longer run-time are accomplished by implementing bulk refueling in place of packaged gas exchange.
 - First deployments during this program have established early demand, either validating or enhancing assumptions for delivery models
 - These validated/enhanced models are being put to immediate use in planning for subsequent deployments outside of this program

- Complete all site acquisition
- Deploy second and third phase of fuel cells and hydrogen storage systems
- Commission second and third phases of installed systems
- Deliver initial bulk fuel to second and third phases of installed systems
- Transition operation of sites as they are commissioned to end-user
- Collect and report installation and operational data

- The project is structured in three phases:
 - Site Acquisition (Selection/Leasing/Permitting)
 - Equipment Installation
 - Data Collection & Reporting
 - The emphasis is on commercial processes and procedures to validate the readiness of the mainstream stakeholders (end-users, construction vendors, fuel providers, permitting officials) to quickly adopt fuel cell backup systems.
 - Originally specified as a serial process for the program, but in reality; serial for any one site and overlapping parallel by site & geographic region
 - *Risk is managed* by pursuing sites in multiple regions, multiple jurisdictions, in a parallel process, with a surplus of sites in the planning phases
- Unique physical aspects of program are as follows:
 - Fuel cell technology as back up power interleaved directly into the existing site's DC power system
 - Specific sizing of fuel cell equipment and corresponding hydrogen fuel storage for individual sites based on connected electrical load and the requirement to provide 72 hours of emergency backup

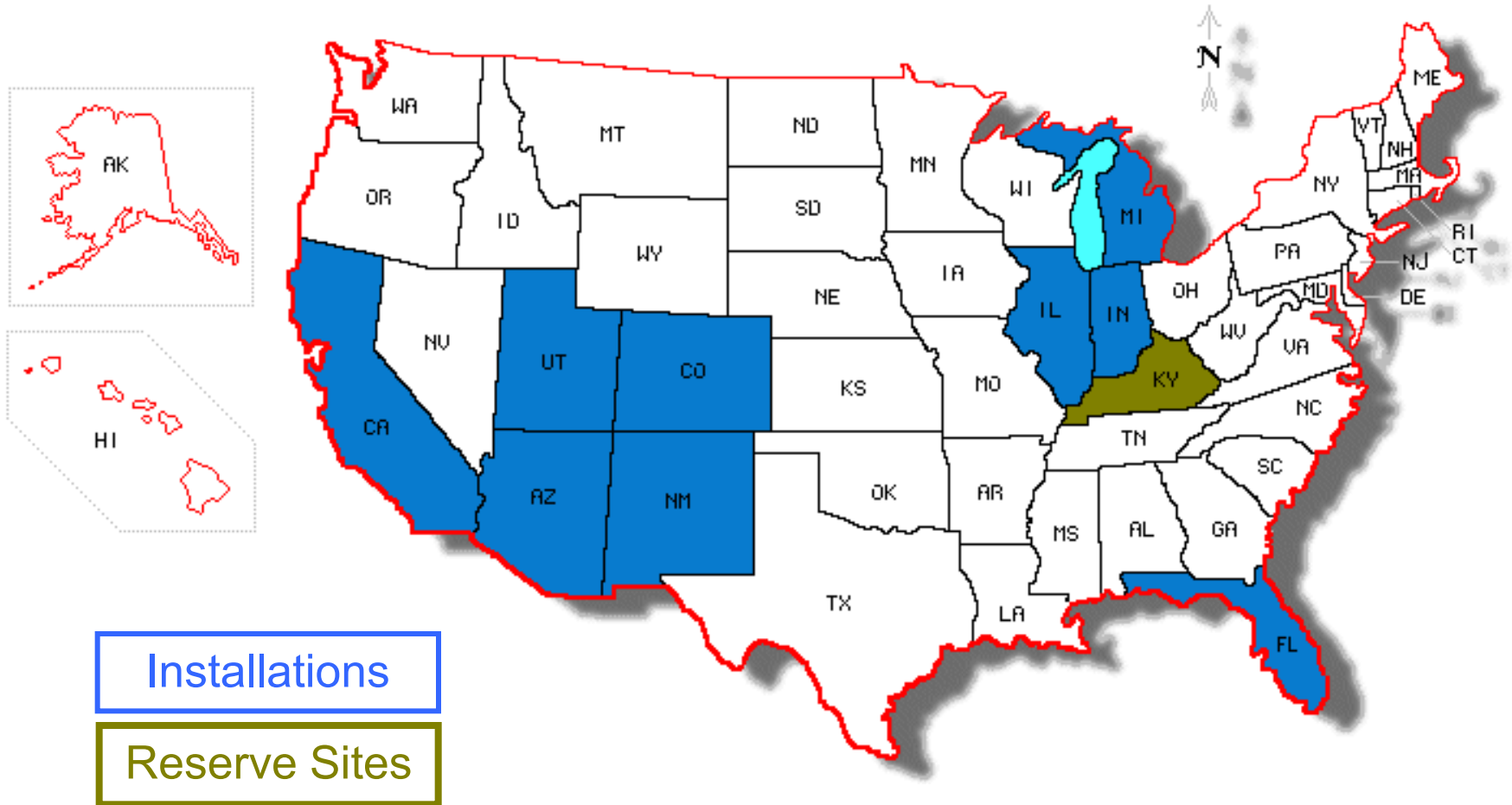
- Phase I: Site Acquisition (Selection/Leasing/Permitting) (100% complete)
 - Site Selection & Surveys: 100% complete
 - Identify final sites from a candidate list of 740 sites
 - GO/NO-GO criteria for each site
 - Power requirements
 - Site space availability
 - Site Access for refueling
 - Milestones
 - AT&T surveys – 100% complete, including reserve sites
 - PG&E surveys – 100% complete
 - Site Acquisition (Leasing & Permitting): 100% complete
 - Building/Electrical/Fire permits
 - Site Acquisition and Lease/Zoning Amendments (NEPA clearance 100%)
 - GO/NO-GO criteria: all permits and amendments secured
 - Milestones
 - AT&T Permits and Site Acquisition 180 of 180 sites – 100% complete
 - » An additional 73 sites did not achieve Site Acquisition for various reasons
 - » Average time to approval = 6 months (assumed 3 months at program launch)
 - PG&E Permits and Site Acquisition 9 of 9 sites – 100% complete
 - » An additional site did not achieve Site Acquisition due to landlord issues

