2011 DOE Hydrogen and Fuel Cells Program Review

Hydrogen Vehicle and Infrastructure Demonstration and Validation

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General Motors
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EQUINOX FUEL CELL

Project ID # TV005

Overview

Timeline

- Project Start = 10/1/04
- Project End = 9/30/11

(Project is in Phase 2 vehicle demonstration with Technology Insertion element "in process" with 10 baseline and 10 Technology Insertion FCEVs)

- Percent complete: *94%*

Barriers

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

Budget

- Total project funding
  - $38.7 M DOE share
  - $38.7 M GM share
- Funding received in FY10: $4.2 Million
- Funding for FY11: $4.6 Million

Gen 2 Partners - 2010

Vehicle operators

- Project Driveway customers and drivers
- U.S. Postal Service
  (Operated 2 vehicles to deliver mail)
- City of White Plains, NY
- University of California at Irvine
- Department of Sanitation – New York City
- Port Authority of NY and NJ
- Monroe County, NY
- Air Products and Chemicals, Inc., PA

Relevance

Program Objective

- General Motors worked with energy partner Shell Hydrogen to deploy 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

- Work with vehicle operators to obtain hours and data
- Collect, analyze, report data from program vehicles and fueling locations
- Operate and maintain fueling stations and provide data
- Start FCS accelerated durability testing

Current Year Objective

- Operate Technology Insertion and Baseline vehicle fleets
- Operate FCS accelerated durability testing
- Collect, analyze, report data from Technology Insertion and Baseline vehicles and accelerated durability testing

Approach

Demonstrate fuel cell electric vehicles

- Deploy fuel cell electric vehicles (FCEVs) in various terrains, driving conditions, and climates including cold weather
- Demonstrate two generations of fuel cell technology
  - Insert Technology with recent advances to test Gen2 learnings

Operate hydrogen stations for public fueling

- Install and operate total of eight fueling stations on East and West coasts
- Explore hydrogen generation/delivery options such as electrolysis

Focus on accumulating durability hours

- More intensive operation of vehicle fleet
- Work with commercial customers
- FCS accelerated durability testing

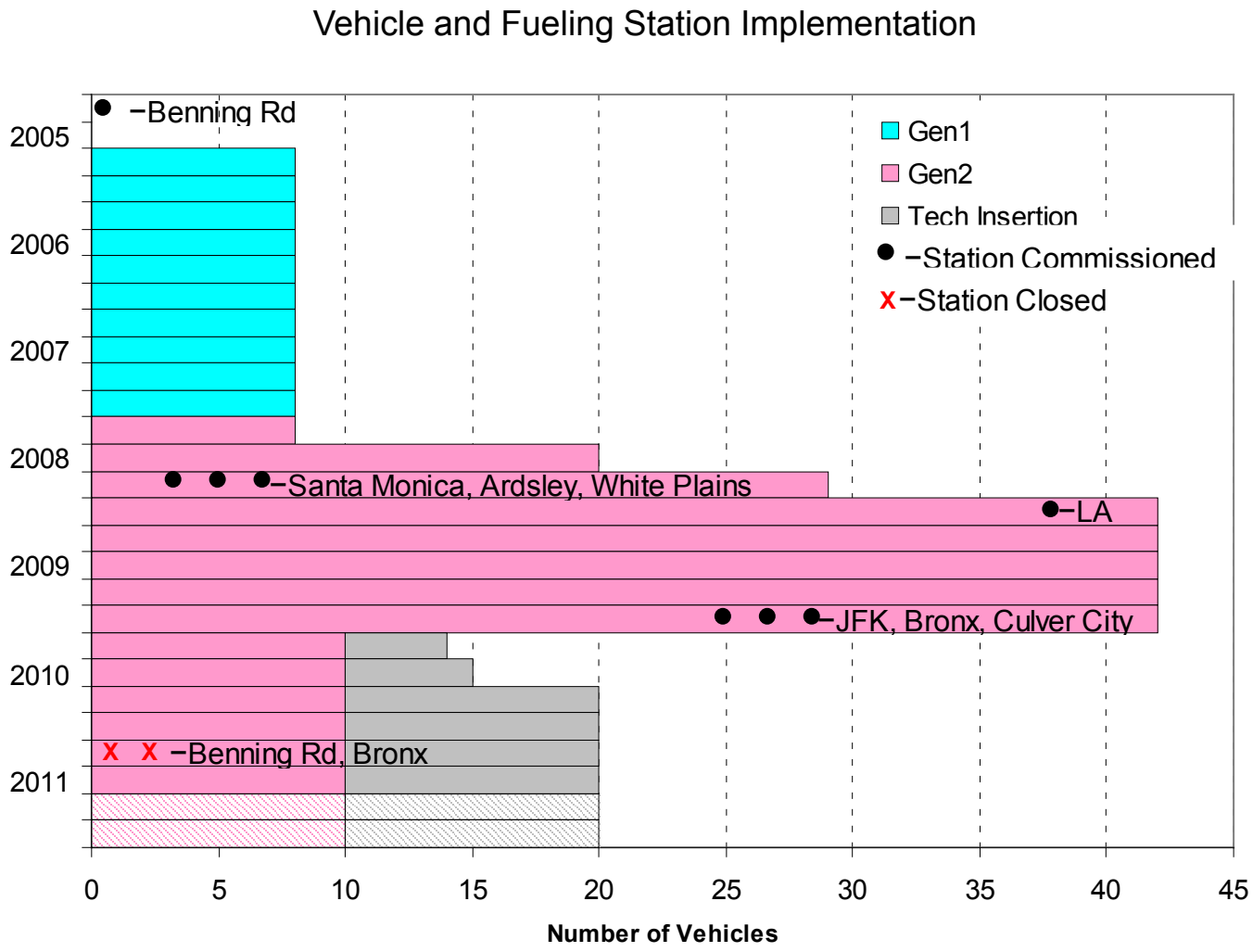
Generate and report data required under the Program

