2008 DOE Hydrogen Program Review

Hydrogen Vehicle and Infrastructure Demonstration and Validation

Rosalind (Roz) B. Sell
General Motors Corporation
June 10, 2008

EQUINOX FUEL CELL

Project ID #: TV4

Overview

Timeline

- Project Start = 10/1/04
- Project End = 9/30/09
- Project is 75% complete

Budget

- $88.0 M Total Project
  - $44.0 M DOE share
  - $44.0 M GM share
- $20.7 M Previous years funding
- $6.0 M FY08 DOE funding

Barriers
- Targets

- Vehicles
  - Vehicle range and FC durability
- Hydrogen Refueling Infrastructure
  - $H2/gge
- Maintenance and Training Facilities

Partners

- Shell Hydrogen, LLC – hydrogen refueling
- U.S. Army Fort Belvoir, VA – maintenance facilities
- Quantum Technologies, Inc. – maintenance facilities
- Viewpoint Systems – data acquisition
- NextEnergy – Codes and Standards

Phase 2 – vehicle operators

- Project Driveway customers and drivers

Phase 1 – vehicle operators

- U.S. Environmental Protection Agency
- State of Virginia Department of Environmental Quality
- U.S. Postal Service
- D.C. Department of Transportation

Objectives

- Program Objective
  - General Motors and energy partner Shell Hydrogen are deploying a system of hydrogen fuel cell electric vehicles 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
- Past Year Objectives – Launch Phase 2 of Learning Demo
  - Obtain vehicle operators
  - Collect, analyze, report data from program vehicles and refueling locations
  - Construct hydrogen refueling stations in NYC metropolitan area and southern California
  - Establish maintenance and training facilities in Burbank, CA and NYC metropolitan area
  - Develop permitting databases and begin data population
  - Meet all Project Deliverables

Approach

- Demonstrate fuel cell vehicles
  - Deploy total of 40 fuel cell electric vehicles (FCEVs) in various terrains, driving conditions, and climates including cold weather
- Establish retail hydrogen stations for public refueling
  - Install total of five retail refueling stations on East and West coasts
  - Explore hydrogen generation/delivery options such as electrolysis
- Set up maintenance and service operations in support of FCEVs
  - Train personnel in maintenance, refueling, technical support, safety
- Generate and report data required under the Program
  - Capture vehicle on-road and dynamometer test data
  - Capture hydrogen infrastructure production/refueling data
- Document Codes and Standards learnings
  - NextEnergy to develop Codes and Standards permitting templates and database of permitting experiences

Project Driveway

- First meaningful and largest market test of fuel cell vehicles
  - Over 100 Chevrolet Equinox Fuel Cell Electric vehicles
  - Launched in late 2007 continuing through 2010
  - Focus markets with diverse climates and conditions:
    - California (LA, Sacramento)
    - Washington, D.C.
    - Greater New York City metropolitan area
- Comprehensive feedback on all elements of customer experience and vehicle performance to guide future fuel cell vehicle and infrastructure development
- Drivers
  - Businesses, government
  - General public
    - Hand raiser collection process currently live on Chevrolet.com
  - Celebrity influencers, policymakers and media

Chevrolet Equinox Fuel Cell Electric Vehicle

Performance

- Range 150+ miles 2008 EPA adjusted
  - Fuel capacity of 4.2 kg at 700 bar
- Acceleration 0-60 mph in 12 seconds
- Top speed 100 mph
- Expected to meet all applicable FMVSS
- Freeze durable over the vehicle life

Content

- Visibly distinctive styling/graphics
- 17 inch aluminum wheels
- 2 front bucket seats (heated) and 2-passenger rear bench
- OnStar
- Navigation radio with fuel cell graphic energy display
- Driver, passenger and roof rail air bags
- ABS, traction control and stability control
- Cruise control
- Front wheel drive
- Regenerative braking
- Single speed electric motor traction system

Managing the Customer Experience

- Driver Relationship Managers (DRMs)
  - Single point of contact 24/7
  - Provides driver education and training
  - Keeps drivers informed on any program or vehicle changes
- All vehicles equipped with OnStar
  - Provides safety and security for drivers
  - Full concierge service: turn-by-turn navigation, hands-free calling, XM radio, fuel station locations