- Phase II: Equipment Installation (87% complete)
 - Site Construction
 - Fuel Cell System Installation
 - System Commissioning
 - Milestones
 - AT&T sites – 87% complete
 - » 156 of 180 sites (361 fuel cells installed, of 419 total) prior to May 2012
 - » Remaining 24 sites projected to be complete by end of June 2012
 - PG&E sites – 100% complete
 - » 9 of 9 sites (9 fuel cells installed, of 9 total)
- Phase III: Data Collection and Reporting (100% complete)
 - Data Collection for 15 representative sites
 - Project Management and Reporting
 - Milestones Completed
 - Safety Plan
 - Quarterly Reports
 - Quarterly Data Collection

- Site Acquisition completed on all remaining sites (41)
 - Coordination with local authorities and landlords was accomplished in multiple regions, educating stakeholders of the benefits and requirements of siting fuel cells. Each subsequent site approval within a region was significantly easier.
- Construction and commissioning completed on additional sites (43 sites/111 fuel cells)
 - Installation data reported on all sites
- Operational data reported on 15 sites configured with wireless modems
 - Monitored sites carried numerous outages
 - Ancillary benefit: data revealed site-specific issues unrelated to fuel cell (e.g. bad batteries)

Accomplishments – Multi-state

- Sites across 10 states



Accomplishments – Typical Site Installations



Ancillary accomplishments (funded independently)

- Development of enhanced vehicle for hydrogen delivery to broader population of sites
 - Smaller vehicle
 - Lighter weight
 - Better fuel economy
 - Better payload utilization



