

2006 DOE Hydrogen Program Review

Hydrogen Vehicle and Infrastructure Demonstration and Validation



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May 19, 2006*

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Overview

Timeline

- Project Start = 10/1/04
- Project End = 9/30/09
- Project is 20% complete

Budget

- \$88.0 M Total Project
 - \$44.0 M DOE share
 - \$44.0 M GM share
- \$6.615 M FY05 DOE funding
- \$5.347 M FY06 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
- WDC Department of Transportation – vehicle operator
- U.S. Army – 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
 - Identify retail refueling sites in NYC metropolitan area and southern California
 - Achieve full operation at Shell WDC Benning Road station for liquid and compressed hydrogen refueling
 - Identify site for maintenance facility in NYC metropolitan area
 - 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 and WDC Department of Transportation (DDOT) 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 Ft. Belvoir facilities
- Maintenance and Training Facilities
 - Ongoing maintenance and training activities at U.S. Army Fort Belvoir, VA facility
 - Site selection underway in NYC metropolitan area



Technical Accomplishments

Eastern Region



DDOT Urban Forestry Administration

Luis A. Luna, Assistant Administrator, US EPA



Technical Accomplishments

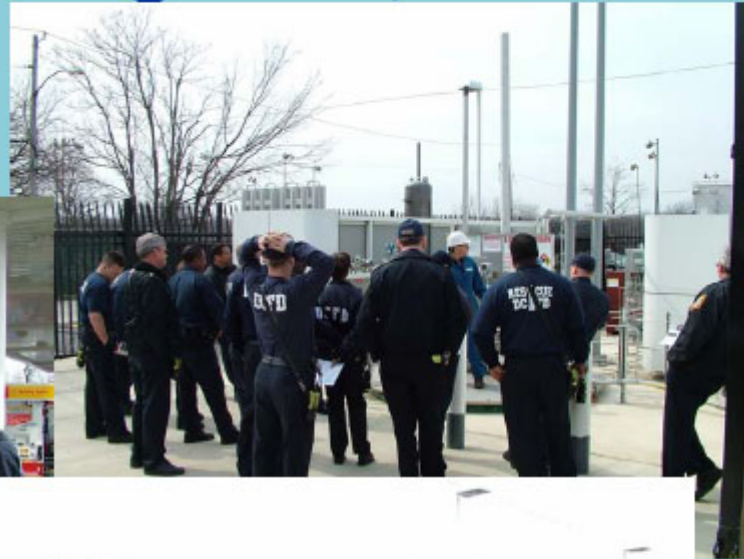
Eastern Region

Hydrogen Refueling Infrastructure

- Shell Benning Road
 - Station and Visitors Center up and running
 - Gaseous and liquid hydrogen refueling operational accommodating all vehicle manufacturers
 - First Responders training conducted for several hundred participants including 200 in '06
- NYC metropolitan area retail refueling station
 - Site selection underway



Operations Practices First Responder Training '06 – (202 attendees)



Technical Accomplishments

Western Region

- Vehicles
 - 2 Opel Zafira compressed hydrogen fuel cell minivans deployed in Southern California area
 - Vehicles collect data according to NREL Data Reporting Templates by operating in driving demonstrations and refueling at Quantum and other sites where available
- Hydrogen Refueling Infrastructure
 - Southern California retail refueling station – site selection underway
- Maintenance and Training Facilities
 - Ongoing maintenance and training at Quantum Lake Forest facility



