

# HYDROGEN TO THE HIGHWAYS

## Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Mercedes-Benz

Research & Development North America, Inc.

Ronald Grasman: Daimler AG

June 10, 2010



DAIMLER

NEXTEnergy  
Economic Security through Energy Diversity



 Mercedes-Benz

Project #: TV004

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

# Program Overview

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

<p><b><u>Timeline</u></b></p> <ul style="list-style-type: none"> <li>- Project Start Date: 01/07/04</li> <li>- Project End Date: 09/30/10*</li> <li>- Percent Complete: 90%</li> </ul>	<p><b><u>Partners</u></b></p> <ul style="list-style-type: none"> <li>- Daimler</li> <li>- MBUSA</li> <li>- DTE Energy</li> <li>- NextEnergy</li> </ul>
<p><b><u>Budget</u></b></p> <ul style="list-style-type: none"> <li>- \$88.8M Total Project Funding             <ul style="list-style-type: none"> <li>- \$44.4M Federal Share</li> <li>- \$44.4M Industry Share</li> </ul> </li> <li>- \$5.1M FY05 Funding</li> <li>- \$6.3M FY06 Funding</li> <li>- \$7.6M FY07 Funding</li> <li>- \$5.2M FY08 Funding</li> <li>- \$3.0M FY09 Funding</li> </ul>	<p><b><u>Barriers</u></b></p> <ul style="list-style-type: none"> <li>A. Vehicles</li> <li>B. Storage</li> <li>C. Hydrogen Refueling Infrastructure</li> <li>D. Maintenance and Training Facilities</li> <li>E. Codes and Standards</li> </ul>

\* 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

DOE Barriers	Mercedes Teams' Project Goal												
<ul style="list-style-type: none"> <li>A. FCV Performance and Durability Data</li> <li>B. Hydrogen Storage</li> <li>C. H<sub>2</sub> Refueling Infrastructure Available Data</li> </ul>	<ul style="list-style-type: none"> <li>• Record, collect and report data from fuel cell vehicles and hydrogen fueling stations to validate DOE performance targets</li> </ul> <table border="1"> <thead> <tr> <th>Performance Measure</th> <th>2009</th> <th>2015</th> </tr> </thead> <tbody> <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> </tbody> </table>	Performance Measure	2009	2015	Fuel Cell Stack Durability	2000 hours	5000 hours	Vehicle Range	250+ miles	300+ miles	Hydrogen Cost at Station	\$3/gge	\$2-3/gge
Performance Measure	2009	2015											
Fuel Cell Stack Durability	2000 hours	5000 hours											
Vehicle Range	250+ miles	300+ miles											
Hydrogen Cost at Station	\$3/gge	\$2-3/gge											
<ul style="list-style-type: none"> <li>D. Maintenance and Training Facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate the safe installation and operation of service facilities</li> <li>• Continuously update safety manuals and provide training</li> </ul>												
<ul style="list-style-type: none"> <li>E. Codes and Standards</li> </ul>	<ul style="list-style-type: none"> <li>• Participate in various working groups to ensure continuous progress</li> </ul>												

# Objectives

## Program Objectives

- Collect data to evaluate the technology status of FCV and H<sub>2</sub> 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

