VII.3 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

Technical Targets

The Technology Validation Program element does not develop new component technologies, and therefore does not have technology targets. Instead, this Program element will validate individual component technical targets developed within the other sub-programs when integrated into a complex system and review the future requirements for each component in such integrated systems.

Performance Target	Units	2010
Fuel Cell Stack Durability	Hours	2,000
Range	Miles	250
Hydrogen Cost at Station; On-site Production	$/kg of H_2	3.00

Accomplishments

- Twenty-five vehicles have entered the project.
- Five infrastructure stations are now operational.
- Two maintenance facilities are now operational.
- Safe and convenient refueling by drivers has been demonstrated.
- Cold weather vehicles testing has begun.
- Initial testing of partial oxidation gas turbine system completed.

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 fuel cell vehicles (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.

Learning's 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

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 10: Validate FCVs 2,000-hour fuel cell durability, using fuel cell degradation data. (4Q, 2009)

Collection of data and validation of fuel cell durability is ongoing. On-road vehicle data of fuel cell operating hours is being reported to the National Renewable Energy Laboratory (NREL) monthly.

Milestone 12: Validate cold start capability at -20°C. (2Q, 2011)

Five vehicles are currently operating at the cold weather station in Selfridge, Michigan (see Figure 1) and will be subject to cold starts in the winter of 2008/2009 (see Figure 2).

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)

The effect of stationary storage inventory on fueling rates was presented at the 2008 Annual Merit Review. Safe and convenient refueling by drivers with training has begun at several infrastructure stations.

Milestone 22: Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures. (4Q, 2006)

FIGURE 1. Infrastructure Selfridge Station

FIGURE 2. Cold Weather Start-Up

Milestone 23: Total of 10 stations constructed with advanced sensor systems and operating procedures. (1Q, 2008)

Chevron is operating five stations in support of DOE milestones 22 and 23. 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. This Chino site serves as the commissioning site for all project vehicles as well as one of the program'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 is now operational at the SCE site in Rosemead, California. This site demonstrates on site production of hydrogen using electrolysis.

A cold weather hydrogen energy station is now operational at the Selfridge Air National Guard site in Selfridge, Michigan (Figure 1). This station demonstrates on-site hydrogen production using high pressure steam methane reforming.

A maintenance facility installed at the Hyundai-Kia America Technical Center in Chino, California (Figure 3) has been upgraded to allow testing of new fuel economy test equipment based on SAE J2572.

HATCI and CTV have participated in first responder training at the Chino station (Figure 4). Yearly retraining sessions will be held at all stations for first responders to allow for training of new hires and turnover of existing first responders.

Task 2.4: Technology Validation of Co-Production of Hydrogen and Electricity at Energy Stations

A partial oxidation gas turbine has been constructed at the Gas Technology Institute in Des Plaines, Illinois. DOE and CTV are collaborating integrate this activity into the project. 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.

FIGURE 3. Maintenance Facility Upgrade (Chino)

FIGURE 4. First Responder Training

Conclusions and Future Directions

Twenty-five vehicles have been entered into the project. Three 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.