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

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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

Start Date: January 15, 2004
Projected End Date: September 30, 2009

Objectives

- Validate performance targets:
  - Fuel cell stack durability: >2,000 hours
  - Vehicle range: >250 miles
  - Hydrogen cost: <$3.00/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, and
  - Electrolysis of water.

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) Hydrogen Storage

(C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

(D) Maintenance and Training Facilities

(I) Hydrogen and Electricity Co-Production

Contribution to Achievement of DOE Technology Validation Milestones

This project will contribute to achievement of the following DOE milestones from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure 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 have entered the project.
- One additional vehicle was added to the project.
- Five infrastructure stations continue safe operation.
- Two maintenance facilities continue safe operation.
- Safe and convenient refueling by drivers has been demonstrated.
- Cold weather vehicle testing has been completed.
- Survey of fuel cell vehicle drivers conducted.

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.

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 fuel cell vehicles, (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

In support of DOE's objective "By 2009, validate 2,000-hour fuel cell durability in vehicles . . .", the fuel cell vehicles continue real world operation accumulating road hours, Figure 1. On-road vehicle data of fuel cell operating hours is being reported to the National Renewable Energy Laboratory (NREL) monthly. Five vehicles are currently operating 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 2. Hyundai is addressing the barrier of

FIGURE 1. Vehicle FJM5

FIGURE 2. Cold Weather Start-Up

"Lack of facilities for maintaining hydrogen vehicles" by operating three maintenance facilities including the training of operators to maintain the vehicles. Training was also conducted for first responders at all stations. In addition refresher training is offered each year to local first responders to support the training of new responders to the communities around the hydrogen stations, Figure 3.

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

Chevron is operating 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 is provided to NREL and is stored at the Hydrogen Secure Data Facility in Golden, CO. A hydrogen energy station continues to operate at the Hyundai-Kia America Technical Center in Chino,

FIGURE 3. Driver Training

FIGURE 4. First Responder Refresher Training

California. This station demonstrates the on-site auto-thermal reformation of natural gas. This Chino site serves 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 continues to operate at Alameda-Contra Costa Transit in Oakland, California. This station is has been only partially funded by the DOE project but the data from this station is being shared with 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. This station has not been funded by DOE but CTV will report the station data to NREL. A hydrogen energy station continues operation at the SCE site in Rosemead, California. This site demonstrates on-site production of hydrogen using electrolysis. A cold weather hydrogen energy station continues operation at the Selfridge Air National Guard site in Selfridge, Michigan.

To address DOE's barrier of hydrogen and electricity co-production, the Gas Technology Institute has constructed a partal oxidation gas turbine. This system will be capable of producing hydrogen and electricity. A partial oxidation reactor will be used to generate hydrogen. Electricity will be generated with a turbine and a slip stream will be sent to a water-gas shift reactor in increase the concentration of hydrogen in the gas stream.

Conclusions and Future Directions

Thirty-two vehicles have been entered into the project. One additional vehicle has been added and 14 vehicles have been retired. Five hydrogen infrastructure stations have been placed into operation.

The project will continue to operate vehicles and infrastructure in real world settings while reporting data to NREL.

FY 2009 Publications/Presentations

1. Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project 2009 Annual Merit Review Presentation.