HYDROGEN TO THE HIGHWAYS

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Mercedes-Benz
Research & Development North America, Inc.

Ronald Grasman: Daimler AG

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DAIMLER NEXTENERGY DTE Energy Mercedes-Benz

Project #: TV004

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Program Overview

US Dept. of Energy Fuel Cell Vehicle and Infrastructure Cooperative Program

Timeline – Project Start Date: 01/07/04 – Project End Date: 09/30/10* – Percent Complete: 90%	***Partners*** – Daimler – MBUSA – DTE Energy – NextEnergy
Budget – $88.8M Total Project Funding - $44.4M Federal Share - $44.4M Industry Share – $5.1M FY05 Funding – $6.3M FY06 Funding – $7.6M FY07 Funding – $5.2M FY08 Funding – $3.0M FY09 Funding	***Barriers*** A. Vehicles B. Storage C. Hydrogen Refueling Infrastructure D. Maintenance and Training Facilities E. Codes and Standards

* Project extended by 1 year in 09/2009

Relevance

- **Address barriers to move toward technology readiness**
- **Align the Mercedes goals with DOE's Hydrogen Program objective**

<table>
<tr><th>DOE Barriers</th><th>Mercedes Teams' Project Goal</th></tr>
<tr><td>A. FCV Performance and Durability Data
B. Hydrogen Storage
C. H_2 Refueling Infrastructure Available Data</td><td>• Record, collect and report data from fuel cell vehicles and hydrogen fueling stations to validate DOE performance targets
<table>
<tr><th>Performance Measure</th><th>2009</th><th>2015</th></tr>
<tr><td>Fuel Cell Stack Durability</td><td>2000 hours</td><td>5000 hours</td></tr>
<tr><td>Vehicle Range</td><td>250+ miles</td><td>300+ miles</td></tr>
<tr><td>Hydrogen Cost at Station</td><td>$3/gge</td><td>$2-3/gge</td></tr>
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<tr><td>D. Maintenance and Training Facilities</td><td>• Demonstrate the safe installation and operation of service facilities
• Continuously update safety manuals and provide training</td></tr>
<tr><td>E. Codes and Standards</td><td>• Participate in various working groups to ensure continuous progress</td></tr>
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Objectives

Program Objectives

- Collect data to evaluate the technology status of FCV and H_2 infrastructure

2009/10 Objectives

- Maintain smooth operation of Gen I and 70MPa upgraded FCVs
- Continue internal operations of Gen II vehicles while preparing for Gen II customer operations
- Continue the high quality of technical vehicle and infrastructure data reporting
- Raise public knowledge of hydrogen technology and demonstration projects
- Operate DTE hydrogen fueling station
- Maintain project safety

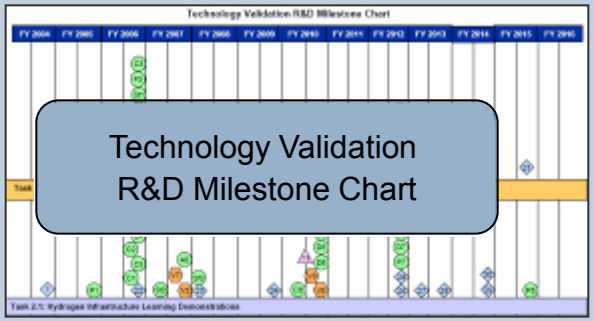
Approach: Technical

- Operate Gen-I and Gen II vehicles under real world condition to monitor DOE performance targets
- Install and maintain data acquisition system that collects vehicle and hydrogen fueling data

- Set up initial fueling network to support FCV fleet
- Establish maintenance and service facilities to support FCV operations
- Support codes and standards activities

