2009 DOE Annual Merit Review

Hydrogen Vehicle and Infrastructure Demonstration and Validation

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Project ID #: tv_05_sell

Overview

Timeline

- Project Start = 10/1/04
- Project End = 9/30/09
- Project is 90% complete

Budget

- $88.0 M Total Project
  - $44.0 M DOE share
  - $44.0 M GM share
- FY08 Funding $6.0 M
- FY09 Funding TBD

Barriers

- Targets

- Vehicles
  - Vehicle range and fuel cell (FC) durability
- Hydrogen Fueling Infrastructure
  - $H2/gge
- Maintenance and Training Facilities

Partners

- Shell Hydrogen, LLC – hydrogen fueling
- 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 fueling 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 fueling
  - Collect and report operating data

Past Year Objectives – Execute next generation of fuel cell technology

- Obtain vehicle operators
- Collect, analyze, report data from program vehicles and fueling locations
- Construct hydrogen fueling stations in NYC metropolitan area and southern California
- Operate maintenance and training facilities in Project Driveway locations
- Complete permitting databases and continue data population
- Meet all Project Deliverables

Approach

Demonstrate fuel cell electric vehicles

- Deploy total of 50 fuel cell electric vehicles (FCEVs) in various terrains, driving conditions, and climates including cold weather
- Demonstrate two generations of fuel cell technology

Establish retail-like hydrogen stations for public fueling

- Install total of five fueling 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, fueling, technical support, safety

Generate and report data required under the Program

- Capture vehicle on-road and dynamometer test data
- Capture hydrogen infrastructure production/fueling 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 electric vehicles

- Over 100 Chevrolet Equinox Fuel Cell Electric vehicles
- Launched in late 2007 continuing through 2010
- 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 FCEV and infrastructure development

Drivers

- Businesses, government
- General public - hand raiser process on Chevrolet.com
- Celebrity influencers, policymakers and media

Project Driveway

- Over 80,000 people applied on Chevrolet.com
- 2,000+ members in Project Driveway blog community
- Exceeded 500,000 miles in customers' hands
- More than 7,200 fills at fueling stations
- Over 55,000 people experienced the vehicle at events
- More than 1,200 first responders trained in 8 cities
- 100s of stories in print, broadcast and digital media

Equinox Fuel Cell Driver Feedback

Top Positive Comments

- The customer support – driver relationship management
- The vehicle performance – quiet, smooth and powerful
- Fuel economy and range – better than expected
- Visibility of the vehicle – drivers like to be approached and talk about the car

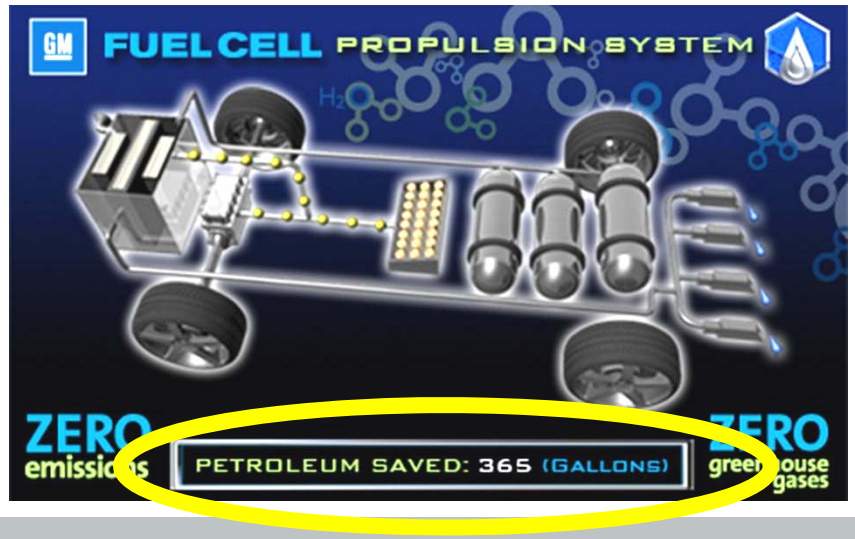
Top Constructive Comments

- Hydrogen fuel availability and the fueling process
- Brake feel, response and effort

Chevrolet Equinox Fuel Cell Electric Vehicle

Performance

- Range 168 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
- Navigation radio with fuel cell graphic energy display
- OnStar
- Driver, passenger and roof rail air bags
- ABS, traction control and stability 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 updates

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

Project Driveway

… in her own words

Technical Accomplishments

Eastern Region

Washington, D.C.

