

VII.4 Hydrogen Vehicle and Infrastructure Demonstration and Validation

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Phase 1 Partners:

- Shell Hydrogen, LLC, Houston, TX
- U.S. Army, Ft. Belvoir, VA
- Quantum Technologies, Inc., Irvine, CA
- Viewpoint Systems Inc., Rochester, NY
- NextEnergy, Detroit, MI
- U. S. Environmental Protection Agency, Washington, D.C.
- District of Columbia Department of Transportation, Washington, D.C.
- Virginia Department of Environmental Quality, Richmond, VA
- U.S. Postal Service, Washington, D.C. and Irvine, CA

Phase 2 Partners:

- Project Driveway drivers composed of media, policy makers, general public, businesses, and government

Project Start Date: October 1, 2004

Project End Date: September 30, 2009

Objectives

General Motors (GM) and energy partner Shell Hydrogen, LLC, are deploying a system of hydrogen fuel cell electric vehicles (FCEVs) integrated with a hydrogen refueling infrastructure to operate under real world conditions:

- Demonstrate progressive generations of fuel cell system technology.
- Demonstrate multiple approaches to hydrogen generation and delivery for vehicle refueling.
- Collect and report operating data.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section (3.6.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Lack of Fuel Cell Electric Vehicle Performance and Durability Data
- (C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
- (D) Maintenance and Training Facilities
- (E) Codes and Standards

Contribution to Achievement of DOE Technology Validation Milestones

This project will contribute to the 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 2:** Demonstrate FCEVs that achieve 50% higher fuel economy than gasoline vehicles. (3Q, 2005)
- **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 22:** Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures. (4Q, 2006)

Accomplishments

GM has accomplished the following project milestones:

- Eight Phase 1 HydroGen3 FCEVs, using GM's third generation fuel cell (FC) technology and fueled with either liquid or 700 bar compressed hydrogen, have completed their deployment and have been retired.
- Phase 2 deployments have started with the successful launch of Project Driveway deploying 32 DOE Chevrolet Equinox FCEVs, using GM's fourth generation FC technology and 700 bar compressed storage system (see Figure 1).
- Addition of a new deployment site that offers cold weather testing - the Greater New York City (NYC) metropolitan area.



FIGURE 1. Chevrolet Equinox Fuel Cell Electric Vehicle

- Full operation for over three and one-half years at nation’s first retail hydrogen refueling station at Benning Road, Washington, D.C. with functional Visitor Center. It is the first retail station in the U.S. equipped to fuel with hydrogen dispensed at 700 bar. Liquid hydrogen was formerly available, but it has been discontinued.
- Successful opening of a refueling station at the City of White Plains, NY Department of Public Works equipped to fuel with hydrogen at 700 bar (see Figure 2) with on-site generation of hydrogen through electrolysis.
- Successful opening of the first retail hydrogen refueling station in California. On-site generation of hydrogen through electrolysis (see Figure 3).
- Over one thousand first responders have received safety training
- Partnered with U.S. Environmental Protection Agency, District of Columbia Department of Transportation, Virginia Department of Environmental Quality, and U.S. Postal Service for fleet operation of vehicles for Phase 1.
- Completion and utilization of two new first class maintenance and training facilities:
 - Eastern Region: NYC metropolitan area, Ardsley, NY (see Figure 4).
 - Western Region: Southern California area, Burbank, CA.
- Vehicles and stations collect data according to National Renewable Energy Laboratory (NREL) Data Reporting Templates.
- On-road data collection:
 - Logbook data entry automated.
 - Implemented automated wireless data transfer from vehicles to a data server via the Web.



FIGURE 2. Grand Opening of Shell Hydrogen Station in White Plains, NY



FIGURE 3. Grand Opening of Shell Hydrogen Station in Los Angeles, CA

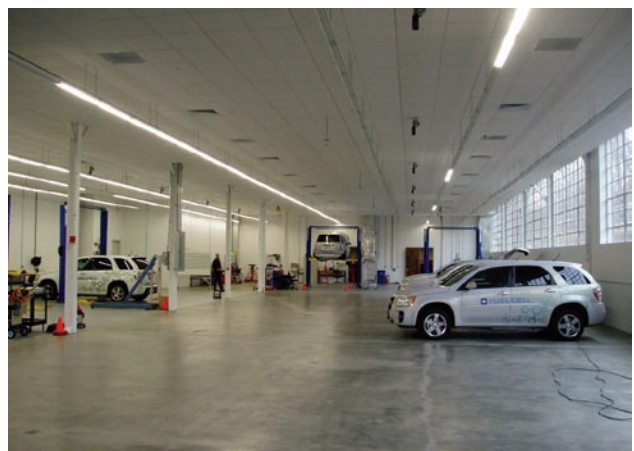


FIGURE 4. GM Maintenance and Training Facility located in Ardsley, NY

- Successful and seamless transition from Phase 1 to Phase 2 in data collection and vehicle testing overcoming the challenges of a new vehicle platform, new generation of fuel cell technology,

and the increase in vehicle volume from eight to 32 vehicles on the road.