Approach: Milestones

Alignment Between the Workplan/Milestones of DOE and Team

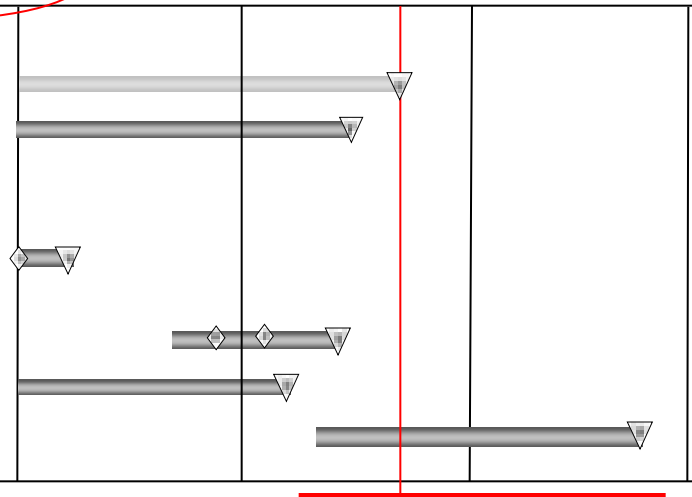


Technology Validation R&D Milestone Chart

2009-2011 DOE Targets

- 10 — Validate 2,000 hours FCV durability
- 12 — Validate cold start

Team's Task	DOE Target	% Complete
• Gen I		
– Gen I Operation	10	100%*
– 70MPa Vehicles Upgrade and Operation	10	100%
• Gen II		
– Fuel Cell Stack System Durability Test & Analysis	10, 12	100%
– Gen II FDA Infrastructure Upgrade	10, 12	100%
	10, 12	85%
– Internally Operate Vehicles	10, 12	0%
– Externally Operate Vehicles		



Accomplishments and Progress
Gen-I Operations

Designed for a 2-year operation

Continuing to accumulate mileage for the 6th consecutive year

Submitted over 100 DVDs of raw data to NREL

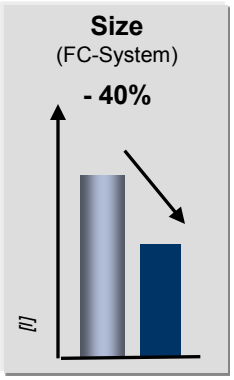
Accomplishments and Progress
Transition to Gen II Technology

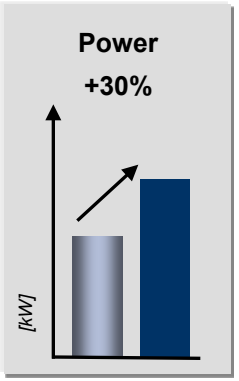
A Class F-Cell
Generation 1

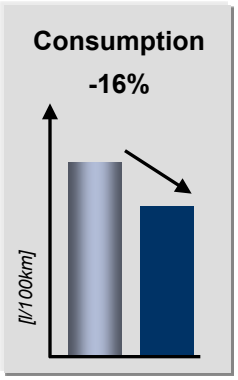
2004 – 2009
Controlled fleet demonstration

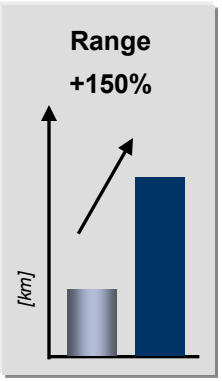
B Class F-Cell
Generation 2

from 2010
Large fleet demonstration









B Class F-Cell:

- Higher stack lifetime (more than 2000h)
- Increased power
  - (65kW, 87hp➔100kW, 134hp)
- Higher reliability
- Longer range
  - (160km, 100 miles➔400km, 250 miles)
- Freeze start ability to -25°C, -13°F
- Li-Ion battery

Accomplishments and Progress
Gen II Technology

Completed internal operation and testing of Gen II pre-production vehicles

Hot Weather Testing

Cold Weather Testing

- Internal Operation/Testing
  - Cold start capability
  - Safety
  - Durability
  - Hot weather conditions
  - NVH
- Raw data to NREL
  - Internal operations
  - Acceleration
  - Durability
  - Gradeability
  - Efficiency
  - Cold Start
- Fleet Data Acquisition

Durability

Dynamometer

Accomplishments and Progress
Gen II Deployment

Preparing for Gen II Pre-Commercialization

Dealerships

- Production assembly (similar to conventional ICE vehicles)
- Dealership involvement
- Maintenance
- Customer selection

