Overview

Timeline
- Project Start = 10/1/04
- Project End = 9/30/09
- Project is 40% complete

Barriers
- Targets
  - Vehicles
  - Hydrogen Refueling Infrastructure
  - Maintenance and Training Facilities

Budget
- $88.0 M Total Project
  - $44.0 M DOE share
  - $44.0 M GM share
- $6.9 M Previous years funding
- $5.3 M FY06 DOE funding
- $6.5 M FY07 DOE funding

Partners
- Shell Hydrogen, LLC – hydrogen refueling
- U.S. Environmental Protection Agency – vehicle operator
- State of Virginia Department of Environmental Quality – vehicle operator
- U.S. Postal Service – vehicle operator
- D.C. Department of Transportation – vehicle operator
- U.S. Army Fort Belvoir, VA – maintenance facilities
- Quantum Technologies, Inc. – maintenance facilities
- Viewpoint Systems – data acquisition
- NextEnergy – Codes and Standards
Objectives

- **Program Objective**
  - General Motors and energy partner Shell Hydrogen are deploying a system of hydrogen fuel cell 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**
  - 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 facility in NYC metropolitan area
  - Develop permitting experience and permitting authority databases and begin data population
  - Meet all Project Deliverables
Approach

- Demonstrate fuel cell vehicles
  - Deploy total of 40 fuel cell vehicles 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 FCVs
  - 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
Technical Accomplishments

Eastern Region

- Vehicles
  - 6 Opel Zafira hydrogen fuel cell minivans deployed in Washington, D.C., area
    - 2 vehicles use compressed hydrogen, 4 vehicles use liquid hydrogen
  - Partnering with U.S. Environmental Protection Agency, D.C. Department of Transportation, State of Virginia Department of Environmental Quality, and U.S. Postal Service for fleet operation of vehicles
  - Vehicles collect data according to NREL Data Reporting Templates by operating in driving demonstrations and refueling at Shell Benning Road and Fort Belvoir facilities

- Maintenance and Training Facilities
  - Ongoing maintenance and training activities at Fort Belvoir facility
  - Site selection, permitting, and construction modifications underway in NYC metropolitan area with anticipated availability mid-07

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Technical Accomplishments

Eastern Region

HydroGen3 demonstration for public school chairpersons of secondary school science departments
(Washington, DC - 11/21/06)

USPS – Springfield, VA
Technical Accomplishments

Visit by President Bush with USPS alternative fuel fleet
Technical Accomplishments

Eastern Region
Hydrogen Refueling Infrastructure

- Washington, DC
  Benning Road Station and Visitors Center
  - Gaseous and liquid hydrogen refueling accommodating all vehicle manufacturers
  - Station has operated over 2 full years with 93% availability
  - 500 total hydrogen fills
  - 880+ kg total hydrogen dispensed to date
  - 400+ First Responders trained

- White Plains, NY
  Department of Public Works (DPW) Facility
  - Project permitted
  - Electrolyzer-based gaseous hydrogen refueling
  - Construction/operation in 2007

- NYC Metro
  - Locations being evaluated for up to two additional projects
  - Sites and station type to be determined in Q2 2007
Technical Accomplishments

Eastern Region
Hydrogen Refueling Infrastructure – DPW, White Plains, NY
Technical Accomplishments

Western Region

- Vehicles
  - 2 Opel Zafira compressed hydrogen fuel cell minivans deployed in southern California area
  - Expanded partnership with U.S. Postal Service for fleet operation of vehicles with addition of Irvine location in October 2006
  - Vehicles collect data according to NREL Data Reporting Templates by operating in driving demonstrations and refueling at Quantum and other sites where available

- Maintenance and Training Facilities
  - Ongoing maintenance and training at Quantum Lake Forest facility
  - Site selection, permitting, and construction modifications underway in Los Angeles metropolitan area with anticipated availability in 2007
Technical Accomplishments

Western Region
Hydrogen Refueling Infrastructure

- Los Angeles Metro
  - Santa Monica Blvd. Station and Visitors Center
    - Project in permit review
    - Aerial-mount electrolyzer-based gaseous station
    - Construction/operation in 2007
  - Locations being evaluated for up to one additional project
    - Site and station type to be determined in 2007
Technical Accomplishments

