FuelCell Energy
Ultra-Clean, Efficient, Reliable Power

Program Fact Sheet

Fuel Cell for Co-production of Electricity and Hydrogen

Among the challenges of using hydrogen as a transportation fuel is development of a hydrogen-fueling infrastructure concurrent with the deployment of hydrogen vehicles. Distributed generation of hydrogen is proposed as a solution. However, the low-volume hydrogen requirements in the early years of fuel cell vehicle deployment and the sporadic nature of vehicle fueling make the economic viability of stand-alone hydrogen generators challenging. The principal effort of this initiative is to demonstrate the technical and economic viability of a hydrogen energy station using a high-temperature fuel cell designed to produce power and hydrogen.

A significant challenge for fueling station developers will be minimizing the financial risk associated with stranded capital assets. A potential solution to this "stranded asset" problem is the use of high-temperature fuel cells to co-produce hydrogen and electricity. This concept has the potential to meet the Department of Energy (DOE) hydrogen cost targets, while producing power for less than $0.10/kW. To validate this conclusion, a DFC300 power plant modified to allow for the separation and purification of hydrogen from the fuel cell anode exhaust needs to be demonstrated. DOE-EERE and Air Products and Chemicals, Inc, have supported a four-year hydrogen co-production development effort led by FCE.

Performance projections based on the system design and component testing can be seen in Table 1. The overall system performance exceeds preliminary estimates and supports the economic viability of the co-production system. Results of the process and component testing verify the technical viability and support the performance requirements necessary to make the co-production system an economically attractive route for distributed hydrogen production.

Through innovative pressure swing adsorption (PSA) cycle design and the selection of optimal adsorbents, hydrogen recovery was improved to over 85% with a 150 psig PSA inlet pressure. Achieving a higher recovery with less compression power significantly improves the economics of the co-production system. The improved PSA performance was verified with pilot plant runs at APCI.

Table 1. Co-Production System Efficiency Projections (LHV)

Overall Efficiency (Note1)	66% LHV
Power Efficiency (Note 2)	49% LHV
Hydrogen Efficiency (Note 3)	77% LHV
Hydrogen Production Rate	~80 Nm3/hr
Net Power w/o & w/Hydrogen	~300/ 243 kW
Natural Gas Flow	~74 Nm3/hr

<u>Notes to Table 1</u>

(1) Overall Efficiency = (Net Power + Hydrogen Product) / Fuel
(2) Power Efficiency = Net Power / (Total Fuel – Hydrogen Product)
(3) Hydrogen Efficiency = (Hydrogen Product – Purification Power) / Hydrogen Product

An equipment plot plan was developed using the preliminary process design and equipment specifications. A rendering of the proposed co-production system can be seen in Figure 2. The system is arranged on skidded modules and has an over all footprint measuring about 50 x 50 ft.

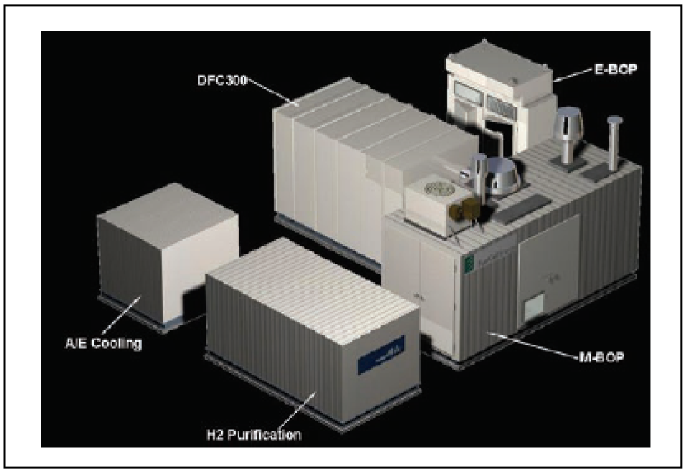

Figure 2. Energy Station Rendition

Detailed bottom-up cost estimates were completed for co-production systems using both the FuelCell Energy DFC-300 and DFC-1500 product lines. Costs for the major pieces of equipment and costs for fabrication are based on actual vendor quotes. The Air Products Construction group developed installation estimates. To match the fueling station criteria in DOE's Multi-Year Program Plan,
two DFC-1500s would be required. In this configuration a total of 1,400 kg/day of hydrogen would be produced with a net power production from the fuel cell of 2.4 MW. Using H2A criteria, analysis by DOE-EERA shows that hydrogen price of $1.63/kg is achievable. In this scenario, power is being sold for 8 cents/kWh. It is important to note that the hydrogen price does not include the fueling station equipment. A graphical rendering of a Hydrogen Filling Station incorporating a DFC® Co-production system is shown in Figure 3.

Figure 3. APCI Hydrogen Filling Station Concept

The computed electricity and hydrogen generation capacity based on the use of commercial design DFC® power plants can be seen in Table 2.

Table 2. Co-production of Hydrogen and Electricity Using DFC® Power Plants

DFC Power Plant	Electrical Output (kW)	Hydrogen Products (lbs/day)	Fuel Cell Fleet Vehicles Serviced
DFC300	250 kW	300	~300
DFC1500	1000 kW	1,200	~1,200

An interim objective of this initiative is to demonstrate the use of a DFC-300 to produce power and electricity for a minimum of 6 months. This project will contribute to the achievement of a key DOE technology validation milestone to demonstrate a prototype energy station for 6 months with a projected durability over 40,000 hours and electrical energy efficiency of 40% with an availability over 80%. Current process projections put the electrical efficiency at 49%. Based on actual field performance data, both the durability and availability of the technologies selected for demonstration can be expected to exceed the DOE milestone values.

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