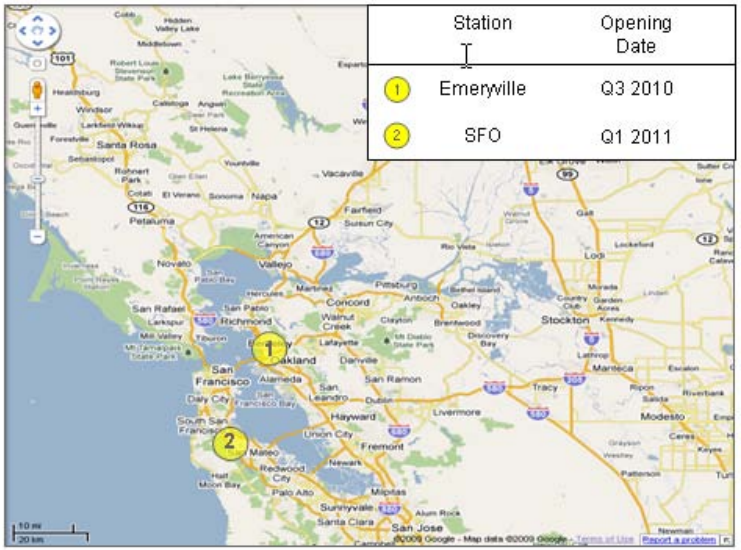
Production

Accomplishments and Progress
Gen II Deployment

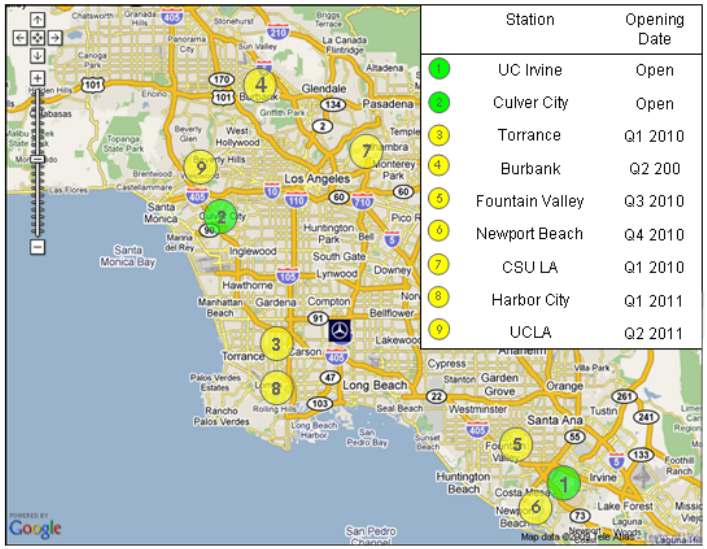
MBRDNA is Preparing for Fueling Infrastructure

- **Supported ARB/CEC** by recommending station specifications, site locations, supplier qualification guidelines and providing OEM commitment letters
- **Worked with CaFCP** to devleop action plan detailing strategy for deploying H_2 fueling stations and FCVs
- **Collaborated with other OEMs** to coordinate locations of future fueling stations

Northern California



Los Angeles



Accomplishments and Progress
Infrastructure

DTE Energy Continuing Operations

University Student Group touring the Hydrogen Technology Park

- Technical Data:
  - Hydrogen produced by electrolysis
  - Storage capacity of 140 kg
  - Capable of dispensing 35 kg/day
- Accomplishments:
  - Operational since 2004
  - Cold weather areas
  - Community outreach
  - New electrolyzer & dispenser installed winter of 2008-2009
  - Improved equipment reliability with new equipment

Accomplishments and Progress
Codes and Standards

MBRDNA Participated in various working groups to establish Codes and Standards essential to clear the way for FCV commercialization

- **First worldwide fueling guideline published in March**
  - J2601: Fueling Protocols for Gaseous Hydrogen Surface Vehicles
    - First worldwide guideline from an SDO establishing a baseline for fueling of hydrogen FCVs
    - New ARB/CEC hydrogen stations most likely to follow J2601