- Development of hydrogen storage solution
 - (prior to ARRA effort)
 - Commercial, multi-cylinder module
 - U.S.DOT 3AA 3000, 80L cylinder
 - Meets requirements of 72 hours capacity

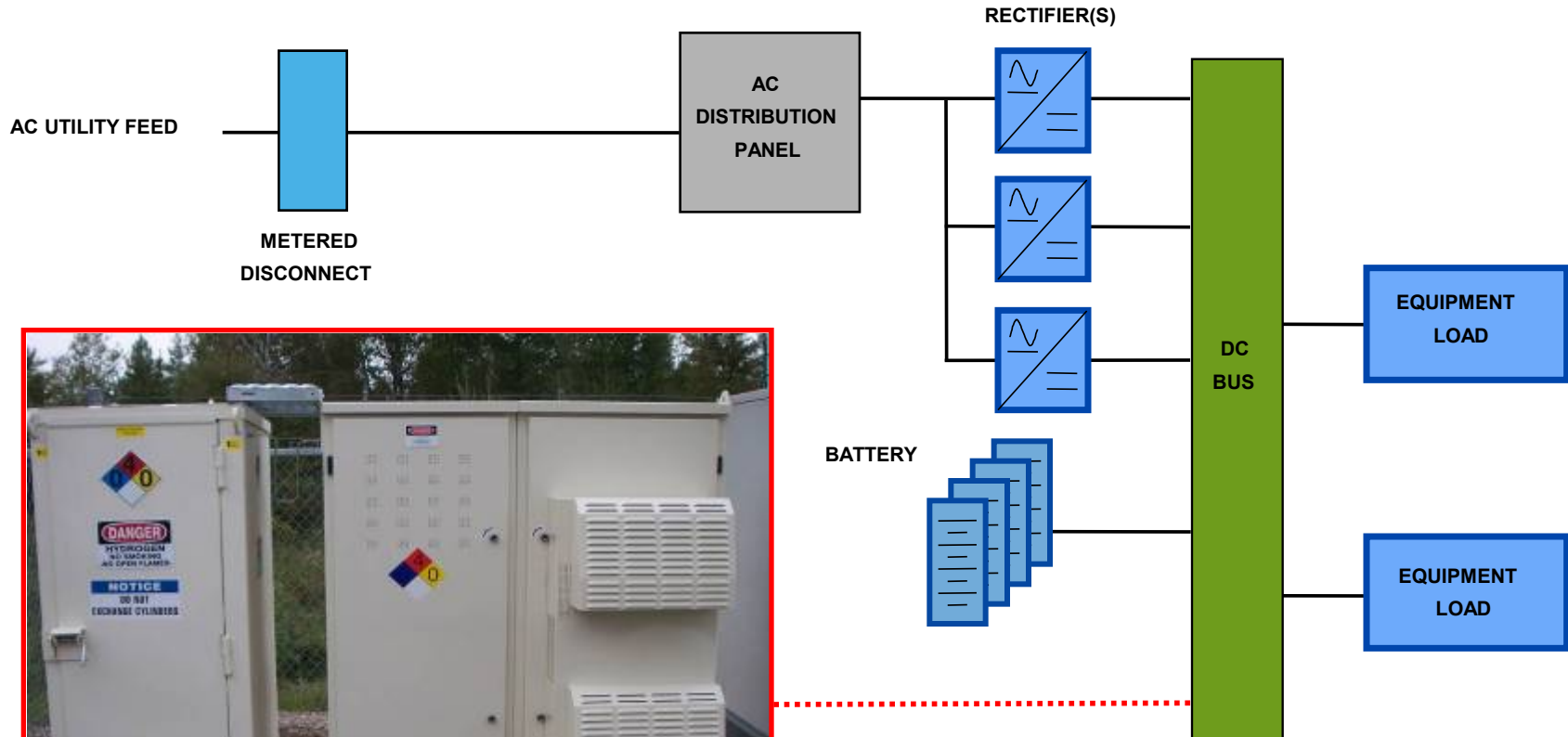
- ReliOn
 - DOE Prime Contractor
 - Fuel Cell System Manufacturer
 - Installation Prime Contractor
- AT&T
 - Customer / Host Sites / End-User
 - Up to 180 sites with hybrid cylinder exchange/bulk refueling solution
 - Extensive involvement in site selection and development
- PG&E
 - Customer / Host Sites / End-User
 - 9 sites with cylinder exchange
- Air Products & Chemicals, Inc.
 - Partner / Supplier
 - Hydrogen Storage / Bulk Fueling Service / Vehicle Development
 - Extensive involvement with storage development and fueling infrastructure

