



HYDROGEN TO THE HIGHWAYS

Controlled Hydrogen Fleet and Infrastructure Demonstration and
Validation Project

DAIMLER



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Project #: TV1

Program Overview

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

<p><u>Timeline</u></p> <ul style="list-style-type: none"> - Project Start Date: 01/07/04 - Project End Date: 09/30/09 - Percent Complete: 85% 	<p><u>Partners</u></p> <ul style="list-style-type: none"> - Chrysler - Daimler - MBUSA 	<ul style="list-style-type: none"> - BP America - DTE Energy - NextEnergy
<p><u>Budget</u></p> <ul style="list-style-type: none"> - \$88.8M Total Project Funding <ul style="list-style-type: none"> - \$44.4M Federal Share - \$44.4M Industry Share - \$5.1M FY05 Funding - \$6.3M FY06 Funding - \$7.6M FY07 Funding 	<p><u>Barriers</u></p> <ul style="list-style-type: none"> A. Vehicles B. Storage C. Hydrogen Refueling Infrastructure D. Maintenance and Training Facilities E. Codes and Standards 	

Objectives

- The main focus of the on-going DOE Fleet Validation and Demonstration Project is to collect data and evaluate the technology status of:
 - Fuel cell powered vehicles (OEM's)
 - Hydrogen infrastructure (energy companies and suppliers)

Performance Measure	Units	2009 Performance Target	2015 Performance Target
Fuel Cell Stack Durability	Hours	2000	5000
Range	Miles	250	300
Hydrogen Cost at Station; On- or Off-site Production	\$/GGE (Gasoline Gallon Equivalent)	\$3.00	\$2.00-\$3.00

Milestones

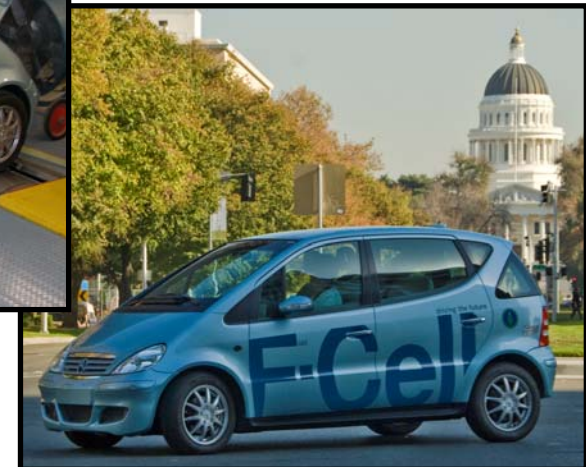
Month/Year	Milestone or Go/No-Go Decision
FUELING STATION MILESTONES	
Feb-2007	Fully-operational hydrogen station utilizing 35MPa fuel delivery system at the NextEnergy site in Detroit, Michigan
Nov-2008	Fully-operational hydrogen station with a reformer as well as a 35MPa and 70MPa fuel delivery system in Burbank, California
FUEL CELL VEHICLE MILESTONES	
Sep-2009	Customer operations of Gen-I vehicles (A-Class and Sprinter vans) in three different eco-systems (i.e. climate, terrain)
Dec-2008	Accelerated durability testing to simulate 2000-hour life cycle of the Gen-II fuel cell stack system
Dec-2009	Internal operations of three Gen-II vehicles in at least three different geographic areas to accumulate approximately 40,000 kilometers in mileage
Pending	Considering project extension through September 2010 to extend external operations of Gen-II fuel cell vehicles

Approach

- Operate thirty Gen-I vehicles under real world condition to monitor performance targets
 - Durability of fuel stack and system
 - Range of operation with compressed H₂
 - Cost of H₂ from various production methods
 - Performance degradation over life via dynamometer and on-road testing
- Maintain data acquisition system that telematically collect vehicle data
 - Submit collected data to NREL for monitoring progress
 - Match vehicles with DOE technology validation milestones
- Develop demonstration projects (e.g. Burbank, CA)
 - Validate hydrogen fueling technology
 - Provide hydrogen to the Chrysler Team fuel cell vehicles
- Provide data from Gen-II vehicles under same operations conditions as Gen-I vehicles
 - Compare technology maturity over program duration
- Align the Chrysler Team activities with the education goals of the DOE
 - Raise public awareness of hydrogen technology
 - Implement safety process (hydrogen station HAZOP/HAZID's)
 - Develop Incident Management Plans

