2008 DOE Hydrogen Program Review
Hydrogen Vehicle and Infrastructure
Demonstration and Validation

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Project ID #: TV4

This presentation does not contain any proprietary, confidential, or otherwise restricted information
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
• 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

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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

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General Public

PUTTING THE FUTURE IN DRIVE(WAYS).

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 4\textsuperscript{th} 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

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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.
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
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
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
Lessons Learned

- Real world experience
- Infrastructure! Infrastructure! Infrastructure!
- Continued DOE funding
# Project Summary

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

- Fuel Efficiency
- E85 Ethanol
- Hybrid
- Electric
- Fuel Cell