- Program officially ended 12/31/2011
 - *In Q1 2012 AT&T re-established previously-frozen program support budget so that deployment can be completed*
- Additional ReliOn activities for FY 2012
 - Complete 24 remaining installations at AT&T sites by EOQ2 2012
- Risks to this program were front-loaded, primarily on site selection/acquisition
- Risks going forward:
 - Final permitting (final sign-offs can still delay completion)
 - Fuel cell installation (minimal risk; weather improving)
 - Refueling (minimal risk; trucks proven at this point, weather)

- **Relevance**
 - The deployment of 189 fuel cell systems in two networks, across 10 states, with a new fueling solution has already begun to transform the market by raising awareness in multiple stakeholders, and has resulted in direct and indirect employment at ReliOn, and indirect employment up and down the supply chain which will continue after the program is completed.
 - New Products (fuel cells, hydrogen storage, and hydrogen delivery) were developed in parallel, without DOE funding, based on lessons learned from this program.
 - Multiple telco regions, installers, and a major gas supplier are enhancing their product portfolios and solution sets with fuel cell experience.
- **Approach**
 - Focusing on commercial processes and industry standards, the deployment moves beyond traditional “demonstration” programs to reach a critical mass necessary to engage a supply chain and a fueling infrastructure, and touch a broad spectrum of stakeholders.
 - A broad geographic installation base extends the reach to myriad markets, installation firms, and permitting districts, raising awareness through actual deployments.
- **Technical Accomplishments & Progress**
 - All 189 sites have completed all pre-construction documentation (“site acquisition”)
 - 165 of 189 sites have completed equipment installation and commissioning and are operational
 - New fueling storage and infrastructure solutions have been deployed.
- **Collaboration**
 - The team brings together a leading fuel cell system manufacturer (ReliOn) with the nation’s largest wireless telecommunications carrier (AT&T), a California utility (PG&E), and a major industrial gas supplier (Air Products), to field commercial systems in real-world installations across a broad range of environments.
 - The critical mass of systems enables the program team to penetrate nation-wide regions with corporate level attention, and catalyze non-DOE-funded activities in fuel storage and delivery.
- **Future work**
 - Complete the construction & commissioning of the remaining 24 sites by EOQ2 2012

Technical Backup Slides

Example Site Power System



**HYDROGEN
STORAGE
MODULE
(HSM)**

**REPLACEABLE
H2 CYLINDER
CABINET**

**RELION FUEL
CELL CABINET**

Site HSM Bulk Fueling Example



- 9 PG&E sites with 1 ea. ReliOn T-1000[®] 1.2kW Fuel Cells and up to 3100 cu-ft of fuel
 - California
- 14 AT&T sites with 1 ea. ReliOn T-2000[®] 2kW Fuel Cells and up to 5500 cu-ft of fuel
 - Illinois, Indiana, and Michigan
- 93 AT&T sites with 2 ea. ReliOn T-2000[®] 2kW Fuel Cells and up to 9500 cu-ft of fuel
 - AZ, CA, CO, IN, KY, MI, NM, and UT
- 73 AT&T sites with 3 ea. ReliOn T-2000[®] 2kW Fuel Cells and up to 13,500 cu-ft of fuel
 - AZ, CA, CO, FL, IN, KY, MI, and UT