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

Evaluate Vehicle performance against Targets

- Vehicle range, stack durability, cold weather performance

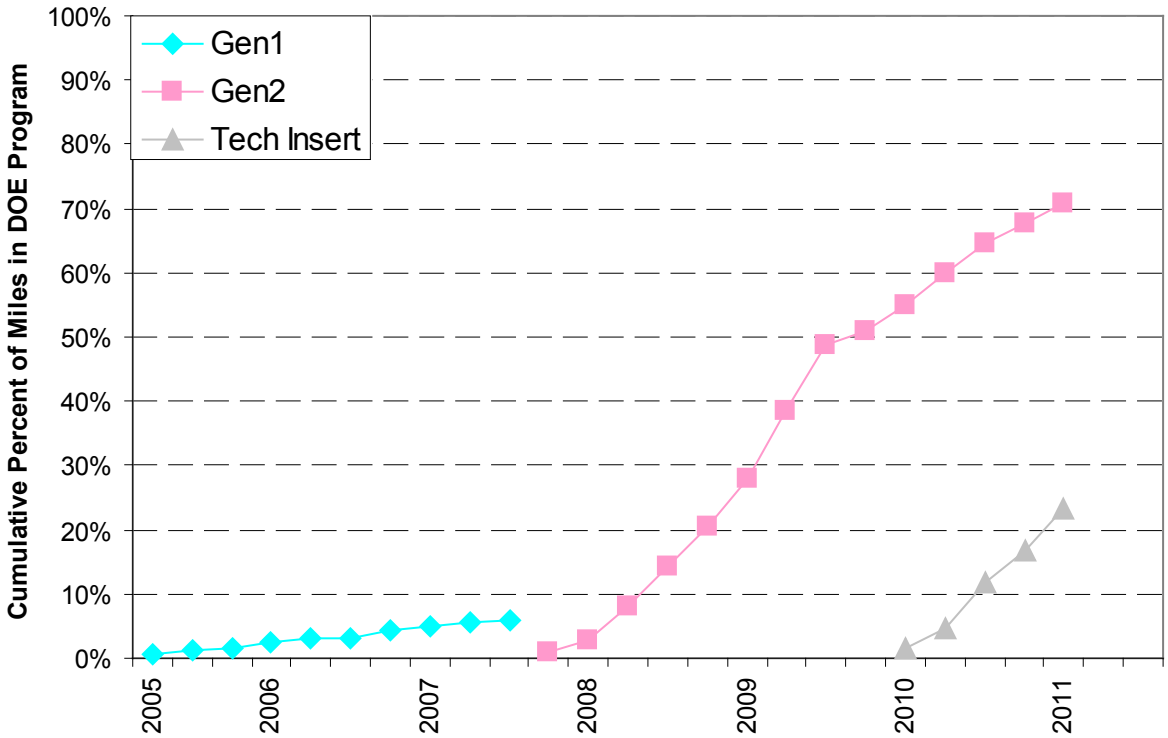
Technical Accomplishments and Progress



Technical Accomplishments and Progress

Objective: Collect and Report operating data

- Across three generations of vehicles, 23% of the miles are from Technology Insertion vehicles



Technical Accomplishments and Progress

Objective: Demonstrate FC vehicles under real-world conditions

Continue Long-Term Testing of Project Driveway Vehicles

- Over 100 Chevrolet Equinox Fuel Cell Electric vehicles
  - 20 Program vehicles 3+ years old with 40-50K miles
- Launched in late 2007 continuing through 2011
- Markets with diverse climates and conditions:
  - Southern California
  - Washington, D.C.
  - Greater New York City metropolitan area