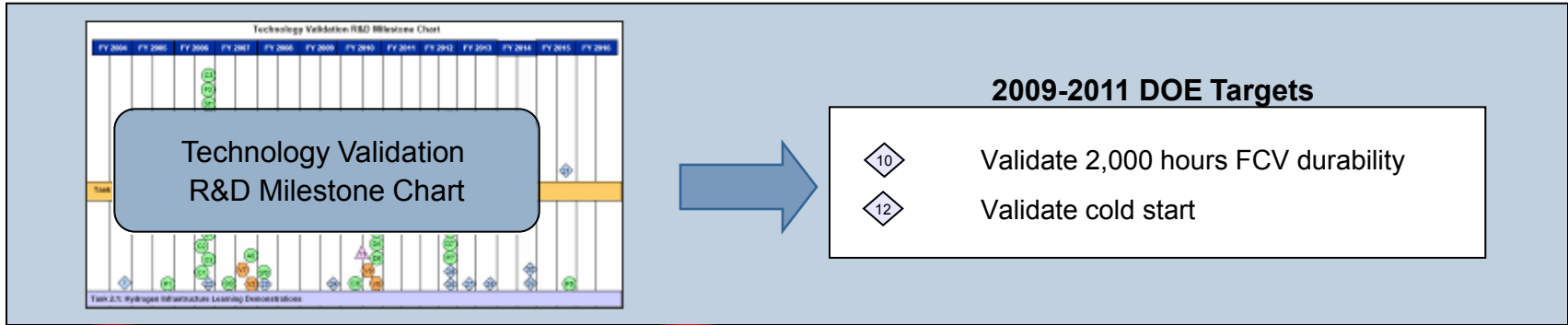


- Set up initial fueling network to support FCV fleet
- Establish maintenance and service facilities to support FCV operations
- Support codes and standards activities



# Approach: Milestones

## Alignment Between the Workplan/Milestones of DOE and Team



Team's Task	DOE Target	2009	2010	2011	% Complete
• Gen I					
– Gen I Operation	10	[Progress bar from 2009 to early 2010]			100%*
– 70MPa Vehicles Upgrade and Operation	10	[Progress bar from 2009 to mid-2010]			100%
• Gen II					
– Fuel Cell Stack System Durability Test & Analysis	10 12	[Progress bar from early 2009 to early 2010]			100%
– Gen II FDA Infrastructure Upgrade	10 12	[Progress bar from mid-2009 to mid-2010]			100%
– Internally Operate Vehicles	10 12	[Progress bar from 2009 to early 2010]			85%
– Externally Operate Vehicles	10 12	[Progress bar from early 2010 to early 2011]			0%

Official End Date

# Accomplishments and Progress

## Gen-I Operations

Designed for a 2-year operation  
Continuing to accumulate mileage for the 6<sup>th</sup> consecutive year  
Submitted over 100 DVDs of raw data to NREL



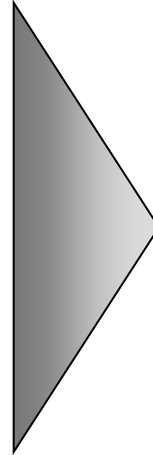
# Accomplishments and Progress

## Transition to Gen II Technology

### A Class F-Cell Generation 1



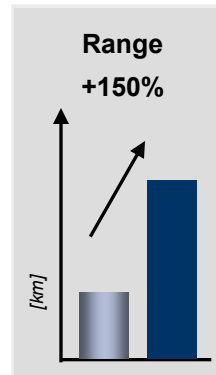
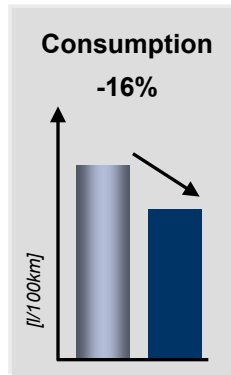
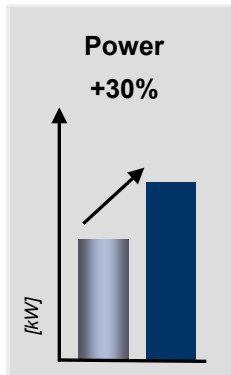
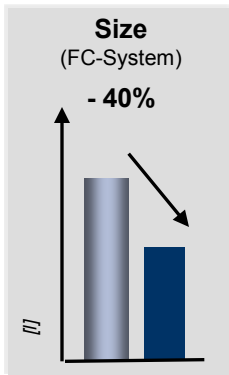
2004 – 2009  
Controlled fleet demonstration