Wireless data transfer from vehicle to data server

Wireless Local Area Network (WLAN) Communication
- WPA-PSK protected
- Recommended distance < 10 -15 meters

Connection Point
- Data Server
- Antenna
- Desktop PC
- User PC
- Internet
- Transfer of data files to a server via world wide web
- Intermediate storage of “on road” data files
- Data analysis and reports generation

Data collection and files generation
- Data acquisition (DAQ) computer with WLAN client
- Datafiles transfer files via secure WLAN

Vehicle under test
- Vehicle under vehicle service station
- Access point at vehicle service station
- Datafiles transfer files via secure WLAN

Internet
- Datafiles transfer files via secure WLAN

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Technical Accomplishments

Data Collection and Vehicle Testing

- On-road data collection
  - Wireless automated data transmission from vehicle to a data server via world wide web operational at selective sites

- Chassis dynamometer testing
  - Completed 4\textsuperscript{th} round of dyno tests in 2006
  - Increased accuracy
    - Gravimetric and mass flow based hydrogen measurement equipment fully operational
  - Increased efficiency
    - Hydrogen supply line installed at dynamometer site provides continuous fuel flow for vehicle testing
Technical Accomplishments

Codes and Standards (C&S) – NextEnergy

• Training
  - Training program has been delivered 9 times since its development in January, 2006
  - Input into DOE First Responder Training program

• Databases
  - Databases moved from build phase to data population phase

• Annual Conference Sep. 14, 2006
  - Focus on C&S development status and education programs
  - Plans for 2007: coordination of lessons learned
Future Work

- **Vehicles**
  - Launch Phase 2 vehicle deployment
  - Pursue new vehicle operators

- **Hydrogen Refueling Infrastructure**
  - Inaugurate usage of hydrogen refueling stations in NYC metropolitan area and southern CA to be operational in 2007

- **Maintenance and Training Facilities**
  - Commission maintenance and training facility in NYC metropolitan area in mid-07
  - Commission maintenance and training facility site in Los Angeles area in 2007

- **Codes and Standards – NextEnergy**
  - Continue to populate permitting experience database
Vehicle Deployment

- Phase 2: Project Driveway
  - 32 vehicles in Eastern and Western regions with diverse climates and driving conditions
    - Eastern – Washington, DC and bringing up new site in NYC metropolitan area for cold weather testing
    - Western – continuing in Los Angeles area
  - Comprehensive feedback on all elements of customer experience and vehicle performance
  - Data collected from participants from general population, business partners, policy makers and media
  - Deployment begins late 2007
Chevrolet Equinox Fuel Cell

**Performance**
- Range 200 miles
  - Fuel capacity of 4.2 kg at 700 bar
- Acceleration 0-60 mph in 12 seconds
- Top speed 100 mph
- Freeze durable over the vehicle life

**Content**
- Branded Chevrolet
- Visibly distinctive styling and graphics
- 2 front bucket seats (heated) and 2-passenger rear bench with center console
- 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
- 17 inch aluminum wheels
- Regenerative braking
- Single speed electric motor traction system
Recommendations

Infrastructure

• Retail-like refueling stations
  − Geographically targeted regions where automakers want to put vehicles
  − 700bar 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
Lessons Learned

- Real world experience
- Replicated infrastructure template
- Continued DOE funding
## Project Summary

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<thead>
<tr>
<th>Focus Area</th>
<th>Barrier / Target</th>
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<tr>
<td>• Continued efforts to establish two additional refueling sites – NYC metropolitan area and Los Angeles area</td>
<td>Hydrogen Refueling Infrastructure</td>
</tr>
<tr>
<td>• Began renovation of additional maintenance and training sites – NYC metropolitan area and Los Angeles area</td>
<td>Maintenance and Training Facilities</td>
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<tr>
<td>• Obtained new vehicle operators – USPS Irvine, State of Virginia DEQ</td>
<td>Vehicle</td>
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| • Implemented data collection enhancements | • Range  
• Durability  
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