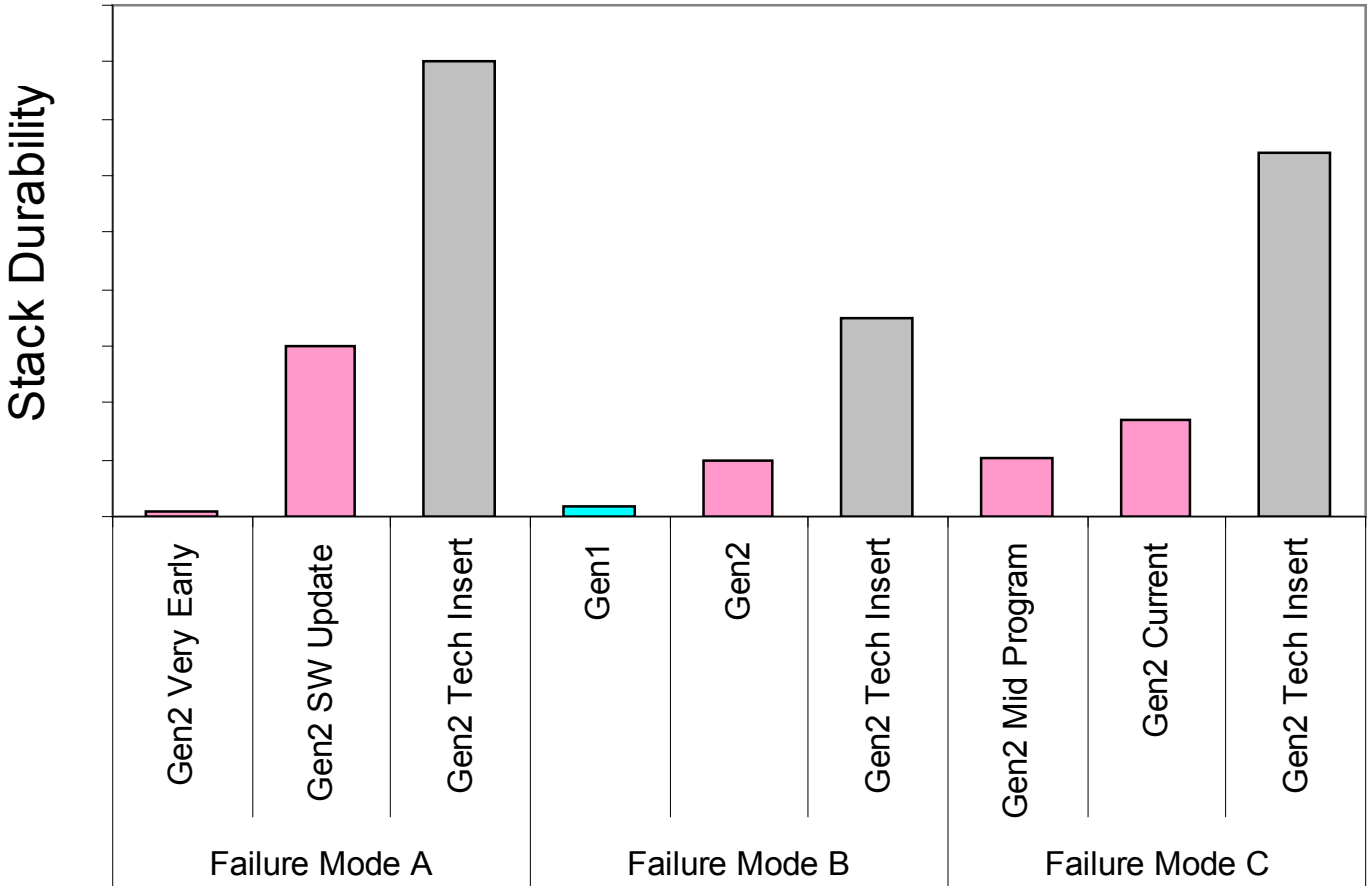
2010 Focus/Accomplishments

- Accumulated significant mileage/hours on vehicles
- Worked with commercial/fleet customers
- Stack durability data confidence increased
- Technology Insertion – data on new controls/materials

Technical Accomplishments and Progress

Objective: Vehicle Range and Fuel Cell Stack Durability

Stack Durability improves as successive iterations mitigate failures

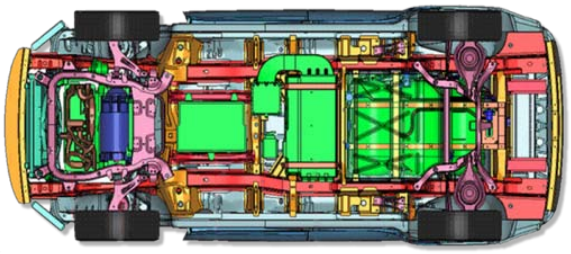


Technical Accomplishments and Progress

Objective: Demonstrate progressive generations of fuel cell system technology