Technical Accomplishments

Eastern Region

Vehicles – Phase 2

- 19 Chevrolet Equinox FCEVs demonstrating GM's 4th generation of fuel cell technology have been deployed in Washington, D.C., and NYC metro area
  - Cold weather testing in New York
- Vehicles collect data according to NREL Data Reporting Templates and fuel at Shell Hydrogen and GM facilities

Maintenance and Training Facilities

- Ongoing maintenance and training activities at Ardsley, NY and Fort Belvoir, VA facilities


Fort Belvoir, VA


Ardsley, NY

Technical Accomplishments

Eastern Region Hydrogen Fueling Infrastructure

Station	Location	350 bar	700 bar	Generation/ Delivery	Comments
GM Maintenance & Training Center 	Ardsley, NY	N/A	3/08	Delivered compressed gas	450+ First Responders trained Infrared capable Can fill 3 FCEVs back-to-back 5 min each, 7-10 per day 1st U.S. station tested for H2 quality at 700 bar
Shell Hydrogen City of White Plains 	White Plains, NY	9/07	3/08	Onsite electrolysis	350 bar & 700 bar offline 8/08 because of fire Incident investigation completed 12/08 with DOE participation 350 bar expected online 3/09 700 bar expected online Q309
Shell Hydrogen Benning Rd. 	Washington, D.C.	11/04	6/08	Delivered liquid	700 bar offline 8/08 expected online 3/09 400+ First Responders trained Gaseous fueling accommodating all vehicle manufacturers

- JFK Airport and Bronx stations are currently under construction; expected to be operational mid 2009

NY First-Term Congressman Eric Massa
Corning, NY to Washington, D.C.

Corning, NY Media Launch

Benning Road Fueling

290 miles

Advocate for the technology

Arrives at Swearing-In Ceremony

Technical Accomplishments

Western Region

Irvine, California

Technical Accomplishments

Western Region

Vehicles – Phase 2

- 23 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 fuel at Shell Hydrogen, Clean Energy, University of California Irvine and GM facilities

Maintenance and Training Facilities

- Ongoing maintenance and training activities at Burbank, CA and Quantum Lake Forest facilities


Burbank, CA

Technical Accomplishments

Western Region Hydrogen Fueling Infrastructure

Station	Location	350 bar	700 bar	Generation/ Delivery	Comments
Clean Energy/GM 	Near LAX, CA	N/A	1/09	Delivered compressed gas	Completed <5 months Permitting <6 weeks Infrared capable Can fill 3 FCEVs back-to-back 5 min each, 7-10 per day
GM Maintenance & Training Center 	Burbank, CA	11/07	11/07	Delivered compressed gas	200+ First Responders trained Faster-fill (15-minute) installation under construction
Shell Hydrogen, Santa Monica Blvd. 	West LA, CA	6/08	N/A	Onsite Electrolysis on Canopy	100+ First Responders trained World's first Canopy-mount electrolyzer based gaseous station at 350 bar Gaseous refueling accommodating all vehicle manufacturers

- GM/SH West LA station is currently under construction; expected to be operational mid 2009

