

## VII.G.4 Residential Fuel Cell Demonstration by the Delaware County Electric Cooperative\*

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*Start Date: October 1, 2004*

*Projected End Date: July 31, 2006*

*\*Congressionally directed project*

### Objectives

- Demonstrate viability of grid-independent home
  - typical upstate New York residence
  - total electrical energy needs met by fuel cell
  - intelligently managed energy storage
  - in-home load control
  - increased efficiency through thermal recovery
- Validate objectives of propane-fueled hydrogen fuel cells for edge-of-grid residences via a field trial demonstration
  - measure and report technical performance
  - provide raw cost data and economic viability analysis
  - document maintenance and operations concept enhancements specific to residential fuel cells
  - share safety-related vulnerabilities analysis and lessons learned
  - promote education of state and local consumers

### Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research Development and Demonstration Plan:

- I. Hydrogen and Electricity Co-Production
  - Cost and durability not statistically validated
  - Permitting, codes, and standards not established for fuel cells in or around buildings
  - Lack of operational and maintenance experience

## Technical Targets

This demonstration and validation project does not develop new component technologies, and therefore does not have technology targets. Instead, this project will validate technical targets developed within the other subprograms and evaluate the future requirements for integrated systems.

## Approach

- Design and install a residential electrical system that allows the 5-kW propane fuel cell to act as a battery charger for an energy storage device, which in turn meets the entire electrical needs of the home
- Design and install a thermal recovery system to efficiently utilize waste heat from the fuel cell to preheat potable hot water and provide space heating through baseboard heaters
- Design and install a data collection and logging system to capture real-time power quality events, power flows, thermal flows, fuel utilization, equipment operating parameters, and ambient conditions
- Create a test matrix to include real-time data and periodic data collection, including chemical composition of propane fuel
- Analyze 1-year demonstration data to determine operational timing parameters, electrical efficiency, and thermal efficiency, all correlated with variables including ambient conditions, fuel composition, stack age, etc.
- Transfer technology to electric cooperatives throughout the United States through the National Rural Electric Cooperative's Cooperative Research Network technology transfer program
- Educate state and local consumers through the State University of New York (SUNY) at Delhi Division of Technology by co-teaching a fuel cell seminar and by integrating fuel cell and energy storage technologies into their energy technology curriculum

## Accomplishments

- Contracts or memorandums of understanding completed with major project partners: Energy Now!, Gaia Power Technologies, Plug Power, and the New York State Energy Research and Development Authority (NYSERDA)
- Site selected and host agreement finalized
- One-minute residential baseline load data collected starting December 17, 2004
- Preliminary and final designs complete for electrical, thermal, water supply, fuel supply, and site plan
- Awarded \$48,000 additional co-funding from the NYSERDA/DOE Energy Storage Initiative to support the energy storage portion of the project
- Awarded \$18,000 additional co-funding from the Propane Education and Research Council to support fuel supply activities including laboratory testing
- Delaware County Electric Cooperative employees trained to install, commission, and maintain fuel cells
- Pre-installation design review completed
- Installation completed
- Real-time data collection started in June 2005
- Fuel cell and energy storage units commissioned in June 2005

## Future Directions

- Continue real-time data collection for a full year demonstration period
- Conduct additional periodic tests, including fuel composition testing and fuel cell startup testing

- Conduct fuel cell and energy storage press event in Delhi, New York, on August 11, 2005
- Create educational materials and conduct fuel cell and energy storage seminar at SUNY Delhi
- Conduct post-demonstration analysis and submit final reports

## **Introduction**

Delaware County Electric Cooperative, Inc. (DCEC) will validate objectives of propane-fueled hydrogen fuel cells for edge-of-grid residences via a field trial demonstration to understand the technical and economic viability of fuel cell alternatives to new line construction. Specifically, they will measure and report technical performance, provide raw cost data and economic viability analysis, document maintenance and operations concept enhancements specific to residential fuel cells, share safety-related vulnerability analysis and lessons learned, and promote education of state and local consumers.

## **Approach**

The DCEC demonstration project will utilize technology experts in fuel cell and energy storage technologies from Plug Power and Gaia Power Technologies, data collection from Enernex Inc. and Sandia National Labs, fuel supply from Mirabito Fuel Group and the Propane Education and Research Council, education and outreach from SUNY Delhi, and technology transfer from Energy Now and the Cooperative Research Network. Co-funding from the NYSERDA/DOE Energy Storage Initiative, the NYSERDA Distributed Generation Program, and the Propane Education and Research Council will leverage and amplify the funding from the DOE Hydrogen Program.

A Plug Power propane fuel cell will act as a battery charger for a large residential energy storage system from Gaia Power Technologies. The maximum amount of thermal recovery will be utilized to pre-heat hot water and provide space heating for the residence. Real-time data will be captured and made available to project partners via satellite internet connection from the rural residence. The demonstration project will be accessible to government, industry, and educators as a means to validate DOE fuel cell objectives while educating students and consumers regarding the potential

contributions of fuel cells and energy storage technologies to our future energy economy.

## **Results**

It is too early in the demonstration period to provide meaningful quantified results with respect to the DOE's technical targets and objectives. However, DCEC can report that the fuel cell was installed in May of 2005 and commissioned on June 13, 2005. Early performance problems with the 5-kW residential propane fuel cell caused considerable down time during the first six weeks of operation, which resulted in the energy storage device acting as a peak-shaving device being fed by the utility grid.

Figure 1 shows the outdoor installation of the Plug Power 5-kW fuel cell, which offers easy access to site visitors in an aesthetically pleasing environment. Note that all connections to the fuel cell, including propane supply, water supply, thermal recovery loop, communications connections, and electrical connections, are routed underground in a manner consistent with the needs of a residential family setting.

Figure 2 shows the Gaia Power Technologies Power Tower energy storage device installation in the utility room of the home. All thermal recovery, communications, control, and data-logging equipment is colocated with the energy storage equipment in the utility room.

Password-protected access to real-time site data is available through our contractor Enernex Inc.



**Figure 1.** Residential Fuel Cell Installation in Upstate New York



**Figure 2.** Residential Energy Storage Towers Fed by 5-kW Fuel Cell

## **Conclusions**

Although DCEC has just begun the demonstration phase of the project, it is clear that the project is drawing considerable positive attention within the utility industry and within the geographic region. Early indications are that residential fuel cells have significant progress yet to be made toward the goal of being commercially viable. DCEC looks forward to quantifying the progress to date as represented by its demonstration project.