VIII.2 Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

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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

Start Date: January 15, 2004
Projected End Date: December 31, 2009

Objectives

Validate performance targets:

- Fuel cell stack durability: >2,000 hours
- Vehicle range: >250 miles
- Hydrogen cost: <$3.00/gasoline gallon equivalent (gge)
- Safe and convenient refueling by drivers (with training)

Demonstrate a variety of hydrogen generation technologies including:

- Auto-thermal reformation of natural gas
- Low pressure steam reformation of natural gas
- High pressure steam reformation of natural gas
- Electrolysis of water

Technical Barriers

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

(A) Lack of Fuel Cell Vehicle Performance and Durability Data

(B) Hydrogen 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 contributed to achievement of the following DOE milestones from the Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- Milestone 10: Validate FCVs 2,000 hour fuel cell durability, using fuel cell degradation data. (4Q, 2009)
- Milestone 12: Validate cold start capability at -20 C. (2Q, 2011)
- Milestone 14: Validate achievement of a refueling time of 3 minutes or less for 5 kg of hydrogen at 5,000 psi using advanced communication technology. (2Q, 2012)
- Milestone 22: Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures. (4Q, 2006)
- Milestone 23: Total of 10 stations constructed with advanced sensor systems and operating procedures. (1Q, 2008)

Accomplishments

- All 32 vehicles entered the project
- One additional vehicle was added to the project
- Five infrastructure stations provided safe operation for the duration of the project
- Two maintenance facilities provided safe vehicle operation
- Safe and convenient refueling by drivers was demonstrated

- Cold weather vehicles testing completed
- Survey of fuel cell vehicle (FCV) drivers conducted

Introduction

As a result of President Bush's Initiative, the DOE detailed a strategy to develop a hydrogen economy that emphasized 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 was an important first step towards achieving the above strategy because the selected consortia developed a complete system solution(s) that addressed all elements of infrastructure and vehicle development.

The goals were accomplished by developing hydrogen infrastructures and hydrogen-powered vehicles at selected U.S. locations. This Technology Validation project provided an opportunity to participate in a cost-shared demonstration of hydrogen infrastructure and vehicle technologies.

Approach

CTV and its project team of HMC, HATCI, UTC and the site hosts operated a fully integrated fueling and fleet operation consisting of 32 FCVs, (including two different generations) while 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 was collected in a manner that allowed 'consumer' (including station operators, fuelers, drivers and maintenance workers) feedback to be recognized and incorporated into lessons learned.

Learning's from the early phases of this project were incorporated into later phases in a way that allowed performance improving technologies to be tested in the most cost-effective and efficacious manner.

Results

In support of DOE's objective "By 2009, validate 2,000-hour fuel cell durability in vehicles . . .", vehicles were subject to real world operation, accumulating on-road hours in a variety of climates. On-road vehicle data of fuel cell operating hours was reported to the National Renewable Energy Laboratory (NREL) monthly. Five vehicles were operated at the cold-weather station in Selfridge, Michigan and were subject to cold starts in the winter of 2008/2009 to validate cold-start capability. Vehicles were left outside overnight prior to starting (Figure 1). Hyundai addressed the barrier of "Lack of facilities for maintaining hydrogen vehicles" by operating three maintenance facilities including the training of operators to maintain the vehicles (Figure 2). Training was also conducted for first responders at all stations. Refresher training was offered each year to local first responders to support the training of new responders to the communities around the hydrogen stations. In addition, hypothetical fire response drills were held at the stations (Figure 3).

In support of DOE's objective "By 2009, . . . safe and convenient refueling by drivers (with training)," Chevron trained drivers to conduct fueling of the FCVs. Drivers performed hundreds of safe refueling events at several infrastructure stations 24/7 (Figure 4).

FIGURE 1. Cold-Weather Site

FIGURE 2. Maintenance Facility

FIGURE 3. Fire Response Training

FIGURE 4. Safe Driver Fueling

Chevron operated five stations in support of DOE's objective "By 2009, . . validate hydrogen infrastructure that results in a hydrogen production cost of less than $3.00/gge (untaxed) delivered". Data from operating these stations was provided to NREL and is stored at the Hydrogen Secure Data Facility in Golden, Colorado. A hydrogen energy station operated at HATCI in Chino, California. This station demonstrated the on-site auto-thermal reformation of natural gas. The Chino site served as the commissioning site for all project vehicles as well as one of the project's fleet operators. The station, as all stations in the project, was designed to utilize state-of-the art remote monitoring and operation systems and incorporates advanced hydrogen and fire sensors. A hydrogen energy station operated at ACT in Oakland California. This station was only partially funded by the DOE project but the data from the station was shared with NREL. This station demonstrated the use of on-site low-pressure and high-pressure steam methane reforming.

A hydrogen energy station was installed at the Progress Energy site in Orlando, Florida. This station was not funded by DOE but CTV reported the station data to NREL. A hydrogen energy station operated at the SCE site in Rosemead, California. This site demonstrated on-site production of hydrogen using electrolysis. A cold-weather hydrogen energy station operated at the Selfridge Air National Guard site in Selfridge, Michigan.

Conclusions and Future Directions

Thirty-two vehicles were entered into the project. One additional vehicle was added to the project. Four vehicles remain in operation at HATCI in Chino, California. The other vehicles have been retired. Five hydrogen infrastructure stations have completed operation for the project.

FY 2010 Publications/Presentations

1. Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project 2010 Annual Merit Review Presentation, Washington, D.C., June 7–11, 2010.