

# 2007 DOE Hydrogen Program Review

## Hydrogen Vehicle and Infrastructure Demonstration and Validation

*Rosalind (Roz) B. Sell  
General Motors Corporation  
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**EQUINOX FUEL CELL** 

Project ID #: TV4



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# Overview

## Timeline

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

## 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

## 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. 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



# Technical Accomplishments

## Eastern Region



**USPS – Springfield, VA**

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





# Technical Accomplishments

## Visit by President Bush with USPS alternative fuel fleet



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# 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

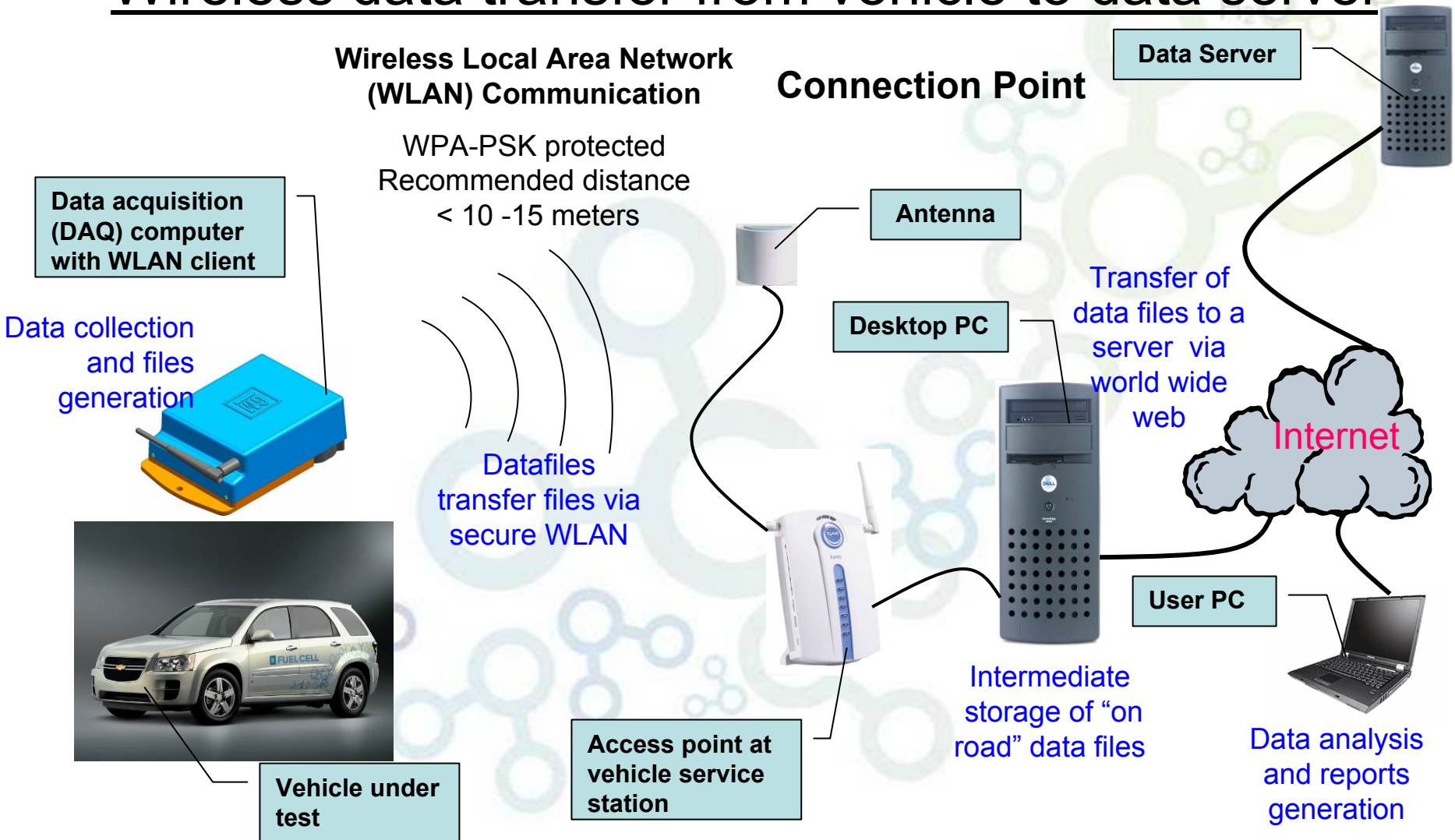
- Los Angeles Metro
  - Santa Monica Blvd. Station and Visitors Center
    - Project in permit review
    - Aerial-mount electrolyzer-based gaseous station
    - Construction/operation in 2007
  - Locations being evaluated for up to one additional project
    - Site and station type to be determined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





# Technical Accomplishments

## Wireless data transfer from vehicle to data server



# 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<sup>th</sup> 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

Hydrogen Consumption Measurement



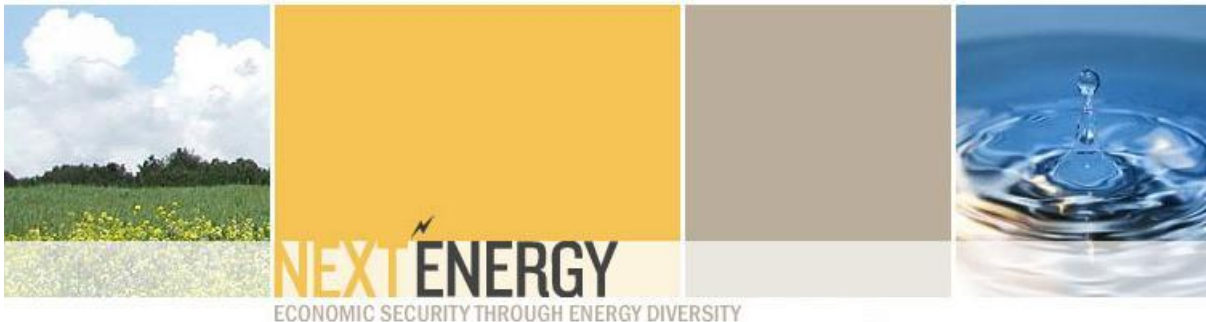
Hydrogen Mass Flow Measurement  
(Fuel Economy)



# 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



# Future Work

## 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



EQUINOX FUEL CELL 



# 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

Focus Area	Barrier / Target
<ul style="list-style-type: none"> <li>Continued efforts to establish two additional refueling sites – NYC metropolitan area and Los Angeles area</li> </ul>	Hydrogen Refueling Infrastructure 
<ul style="list-style-type: none"> <li>Began renovation of additional maintenance and training sites – NYC metropolitan area and Los Angeles area</li> </ul>	Maintenance and Training Facilities
<ul style="list-style-type: none"> <li>Obtained new vehicle operators – USPS Irvine, State of Virginia DEQ</li> </ul>	 <p style="text-align: center;">Vehicle</p>
<ul style="list-style-type: none"> <li>Implemented data collection enhancements</li> </ul>	<ul style="list-style-type: none"> <li>Range</li> <li>Durability</li> <li>\$H<sub>2</sub>/gge</li> </ul> 