### 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**



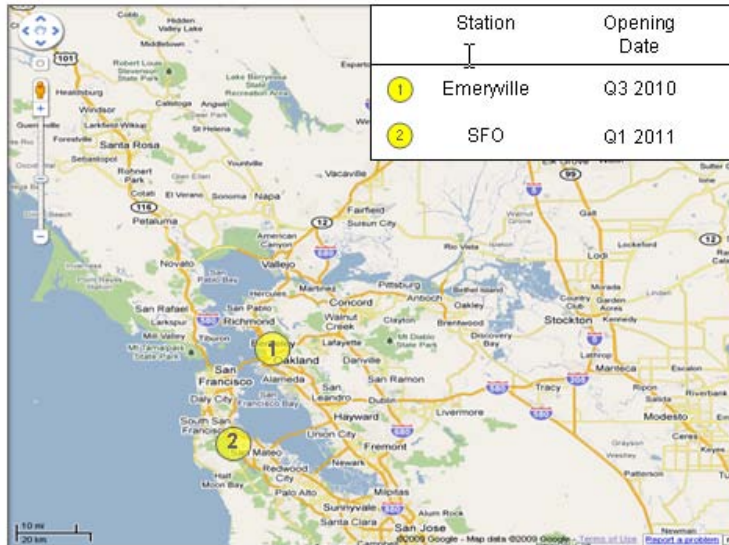
# Accomplishments and Progress

## Gen II Deployment

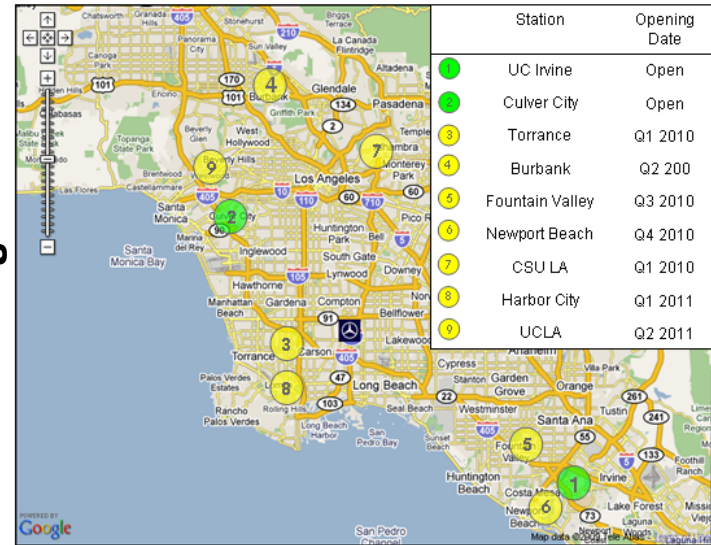
### MBRDNA is Preparing for Fueling Infrastructure

- **Supported ARB/CEC** by recommending station specifications, site locations, supplier qualification guidelines and providing OEM commitment letters
- **Worked with CaFCP** to develop action plan detailing strategy for deploying H<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> Vehicles
- Vehicle Battery Standards Committee



