V.H.1 Development and Demonstration of a New-Generation High Efficiency 2-5 kW Stationary Fuel Cell System

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Objectives

Develop and demonstrate a proton exchange membrane (PEM) fuel cell-based 2-5 kW_e combined heat and power (CHP) system that can meet DOE cost and performance targets.

Technical Barriers

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

(A) Durability
(B) Cost
(C) Performance

Technical Targets

This project is developing novel fuel processing, PEM fuel cell technologies and integration strategies in order to achieve DOE targets for integrated stationary PEM fuel cell power systems for year 2011. The key targets are in the following list. As of this writing, work has just begun, so progress against these targets cannot be addressed at this time.

- Electrical energy efficiency @ rated power – 40%
- CHP energy efficiency @ rated power – 80%
- Cost – $750/kW (in volume production)
- Durability – 40,000 hours lifetime

Approach

The approach used to develop the new-generation 2-5 kW_e CHP unit that achieves the high efficiency, high durability and low cost targets simultaneously includes a bold optimization and integration of existing Intelligent Energy (IE) technology platforms. The CHP unit will be based on IE's open architecture integration philosophy that maintains a high purity hydrogen interface between the hydrogen generation and fuel cell subsystems.

The fuel cell subsystem will be derived from IE's 2 kW CHP platform and its advanced 10 kW auxiliary power unit platform that achieves 60% efficiency on pure hydrogen. An innovative hydrogen generation subsystem will be developed to support the aggressive cost and performance targets, but will leverage IE's experience from two validated technology platforms: IE's 100 to 500 W_e membrane reformer that achieves 99.9+% purity with seven different fuel types, and its 10 kW_e steam reformer integrated with a fast cycle pressure swing adsorption hydrogen purification system. Both of these hydrogen generation platforms currently achieve efficiencies in the 60-65% range. IE plans to investigate significant improvements in these technologies to increase hydrogen generation efficiency to over 75%.

The greatest challenge of the development will be to achieve an optimized balance between increased stack performance (high cell voltage at high current densities), low cost cell components, increased hydrogen generation efficiency (high fuel conversion, lower steam/carbon ratios, maximum recuperation of heat and water vapor, and high hydrogen recovery factors), low parasitic power components and efficient grid connected inverter, and least cost balance of plant in a fully integrated system.

Accomplishments

As of this writing, only preliminary work in support of the project deliverables has begun. Accomplishments to date include the following:

- Fuel processor development
  - Fabricated two reactor prototypes of two different designs
  - Assembled and commissioned one new test station
- Fuel cell development
  - Initiated characterization of increased porosity diffusion media
  - Designed matrix of flow field variants
  - Assembled and commissioned dedicated test station