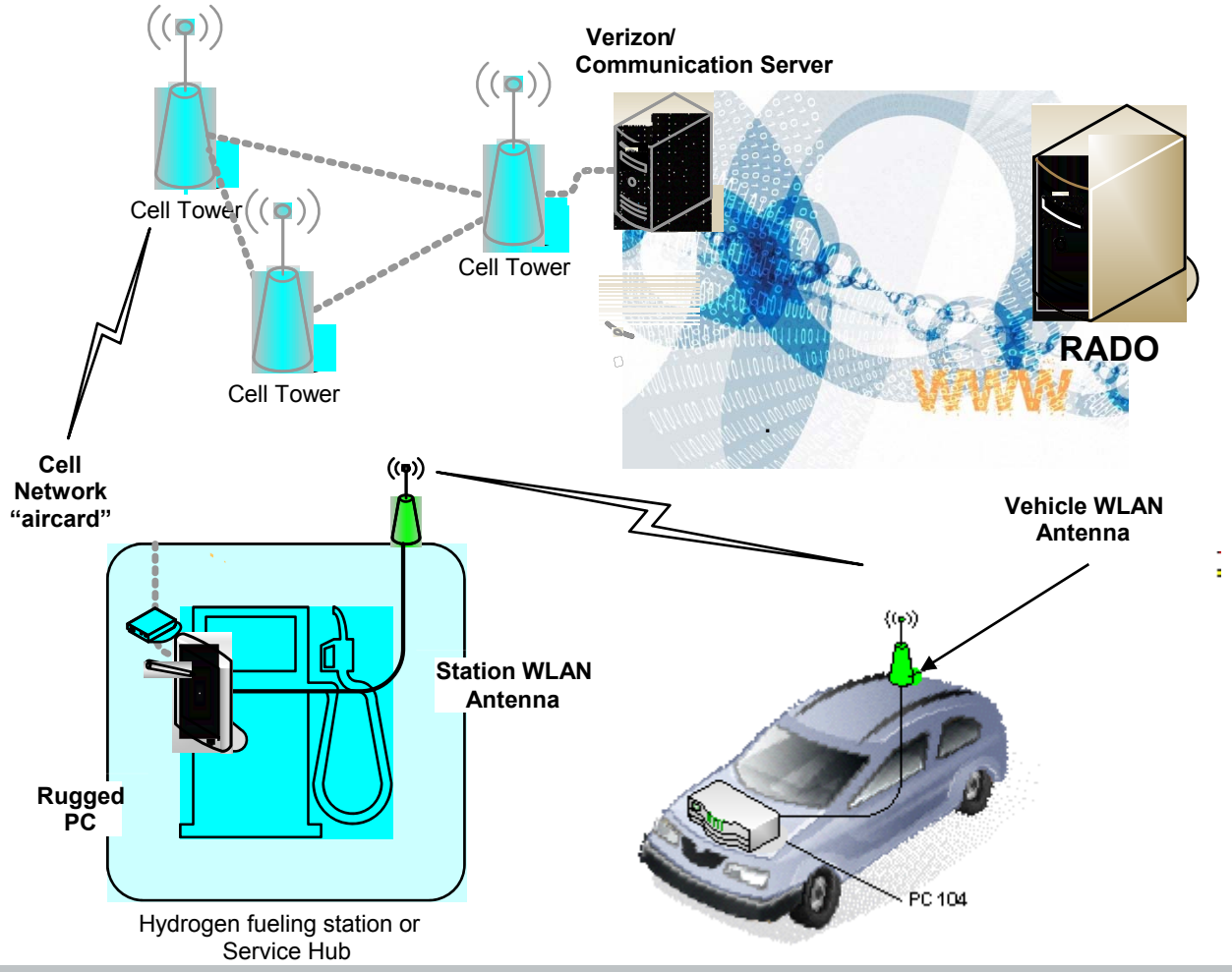
Cold Weather Performance

Proving ground testing for cold start up (Kapuskasing, ON in Canada)

19 DOE vehicles were deployed in North East this winter and performed with customers as expected

Data Upload During Fueling

Wireless transfer of data between vehicle and fueling stations



Technical Accomplishments

Codes and Standards (C & S) – NextEnergy

Database

- Hydrogen Permitting Officials database posted to NextEnergy Center website

Annual Conference September 18-19, 2008

- Focus on current industry efforts toward C&S development
- Featured panels from C&S organizations, city and state authorities

Code Development

- NextEnergy is a member of NFPA 2 hydrogen code Task Group 8
- Working toward public release of the NFPA 2 document in March 2009

Future Work

Vehicles

- Continue executing Phase 2 vehicle deployment

Hydrogen Fueling Infrastructure

- Inaugurate remaining hydrogen fueling stations
  - Two new NYC metro stations by mid 2009 at 350/700 bar
  - One new West LA station by mid 2009 at 700 bar

Maintenance and Training Facilities

- Continue to conduct new driver training on Equinox FCEV, hydrogen safety, hydrogen fueling
- Continue to service vehicles

Codes and Standards – NextEnergy

- Annual conference slated for Fall 2009; designed for attendees to experience permitting process firsthand

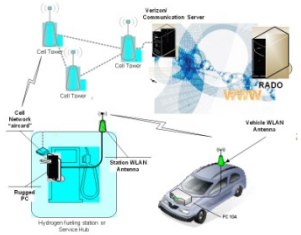
Critical Infrastructure Next Steps

- Compelling, retail-like fueling stations
  - Geographically targeted regions where automakers want to put vehicles
  - 700bar fast-fill fueling with infrared communication link
  - Compelling station designs (customer and technology perspectives)
  - Robust hydrogen capacity and throughput – designed for growth
  - Operational with (or before) vehicles – market enabler
- Access to all stations
  - All automotive companies and their customers have access
  - Standard fueling protocol – safe / fast / effective fueling of all vehicles
  - 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.

Project Summary

Accomplishments	Barrier / Target
• 6 stations in operation with 3 more in process demonstrating multiple approaches to hydrogen generation and delivery	Hydrogen Fueling Infrastructure 
• 4 GM facilities for customer training and vehicle service – each equipped with 700 bar	Maintenance and Training Facilities 
• 50 vehicles deployed demonstrating 2 generations of fuel cell technology	  Vehicles
• Data collection, analysis and reporting	• Range • Durability • $\$H_2$/gge 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