- **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



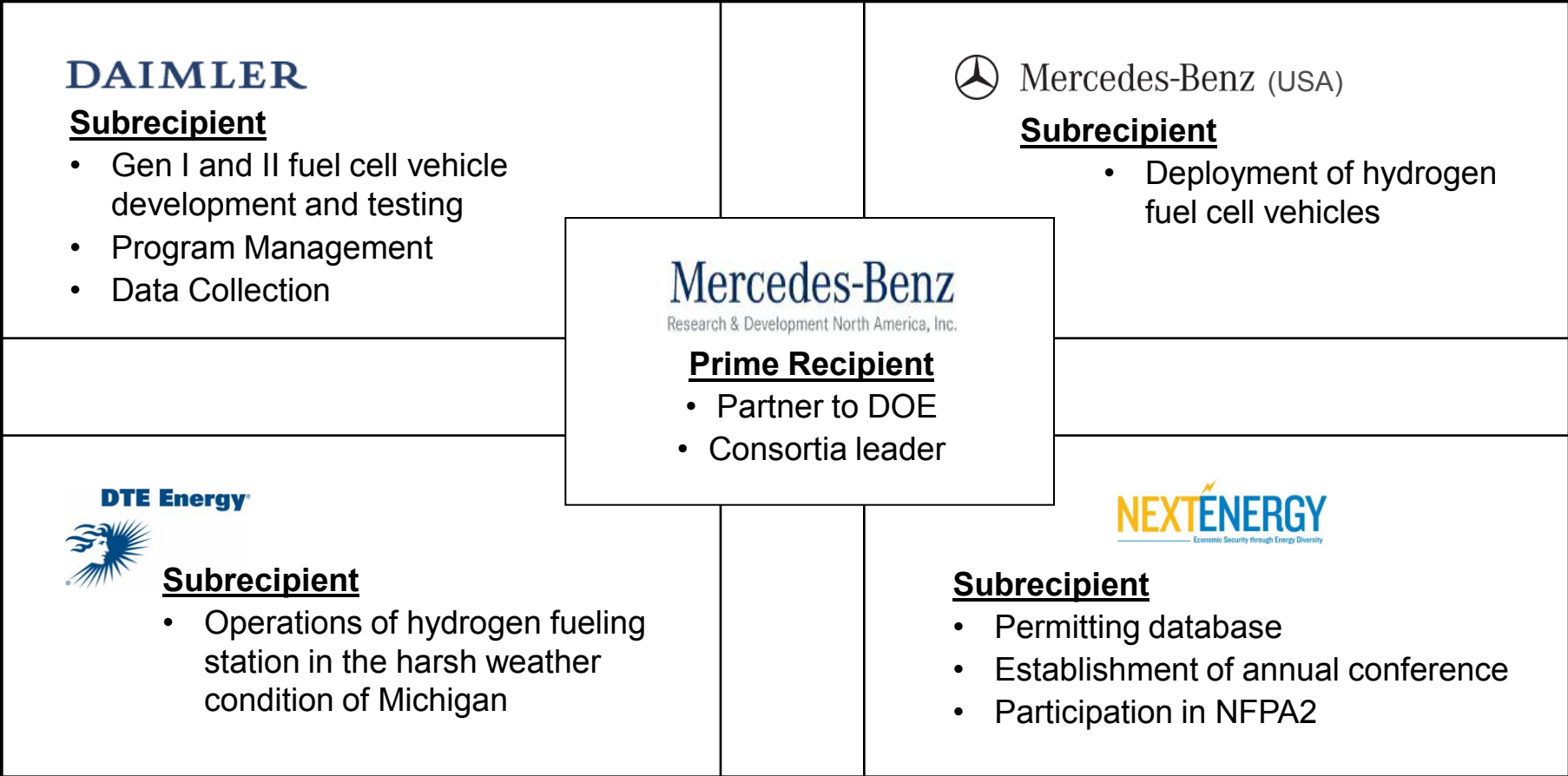
### LA Auto Show



### Washington Auto Show



# Collaboration



# 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

	<ul style="list-style-type: none"><li>• Improved equipment reliability and maintained operation of the DTE Station</li></ul>
	<ul style="list-style-type: none"><li>• Continued mileage accumulation of Gen I vehicles</li></ul>
	<ul style="list-style-type: none"><li>• Finalized internal operation and testing of Gen II pre-production vehicles</li></ul>
	<ul style="list-style-type: none"><li>• Preparing for Gen II deployment with external customers and dealerships</li></ul>
	<ul style="list-style-type: none"><li>• Participated in various working groups to ensure continuous progress with regards to Codes and Standards</li></ul>
<ul style="list-style-type: none"><li>• Continued data collection, analysis and reporting</li></ul>	