Introduction

This project has been underway for approximately three and one half years and has made progress in support of the long-term goals of the DOE's Technology Validation Program. GM has retired the eight commercially developed FCEVs from Phase 1, according to plan. Deployments of 32 Phase 2 vehicles have been made in the NYC metropolitan area, Washington, DC, and Los Angeles, CA. Two maintenance and training hubs are used to support these deployments with two additional locations available at Ft. Belvoir, VA and Lake Forest, CA. The vehicles are accumulating miles and generating data that is submitted according to the NREL Data Reporting Templates.

Our partner, Shell Hydrogen, is operating three hydrogen refueling stations that GM FCEVs and other companies' FCEVs are using. In addition, GM can refuel at GM maintenance and training sites. Data from retail station operation is recorded and submitted according to the NREL Data Reporting Templates. Hydrogen is trucked in from a central location and stored at the refueling station for dispensing at the Benning Rd. facility. The White Plains facility and the Santa Monica Blvd. facility both generate hydrogen on-site through electrolysis.

Approach

GM is demonstrating FCEVs through the deployment and testing of 40 FCEVs in various terrains, driving conditions, and climates including cold weather. The project approach is to establish and install retail hydrogen stations for public refueling on the east and west coasts, as well as explore hydrogen generation/delivery options such as electrolysis. Service operations support these FCEVs with personnel trained in maintenance, refueling, technical support and safety. Project Driveway operators can expect an exciting and confident driving experience through the utilization of locally-based GM Driver Relationship Managers and OnStar service.

Report data required under the project is generated through on road and dynamometer test data captured from the vehicles, as well as from the hydrogen infrastructure production and refueling operation data. In addition to these efforts, NextEnergy will develop codes and standards permitting templates and a database of permitting experiences.

Results

Chevrolet Project Driveway is designed to provide GM with comprehensive feedback on all elements of the customer experience and vehicle performance. Thirty-two of 100 vehicles to be launched under Project Driveway will be a part of the Learning Demo. The eight Phase 1 FCEVs have been retired and 32 Phase 2 vehicles have been deployed. GM has taken a balanced approach for deployments by dividing the vehicles between the eastern and western regions.

GM has successfully partnered with the U.S. Environmental Protection Agency, District of Columbia Department of Transportation, Virginia Department of Environmental Quality, and the U.S. Postal Service for fleet operation of the Phase 1 HydroGen3 FCEVs. Maintenance and training are ongoing at the Burbank, CA, Lake Forest, CA, Ardsley, NY, and Ft. Belvoir, VA facilities. Refueling sites in the NYC metropolitan and Southern California area have been constructed.

Key vehicle and infrastructure data generated and reported that support the milestones are stack durability, fuel economy and vehicle range, fuel cell system efficiency, maintenance and safety, and refueling rate.

Dynamometer testing, including end-of-life testing, of Phase 1 vehicles has been conducted at GM's Milford Proving Ground according to the DOE schedule. Phase 2 vehicles have gone through the beginning of life testing which included cold-weather tests. On road data collection has been automated wherever possible. Automated wireless data transfer from the FCEVs to a data server via the Web has been implemented.

The hydrogen orientation program for emergency first responders has now been delivered in cities where GM's DOE vehicles operate. The cities include Los Angeles, CA, New York City, NY, and Washington, DC. The Emergency First Responder – Authorities Having Jurisdiction (EFR-AHJ) training will be expanded to City Building Department Officials. The codes and standards permitting authority databases are complete.

Conclusions and Future Directions

Future Work

- Complete launch of Phase 2 vehicles.
- Continue to conduct new driver training on Chevrolet Equinox FCEVs, hydrogen safety, and hydrogen fueling.
- Inaugurate usage of hydrogen refueling stations in NYC metropolitan area, capable of dispensing at 700 bar.
- Participate in the NextEnergy annual conference to gain experience of the permitting process firsthand.

- Data collection enhancements for collecting and reporting.
- Continue to collect, analyze, and report data from project vehicles and refueling locations and meet all project deliverables.

The commissioning of a facility that dispenses hydrogen is a unique experience and breaks new ground. Based on our experience and lessons learned to date, we are making the following infrastructure recommendations:

- Retail-like refueling stations:
 - Geographically targeted regions where automakers want to put vehicles.
 - 700 bar fast-fill refueling.
 - Operational with (or before) vehicles.
- Access to key existing stations:
 - Access agreements with consistent principles, or
 - Gasoline-like liability terms, or
 - Eliminate access agreements altogether.
- Expedient station approval and permitting process:
 - State-wide consistency and local adherence.
 - Community acceptance.
- Funding support and incentives:
 - Stations and upgrades.
 - Liability coverage (funded liability pool, liability cap) or full-service attendants to mitigate liability issues.
 - Station operating costs/refueling costs.