

## VI.A.3 Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Puneet Verma

Chevron Technology Ventures LLC (CTV)  
3901 Briarpark Drive  
Houston, TX 77042  
Phone: (703) 848-0419  
Email: dpverma@chevron.com

DOE Technology Development Manager:  
John Garbak

Phone: (202) 586-1723; Fax: (202) 586-9811  
E-mail: John.Garbak@ee.doe.gov

DOE Project Officer: Doug Hooker  
Phone: (303) 275-4780; Fax: (303) 275-4753  
E-mail: Doug.Hooker@go.doe.gov

Contract Number: DE-FC36-04GO14286

### Subcontractors:

- Hyundai Motor Company (HMC), Seoul, South Korea
- Kia Motors Corporation (KMC), Seoul, South Korea
- Hyundai-KIA America Technical Center Inc. (HATCI), Chino, CA
- UTC Power (UTC), South Windsor, CT
- Alameda Contra Costa Transit (ACT), Oakland, CA
- Southern California Edison (SCE), Rosemead, CA
- Gas Technology Institute (GTI), Des Plaines, IL
- Tank Automotive Research Development Engineering Center, (TARDEC), Selfridge, MI

Start Date: January 15, 2004

Projected End Date: September 30, 2009

### Objectives

Record, collect, report, and analyze data from fuel cell vehicles (FCVs) and hydrogen fueling operations to validate certain validation project performance targets

- Vehicle range: >250 miles
- Hydrogen cost: <\$3.00/gge
- Safe and convenient refueling by drivers (with training)

### Technical Barriers

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

- (A) Lack of Fuel Cell Vehicle Performance and Durability Data
- (B) Storage
- (C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
- (D) Maintenance and Training Facilities

### Contribution to Achievement of DOE Technology Validation Milestones

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

- **Milestone 4:** Operate fuel cell vehicle fleets to determine if 1,000-hour fuel cell durability, using fuel cell degradation data, was achieved by industry. (4Q, 2006)
- **Milestone 7:** Validate refueling time of 5 minutes or less for 5 kg of hydrogen (1 kg/min) at 5,000 psi through the use of advanced communication technology. (4Q, 2007)
- **Milestone 22:** Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures. (4Q, 2006)
- **Milestone 24:** Validate a hydrogen cost of \$3.00/gge (based on volume production). (4Q, 2009)

### Accomplishments

- Eighteen vehicles in the project.
- Start up and operation of the Orlando Hydrogen Station.
- Mechanical completion of Selfridge ANG compression, storage and dispensing station.
- Mechanical completion and operation of Southern California Edison electrolyzer station.
- Design of partial oxidation gas turbine (POGT) system.



### Introduction

As a result of the President's Initiative, the DOE recently detailed a strategy to develop a hydrogen economy that emphasizes co-developing hydrogen

infrastructure in parallel with hydrogen fuel cell-powered vehicles to allow a commercialization decision by 2015. In the past, efforts to introduce new energy technologies in the transportation sector have been thwarted by the classic “chicken and egg” dilemma of which comes first; in this case, hydrogen infrastructure or hydrogen vehicles. The Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation project will be an important first step towards achieving the above strategy because the selected consortia will develop a complete system solution(s) that will address all elements of infrastructure and vehicle development.

These goals will be accomplished by developing hydrogen infrastructures and operating hydrogen-powered vehicles at selected U.S. locations. The validation project provides selected consortia an opportunity to participate in a cost-share demonstration of hydrogen infrastructure and vehicle technologies.

## Approach

CTV and its project team of HMC, HATCI, UTC and the site hosts intend to operate a fully integrated fueling and fleet operation consisting of 32 FCVs (including two different generations) with the aim of developing a database of operational experience under a wide variety of conditions including, for the stations, different technology and feed stocks, and for the vehicles, differing driving patterns and ambient temperatures. This data will also be collected in a manner that allows ‘consumer’ (including station operators, fuelers, drivers and maintenance workers) feedback to be recognized and incorporated into lessons learned.

Learnings from the early phases of this project can be incorporated into later phases in a way that allows performance improving technologies to be tested in the most cost-effective and efficacious manner.

## Results

**Milestone 4:** Operate fuel cell vehicle fleets to determine if 1,000 hour fuel cell durability, using fuel cell degradation data, was achieved by industry. (4Q, 2006)

On road testing is in progress with 18 vehicles in the project.

**Milestone 7:** Validate refueling time of 5 minutes or less for 5 kg of hydrogen (1 kg/min) at 5,000 psi through the use of advanced communication technology. (4Q, 2007)

Vehicles have been fueled following California Fuel Cell Partnership protocol 6.1. Vehicles have been safely fueled in less than 5 minutes with fuel rates greater than 1 kg/minute.

**Milestone 22:** Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures.

A hydrogen energy station continues to operate at the Hyundai-Kia America Technical Center in Chino, California. This station demonstrates the on-site auto-thermal reformation of natural gas.

A hydrogen energy station continues to operate at Alameda Contra Costa Transit in Oakland, California. This station is has been only partially funded by the DOE but the data from this station is being shared with the NREL. This station demonstrates the use of on-site low pressure and high pressure steam methane reforming.

A hydrogen energy station has been installed at the Progress Energy site in Orlando, Florida (Figure 1). This station has not been funded by DOE but CTV will report the station data to NREL.

A hydrogen energy station has reached mechanical completion at the Southern California Edison (SCE) site in Rosemead, California (Figure 2). This site demonstrates on-site production of hydrogen using electrolysis.

A hydrogen energy station has reached mechanical completion for compression storage and dispensing at the Selfridge Air National Guard site in Selfridge, Michigan (Figure 3). This station will have on site hydrogen using high pressure steam methane reforming in 4Q 2007.

Maintenance facilities are located at Chino, California (Figure 4). Employees have been trained for maintenance and repair of the vehicles.

**Milestone 24:** Validate a hydrogen cost of \$3.00/gge (based on volume production). (4Q, 2009)



FIGURE 1. Infrastructure at the Orlando Station



**FIGURE 2.** Infrastructure at the Rosemead Station



**FIGURE 3.** Infrastructure at the Selfridge Station

Lack of demand has made it as yet impossible to calculate efficiencies based on long-term operation.

Working with DOE, CTV is collaborating to incorporate a Gas Technology Institute (GTI) R&D project into this deployment project. GTI will design, build and operate a partial oxidation gas turbine system. This system will be capable of producing hydrogen and electricity.

### Conclusions and Future Directions

Eighteen vehicles have been entered into the project and been deployed. One vehicle has been retired. Five on-site hydrogen energy stations are mechanically complete and dispensing hydrogen. Four stations are currently generating hydrogen on-site. An on-site reformer will be added to the fifth station in Q4 2007. We are targeting for fourteen more vehicles and a total of five energy stations in operation in 2007/2008.



**FIGURE 4.** Hydrogen Safe Maintenance Bay