Chevy Rocks the Future / Disney

Virgin Atlantic Airways

Sir Richard Branson
and Dr. Larry Burns

General Public

Source: GM 2007 Annual Report

Technical Accomplishments

Eastern Region

Technical Accomplishments

Eastern Region

- Vehicles – Phase 2 has been launched
  - 14 Chevrolet Equinox FCEVs demonstrating GM's 4th generation of fuel cell technology have been deployed in Washington, D.C., and NYC metro area
  - Greater New York City metropolitan area has been added as a new deployment site along with existing Washington, D.C., location
    - Cold weather testing in New York
  - Vehicles collect data according to NREL Data Reporting Templates and refuel at Shell Hydrogen sites and GM facilities

- Maintenance and Training Facilities
  - New site opened in Ardsley, NY to support NYC regional deployments
  - Ongoing maintenance and training activities at Fort Belvoir facility

Ardsley, NY

Technical Accomplishments

Eastern Region

Hydrogen Refueling Infrastructure

- Washington, D.C.
  Benning Road Station & Visitors Center
  - **700 bar modification expected May 2008**
  - Gaseous and liquid hydrogen refueling accommodating all vehicle manufacturers
    - Station no longer operates for liquid fuelings
  - 93% availability over 3 full years
  - 700+ total hydrogen fills
  - 400+ First Responders trained

- City of White Plains, NY
  Department of Public Works (DPW)
  - Operational Sept 2007
  - **700 bar modified Feb 2008**
  - Electrolyzer-based gaseous hydrogen refueling
- NYC Metro
  - Two locations in design and pre-permitting discussions
  - Tube trailer supplied, 350/**700 bar** dispensing
  - Non-retail, private facilities
  - Potential to complete installations in 2008/early 2009

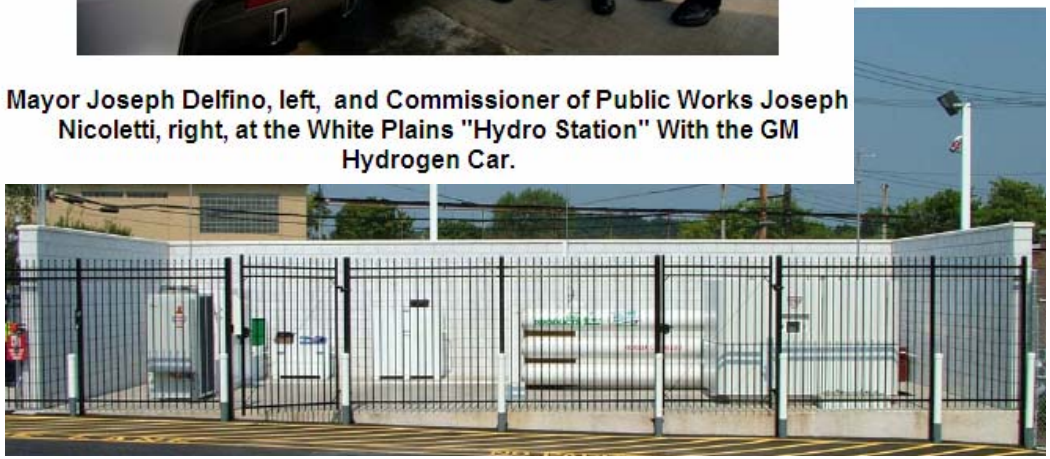
Technical Accomplishments

Eastern Region

Hydrogen Refueling Infrastructure

City of White Plains, NY – Department of Public Works

Mayor Joseph Delfino, left, and Commissioner of Public Works Joseph Nicoletti, right, at the White Plains "Hydro Station" With the GM Hydrogen Car.



Technical Accomplishments

Western Region

- Vehicles – Phase 2 has been launched
  - 11 Chevrolet Equinox FCEVs demonstrating GM's 4th generation of fuel cell technology have been deployed in the Los Angeles area
  - Vehicles collect data according to NREL Data Reporting Templates and refuel at University of California at Irvine 700 bar station, GM facility, and other available sites

- Maintenance and Training Facilities
  - New site opened in Burbank, CA to support regional deployments
  - Ongoing maintenance and training at Quantum Lake Forest facility

Technical Accomplishments

Western Region

Hydrogen Refueling Infrastructure

- Los Angeles Metro
  - Santa Monica Blvd. Retail Station and Visitors Center
    - Project receiving final inspections late April
    - Canopy-mount electrolyzer-based gaseous station at 350 bar only
    - Operational May 2008