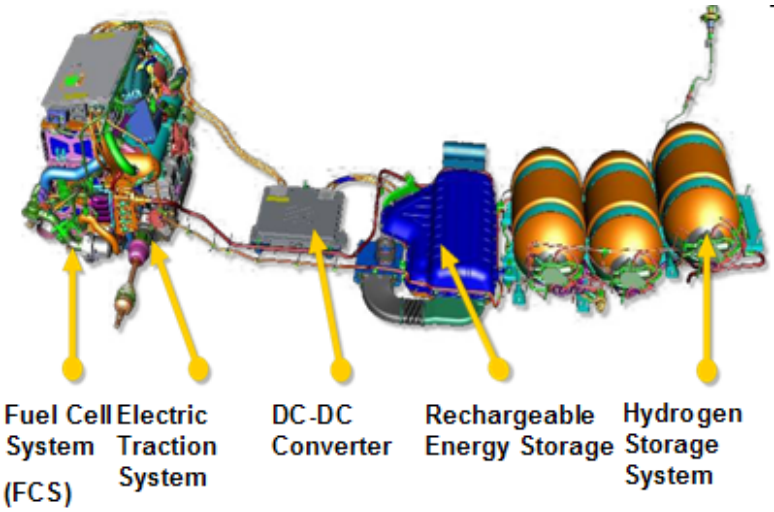
Gen2 Technology Insertion

- Advanced hardware, diagnostics and software controls developed from Gen2 learnings are implemented in the Gen2 Technology Insertion vehicles.



FCS accelerated durability testing

- Stressors
  - Reduce stack damage caused by vehicle startup/shutdown
  - Reduce effects of voltage cycling on stack
  - Remove stack contaminants
  - Humidity control
- Assess Improvement
  - Test various material sets for durability
  - Testing of new hardware, components and controls algorithm other than stack