SAE International

- **Continued participation in SAE working groups**
  - J2600: Compressed Hydrogen Surface Vehicle Fueling Connection Devices
  - J2719: Information Report on the Development of H_2 Quality Guideline for Fuel Cell Vehicles
  - J2578: Recommended Practice for General Fuel Cell Vehicle Safety
  - J2579: Technical Information Report for Fuel Systems in Fuel Cell and Other H_2 Vehicles
  - Vehicle Battery Standards Committee

ISO International Organization for Standardization

NHTSA www.nhtsa.gov

- **Initial involvement in ISO TC197 WG 5**
  - ISO DIS 17268: Gaseous hydrogen land vehicle refuelling connection devices

Accomplishments and Progress
Codes and Standards – Next Energy

Continual progress in the development of appropriate Codes and Standards, updating hydrogen stakeholders of current and future directions from state, national and international perspectives.

- Database (NextEnergy)
  - Hydrogen Permitting Officials database posted to live NextEnergy Center website
  - Offered to DOE as a tool to identify H2 AHJs in Michigan
  - Hydrogen Station database posted to live NextEnergy Center website.
  - Offered to the H2 industry to voluntarily catalog installed infrastructure world-wide
- Annual Conference (NextEnergy)
  - Offered in 2007, 2008 and 2009
  - Slated for Fall/Winter 2010
  - Focus on current industry efforts toward C&S development
- NFPA 2 - Hydrogen Technologies Code
  - NextEnergy is a voting member of the Technical Committee
  - Instrumental in developing this extraction code for the industry
  - Intended to provide clarity to the infrastructure design process and to streamline permitting

Accomplishments and Progress

Safety

Safety practices insured
- No safety incidents
- Customer satisfaction

Operation & Maintenance

- Updated Project Fleet Vehicle Incident Management Plan
- Modified Safety Plan

Emergency Response

- Supported multiple emergency responder trainings
- Convinced station operators to remove PPE requirement

Station Commissioning

- Commissioned and tested 70MPa station in Burbank, CA

Accomplishments and Progress
Public, Political & Industry Outreach

Participated in outreach activities to educate the public, encourage government support and raise awareness about the Team's commitment to the technology

Public Outreach

Hydrogen Road Tour

LA Auto Show

Washington Auto Show

Collaboration

DAIMLER

Subrecipient

- Gen I and II fuel cell vehicle development and testing
- Program Management
- Data Collection

Mercedes-Benz (USA)

Subrecipient

- Deployment of hydrogen fuel cell vehicles

Mercedes-Benz
Research & Development North America, Inc.

Prime Recipient

- Partner to DOE
- Consortia leader

DTE Energy

Subrecipient

- Operations of hydrogen fueling station in the harsh weather condition of Michigan

NEXTENERGY
Economic Security through Energy Diversity

Subrecipient

- Permitting database
- Establishment of annual conference
- Participation in NFPA2

Future Work

- Prepare for Gen II demonstrations
- Maintain and finalize smooth operation of Gen I fuel cell vehicles with on-going service, maintenance and customer support
- Begin customer operations of production-level Gen II vehicles
- Maintain the high quality of technical vehicle and infrastructure data reporting to NREL/DOE
- Enlist support of corporate communications for a more expansive national outreach in addition to ongoing community and industry related events

Lessons Learned

- Vehicle
  - Extensive real world experience provided by DOE's Demonstration and Validation Project has shown that vehicles are ready for the commercialization phase
- Infrastructure
  - Need public, customer-friendly fueling stations
  - Upgrade older, strategic stations
  - Coordination with OEMs to identify station locations
- Continued DOE funding and political support is essential

Summary

- Improved equipment reliability and maintained operation of the DTE Station

- Continued mileage accumulation of Gen I vehicles
- Finalized internal operation and testing of Gen II pre-production vehicles
- Preparing for Gen II deployment with external customers and dealerships

- Participated in various working groups to ensure continuous progress with regards to Codes and Standards

- Continued data collection, analysis and reporting