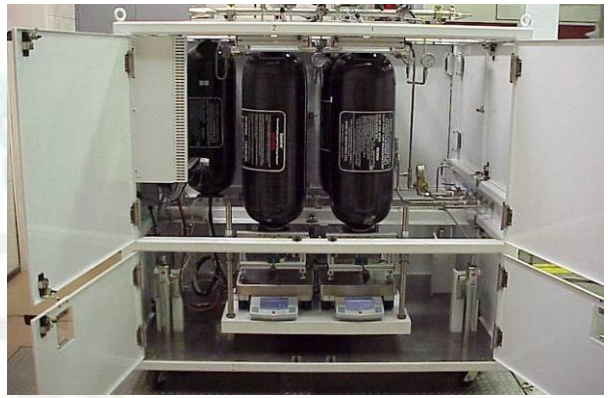
Santa Monica Blvd., West LA

Technical Accomplishments

Data Collection and Vehicle Testing

- On-road data collection
  - Seamless transition for data collection Phase 1 to Phase 2
  - Wireless automated data transmission from vehicle to data server operational at selective sites
- Chassis dynamometer testing
  - Completed beginning of life dyno tests on Phase 2 vehicles

Hydrogen Consumption Measurement



Hydrogen Mass Flow Measurement (Fuel Economy)

Technical Accomplishments

Codes and Standards (C&S) – NextEnergy

- Database
  - Hydrogen Permitting Officials database posted to live NextEnergy Center website; accessible May 30
- Annual Conference November 28, 2007
  - Focus on current industry efforts toward C&S development
  - Featured panels from C&S organizations, city and state authorities

Future Work

- Vehicles
  - Continue Phase 2 vehicle deployment
- Hydrogen Refueling Infrastructure
  - Inaugurate remaining hydrogen refueling stations
    - Los Angeles May 2008
    - Two new NYC metro stations by year-end/early 2009 at 350/700 bar
- Maintenance and Training Facilities
  - Continue to conduct new driver training on Chevy Equinox FCEV, hydrogen safety, hydrogen fueling
- Codes and Standards – NextEnergy
  - 2008 conference slated for Fall 2008; designed for attendees to experience permitting process firsthand

Critical Infrastructure Next Steps

- Compelling, retail-like fueling stations
  - Geographically targeted regions where automakers want to put vehicles
  - 700bar fast-fill refueling
  - Compelling station designs (customer and technology perspectives)
  - Robust hydrogen capacity and throughput – designed for growth
  - Operational with (or before) vehicles
- Access to all stations
  - All automotive companies and their customers have access
  - Address liability exposure
    - Straight-forward access agreements with consistent principles or
    - Eliminate access agreements altogether
- Expedient station approval and permitting process
  - State-wide consistency and local adherence
  - Community support
- Funding support and incentives/enablers
  - Stations, station technology and capacity upgrades, operating costs
  - Liability coverage/solution (funded liability pool, liability cap)
  - Assurance stations will be there on time - supply base

Germany

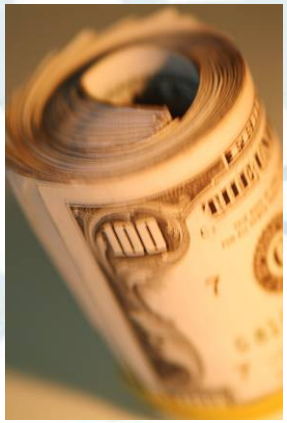
U.S.

Lessons Learned

- Real world experience

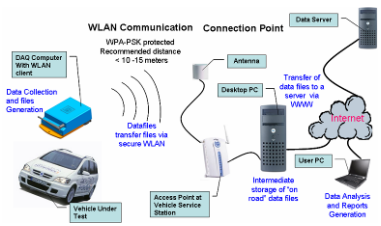
- Infrastructure! Infrastructure! Infrastructure!

- Continued DOE funding



Mayor Joseph Delfino, left, and Commissioner of Public Works Joseph Nicoletti, right, at the White Plains "Hydro Station" With the GM Hydrogen Car.

Project Summary

Focus Area	Barrier / Target
• Continued efforts to establish two additional refueling sites in NYC metropolitan area	Hydrogen Refueling Infrastructure 
• Utilize facilities for customer training and vehicle service	Maintenance and Training Facilities 
• Collect customer feedback on all aspects of the driving and refueling experience	 Vehicle
• Continued data collection, analysis and reporting	• Range • Durability • H_2/gge 

Gas-Friendly to Gas-Free

FUEL EFFICIENCY

E85 ETHANOL

HYBRID

ELECTRIC

FUEL CELL