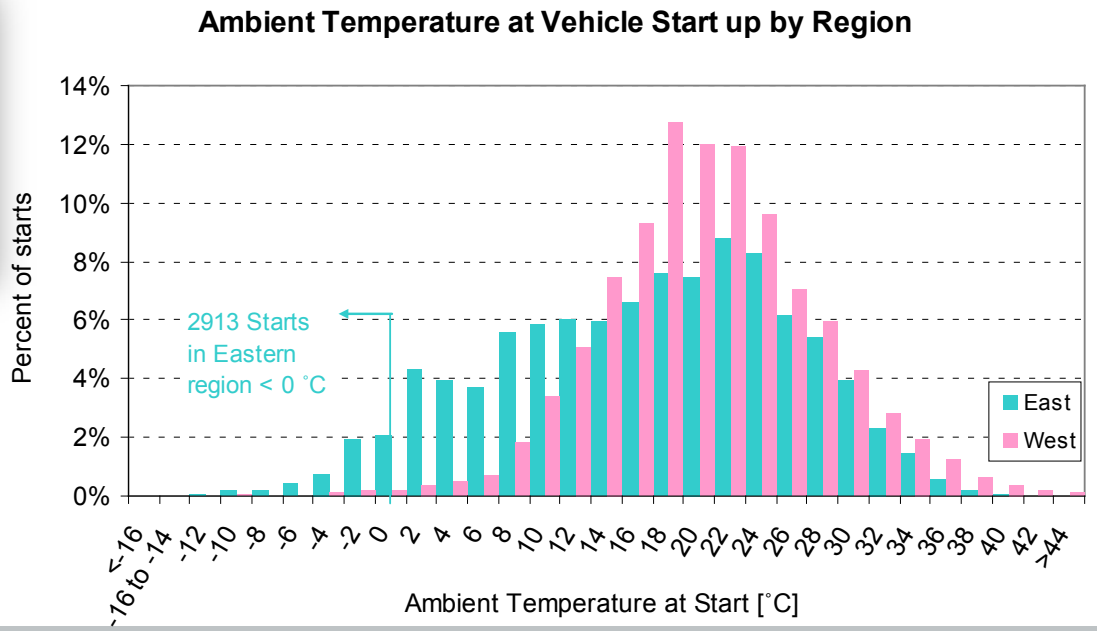


Technical Accomplishments and Progress

Objective: Cold Weather Performance

- Vehicles in the eastern region performed 2,913 starts at ambient temperature less than 0˚C without any issues.

- GM Vehicles exhibited very fast cold start/driveaway times under sub-freezing temperatures.



Technical Accomplishments and Progress

Objective: Demonstrate multiple approaches to hydrogen generation and delivery for vehicle refueling

- www.sustainability.rit.edu/csm.html

  "Analysis of FC Equinox and Green Hydrogen"

- Video emphasis on renewable pathway in use (play video here)

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Technical Accomplishments and Progress

Objective: Demonstrate multiple approaches to hydrogen generation and delivery for vehicle refueling

- First agreements to purchase fuel “by the kilogram”
- Launching new relationships with H2 stations outside original project stations
  - –Rochester Institute of Technology
  - –Town of Hempstead, NY
  - –SunHydro, Wallingford, CT

Collaboration

- Individual “retail” customers
- Fuel providers/suppliers/ infrastructure equipment
  - Air Liquide (dispensing equipment)
  - Air Products
  - Praxair (“Green Hydrogen”)
- State/university collaborations
  - UCI
  - CaFCP
  - RIT
- NREL (methodology development)
- Business-to-Business fleet Applications
  - Port Authority of New York and New Jersey (siting of fuel dispensing)
  - Air Products and Chemicals, Inc. (vehicle outreach and station utilization)
- Agencies
  - U.S. Department of Defense (Army, Navy/Marines, USAF)
    - Launching Hawaii demonstrations
  - U.S. Postal Service (>1 million pieces of mail in Gen2)
  - Department of Energy
  - D.C. Department of Transportation
- Influential
  - Various WDC dignitaries, policy makers and celebrities

Proposed Future Work - 2011

- Accumulate as much vehicle Fuel Cell Stack durability data as possible during the remainder of the program.
- Complete FCS Accelerated Durability testing.
- Conduct End-of-Program dynamometer testing.
- Complete Final Technical Report

Summary

Accomplishments	Barrier / Target
• Real world application in Project Driveway • Multiple Generations of Vehicles • Collect and report operating data	Learnings 

• Stack Durability
  • Identification/correction of specific failure modes
  • Rapid implementation in Tech Insertion
• Cold Weather performance
	Vehicle Performance 

• Ease of Use – retail like operation • Multiple H2 supply approaches • New H2 stations and commercial relationships	Infrastructure 

Program learnings moving us towards Commercial product