

II.H.4 EVermont Hydrogen Electrolyzer Project*

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Subcontractors:

Northern Power Systems, Waitsfield, VT 05673
Proton Energy Systems, Inc., Wallingford, CT 06492

Start Date: October 1, 2004

Projected End Date: June 30, 2007

*Congressionally directed project

Objectives

- Develop advanced proton exchange membrane (PEM) electrolysis fueling station technology.
- Build and test a validation system in Vermont that utilizes renewable electricity and is capable of providing hydrogen fuel to vehicles.
- Procure a hydrogen fueled vehicle for testing and validation of the station.
- Gain experience with hydrogen as a motor fuel.
- Document vehicle performance operating on hydrogen motor fuel.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Generation by Water Electrolysis section (3.1.4.2.2) of the DOE Multi-Year Research, Development and Demonstration Plan:

- (G) Capital Cost
- (H) System Efficiency
- (I) Grid Electricity Emissions
- (K) Electricity Costs

Technical Targets

This project will contribute to achievement of the following DOE Hydrogen Production milestones from the Hydrogen Production section (3.1) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- **Milestone 7: Verify feasibility of achieving \$2.85/gge (delivered) from electrolysis.** Several activities under the EVermont project will support this milestone. An advanced lower cost, higher efficient PEM electrolysis cell stack will be field tested and evaluated. An advanced, low cost power supply will be field tested and evaluated. Time-of-day/time-of-year electricity pricing will be monitored to determine favorable periods for which low cost hydrogen can be produced.

Accomplishments

- Successfully tested the full-scale advanced PEM electrolysis cell stack in-house and observed 5-10% efficiency improvement.
- Successfully tested full-scale advanced (low cost) power supply in-house.
- Completed first version of computer algorithm for determining price of hydrogen production considering system efficiency and time-of-day electricity pricing.
- Completed fueling station construction.
- Commissioned station.
- Received converted vehicle and fueled successfully.

Introduction

EVermont was formed in 1993 as a public-private partnership of entities interested in documenting and advancing the performance of advanced technology vehicles that are sustainable and less burdensome on the environment, especially in areas of cold climates, hilly terrain and with rural settlement patterns. EVermont has teamed with Northern Power Systems and Proton Energy Systems to carry out this DOE project to utilize renewable electricity to produce hydrogen transportation fuel. Under this project, advanced PEM electrolysis technology will be implemented at a fueling station site in Burlington, VT. This fueling station will serve as a test bed for the advanced technology and to demonstrate a renewable hydrogen fueling pathway for transportation applications.

Current commercial PEM electrolyzers are used in industrial applications today. The life cycle cost of those systems needs to be improved in order to gain acceptance into future hydrogen vehicle fueling systems. In this project, a focus is being placed upon advancing the state-of-the-art of the cell stack and the power supply. In addition, an effective method for allowing operation in the extreme cold climate of Vermont will be devised and implemented. A hydrogen-fueled vehicle will be procured and operated as part of this project.

Approach

The approach encompasses research and development aspects for electrolysis-based hydrogen fueling systems and fueling system demonstrations.

- An advanced PEM electrolysis cell stack and advanced power supplies will be tested in-house, and then incorporated into the fueling station.
- A design to allow for outdoor installation of the PEM electrolyzer in extreme cold weather will be devised and implemented.
- In-house testing of the entire fueling station was completed, followed by final commissioning in Burlington, VT.
- Performance of individual subsystems (cell stacks, power supplies) will be monitored as well as performance of the overall system, including the usage of renewable electricity.
- Procure and operate a hydrogen-fueled vehicle

Results

- The advanced cell stack was successfully tested in-house and was deployed to the field in May 2006 (Figure 1).



FIGURE 1. Proton's Cell Stacks on Site (the advanced 20/20 cell stack is in the middle)

- The advanced power supplies have undergone several months of successful testing and were also deployed into the field in May 2006 (Figure 2).
- The cold-weather heating package was successfully tested in-house and will be tested in the field over the winter 2006/2007.
- The site was successfully approved, constructed and commissioned (Figure 3).



FIGURE 2. Proton's Advanced Power Supply



FIGURE 3. The Completed Station and Associated Equipment

- A Toyota Prius was procured and converted by Quantum Technologies to run on hydrogen (Figure 4).



FIGURE 4. The Converted Vehicle at the July 3, 2006 Kickoff

Conclusions and Future Directions

Technology development of the advanced PEM electrolysis cell stack and power supplies was completed successfully. The station and vehicle are complete and ready for testing over the coming year.

Special Recognitions & Awards/Patents Issued

1. Applying for patent "COLD WEATHER HYDROGEN GENERATION SYSTEM AND METHOD OF OPERATION" – in August 2006.

FY 2006 Publications/Presentations

Presented educational and project information to the following groups:

- Department of Public Works Commission
- Fire marshal, Vermont regional fire manager and other fire officials
- Burlington Electric Department
- City Council Transportation, Energy and Utilities Committee
- Burlington Conservation Board
- Burlington Development Review Board