CaFCP Road Rally Team




Western Region



NREL Data Collection

Data Collection: Overview

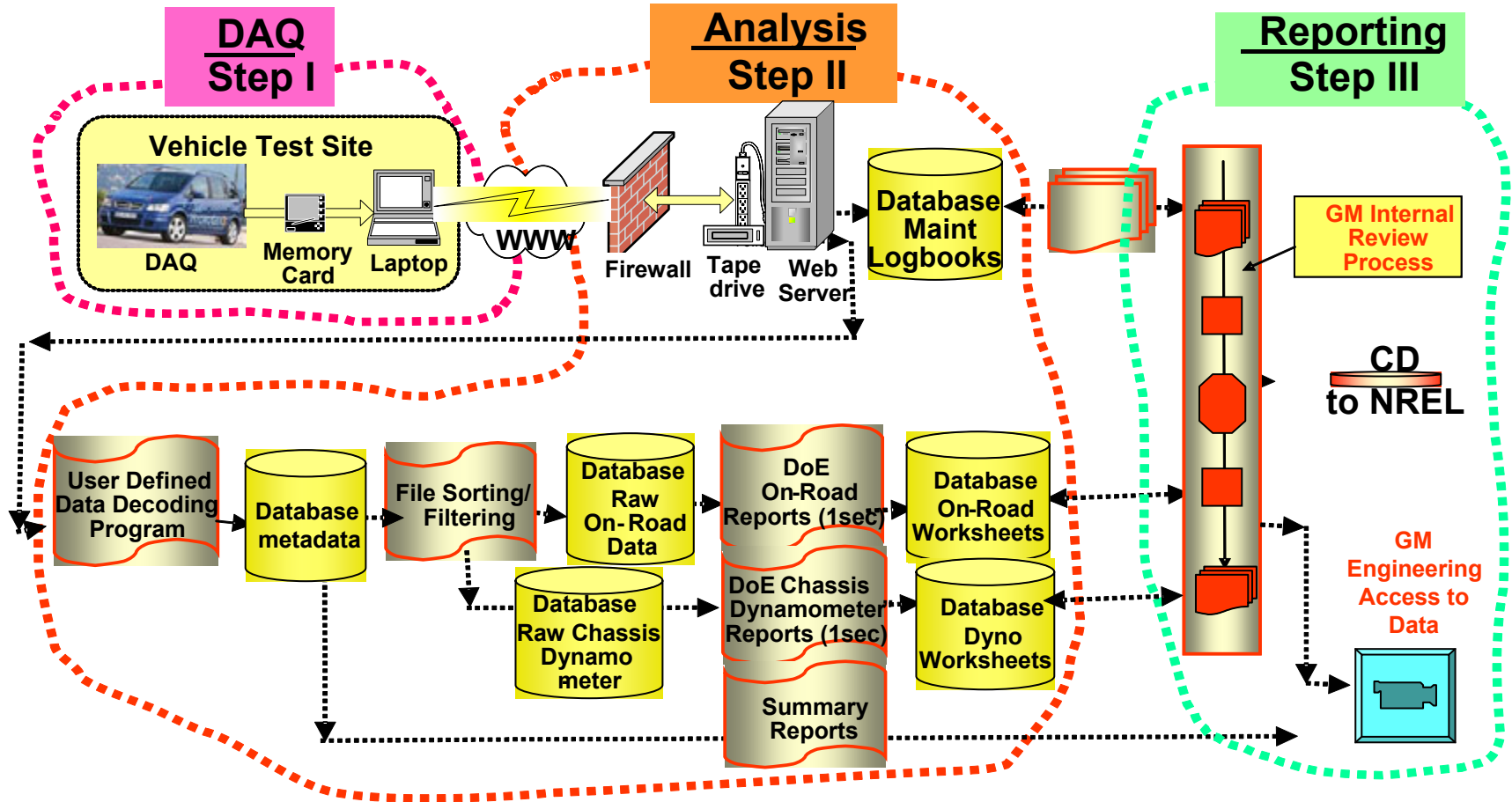
Key Vehicle Data	Key Infrastructure Data
Stack Durability	Conversion Method
Fuel Economy (Dyno & On-Road) and Vehicle Range	Production Emissions
Fuel Cell System Efficiency	Maintenance, Safety Events
Maintenance, Safety Events	Hydrogen Purity/Impurities
Top Speed, <u>Accel.</u> , Grade	Refueling Events, Rates
Max <u>Pwr</u> & Time at 40C	H ₂ Production Cost
Freeze Start Ability (Time, Energy)	Conversion, Compression, Storage and Dispensing Efficiency
Continuous Voltage and Current (or Power) from Fuel Cell Stack, Motor/Generator, Battery & Key Auxiliaries: (Dyno & On-Road)	

 NREL National Renewable Energy Laboratory 8



Technical Accomplishments

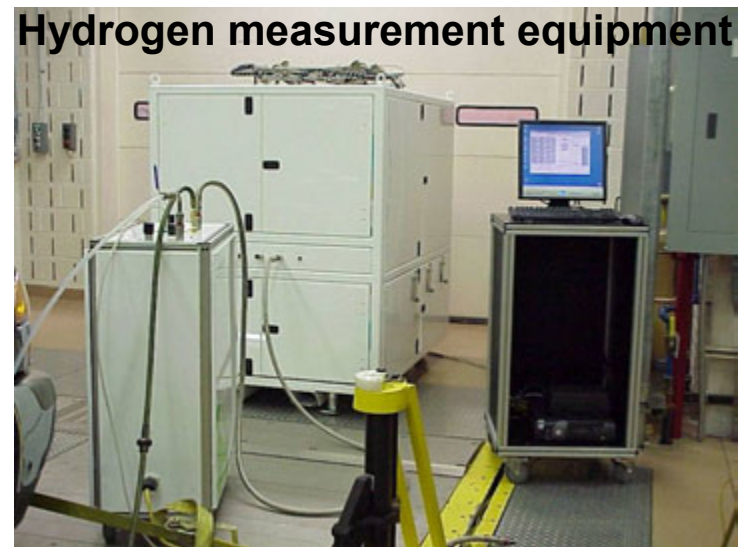
GM Data Acquisition (DAQ), Analysis and Reporting Process



Technical Accomplishments

Data Collection and Reporting

- On-road data collection
 - Logbook data entry has been automated wherever possible
- Chassis dynamometer testing
 - Vehicle availability for demonstration and operation increased by optimizing scheduling and logistics of dynamometer testing
 - Data accuracy has been enhanced by installation of precision hydrogen massflow measurement equipment



Technical Accomplishments

Codes and Standards – NextEnergy

- Training
 - Developed presentation materials based partially on CaCFP Emergency First Responder Training Program for Hydrogen Awareness and Safety Overview for Responders; input from program partners and State of Michigan Office of Fire Fighter Training
 - Completed presentations of First Responder Hydrogen Education to Michigan Arson Prevention Committee and Michigan Fire Inspectors Society 1Q06
- Databases
 - Completed final design changes to permitting experience and permitting authority databases based on stakeholder feedback
 - Databases moved from design phase to build phase
- Annual Conference
 - Developed outline and agenda for Codes & Standards annual conference



Future Work

- Vehicles
 - Pursue new vehicle operators
- Hydrogen Refueling Infrastructure
 - Construct retail hydrogen refueling stations in NYC metropolitan area and southern California to be operational by December 2006
- Maintenance and Training Facilities
 - Establish NYC metropolitan area maintenance and training facility to be operational by December 2006
- Codes and Standards – NextEnergy
 - Permitting experience and permitting authority databases to be completed during Q206 and data population to begin



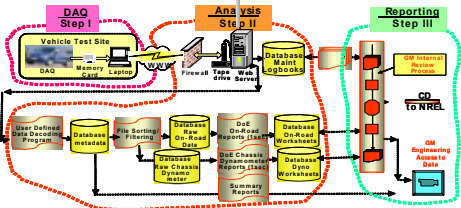


Recommendations – Lessons Learned

- Develop credible third party hydrogen safety experts
 - Independent authority
 - Trained in media relations
 - Someone local community will accept
- Develop fire training roadshow
 - Self-contained trailer to move around the country
 - Leverage refueling stations, maintenance sites and FCVs from DOE Learning Demo teams
- Engage local government officials and urban planners in developing community enthusiasm for hydrogen
 - Focus on educational institutions and community organizations and neighborhoods



Project Summary

Focus Area	Barrier / Target
<ul style="list-style-type: none"> Two additional retail hydrogen refueling sites – NYC metropolitan area and southern California 	Hydrogen Refueling Infrastructure 
<ul style="list-style-type: none"> Additional maintenance and training site – NYC metropolitan area 	Maintenance and Training Facilities
<ul style="list-style-type: none"> New vehicle operators – DDOT and U.S. EPA 	 <p style="text-align: center;">Vehicle</p>
<ul style="list-style-type: none"> Data collection enhancements 	<ul style="list-style-type: none"> Range Durability \$H₂/gge 



Back-Up Slides



Presentations, Briefings, Testimony

Presentations/briefings

- Executive Leadership Panel Summit, NextEnergy, Detroit – 10/05
- State of International Platinum Association, Washington, D.C. – 9/05
- Hydrogen Virginia Building Codes Conference, Norfolk, VA – 10/05
- Fuel Cell Seminar, Palm Springs, CA – 11/05
- Delegation from Henan Province, China, Methanol Institute, Washington, D.C. – 11/05
- Assoc. for Public Policy Analysis and Management, Washington, D.C. – 11/05
- Hydrogen Fuel Cell Technology, Washington International School – 12/05
- Johns Hopkins School of Advanced International Studies – 12/05
- North Carolina State Univ. Transportation Research, Raleigh – 3/06
- Stockholm Auto Show, Sweden – 3/06

Congressional Testimony

- House Government Reform Committee – 7/05
- Senate Energy Committee – 7/05
- House Science Committee – 12/05



Previous Year Review Comments

- A more detailed technology transfer plan would be helpful”
 - Data is the project deliverable; project is not defined as technology transfer
- “Project must address the efforts to reduce technology costs”
 - Economic viability report is Project Deliverable and submitted to DOE as required
- “Failure and mitigation reporting not defined or shared”
 - Safety Plan and FMEA are Project Deliverables and submitted to DOE as required
 - DOE/NREL have responsibility for this area as part of data collection process



Critical Assumptions and Issues

- See Recommendations – Lessons Learned in main body of presentation