Accomplishments and Progress Gen-I Customer Operations

- Continued to accumulate miles by external customers who provide a full range of driving patterns in a variety of terrain, traffic and climatic conditions
- Finalized all performance vehicle testing including dynamometer, acceleration, gradeability and 'power at' 40°C
- Doubled accumulated mileage from 2006 to 2007 as customers gained driving and fueling experience
- Encountered no major safety issues
- Submitted over 69 DVD's of raw data to NREL



Accomplishments and Progress

Gen-I Customer Operations (cont'd)



- Successfully completed the 2-year commitment of Gen-I operations with thirty fuel cell vehicles
- Operation of Gen-I vehicles will operate until the end of the DOE Project
 - Approximately twenty fuel cell customer contracts will be extended for further Gen-I operations within DOE projects
 - One will be operated at NREL facility for approximately six months
 - Remaining vehicles will be operated outside the DOE project
 - The Chrysler Team will continue to provide NREL data to all A-Class fuel cell vehicles until end-of-project

Accomplishments and Progress

Gen-I Technical Accomplishments

- Upgraded the fuel tank system from 35MPa to 70MPa to improve vehicle range by 60%
- Optimized software algorithm to improve fuel economy by 10%



Accomplishments and Progress

Gen-II Technical Accomplishments



- Internally operated Gen-II vehicles in cold weather conditions
- Completed first phase of durability testing on Gen-II fuel cell stack system
- Modified FDA infrastructure to collect and process data from Gen-II vehicles

Specifications	B-Class Fuel Cell
Vehicle Type	Mercedes Benz B-Class (T245)
Body Style	4-Door Sport Tourer
Seating	4-Seats
Engine	Electric Motor
Net Power	136hp
Net Torque	215 lb-ft
Transmission	Single Speed
Fuel Cell System	PEM 108hp
Stability Control	Electronic Stability Program (ESP)
Fuel	Compressed Hydrogen (70MPa)

Accomplishments and Progress

Codes and Standards

Significant progress was made with regards to Codes and Standards

- Published Hydrogen Safety Best Practices Manual
- Hydrogen Fuel Quality
 - Published SAE TIR J2719-V2, Hydrogen Quality Guideline for Fuel Cell Vehicles
 - Aligned California SB-76 hydrogen quality requirement with SAE
- CSA America
 - HGV 4.X standards for hydrogen fueling devices and hardware in draft form
 - HPRD1 (standard for hydrogen pressure relief devices) draft completed, Public comment completed, work group responding to public comments
- ASTM – 70MPa Fueling Device Completed testing scheduled 2nd Quarter 2008
- ICC – International Fire Code now includes fueling pad requirements that eliminate the need for cable grounding of vehicles
- Michigan Hydrogen Storage and Dispensing Rules – Successfully completed public comment – expected to be promulgated by 4th quarter 2008

Accomplishments and Progress

Safety

- Updated and distributed the DOE Project Fleet Vehicle Incident Management Plan to the Incident Management Team leaders and commanders in the first quarter of 2007
- Conducted a joint table top exercise using the updated DOE incident management plan that included personnel from the Michigan and California sites second quarter 2007
- Conducted emergency responder training at NextEnergy which was attended by Wayne State Security, Detroit Police and Detroit Fire Fighter personnel during the second quarter of 2007
- Risk assessment and HAZOP activities for the 700 bar Burbank, California station began the third quarter of 2007 and are on-going
- Successfully inspected hydrogen vehicle storage tanks as required by TUV
- Commissioned the NextEnergy facility during the first quarter of 2007

Accomplishments and Progress

Outreach and Media Events



Shows & Conferences: 5
Public Outreach Events: 22



Customer Outreach:
Events w/ Customer: 4
Events by Customer: 60

Media Outreach Events: 10



Accomplishments and Progress Outreach

- The DOE continues to play a more prominent role in outreach efforts:
 - DOE flyers distributed at outreach events
 - Display banner produced describing the DOE project and F-Cell customers
 - Joint flyer created describing the DOE project and Daimler and Chrysler's role in it

Accomplishments and Progress Infrastructure



- **Northern California – PG&E Mobile**

- Technical Data: hydrogen produced by remote SMR, storage capacity of 150 kg, 10-15 kg/day
- Accomplishments: installed and commissioned at ideal downtown location within 2 months after PG&E reached agreement with the Chrysler Team, all legal agreements were finalized on time (PG&E, BAAQMD, APCI)

- **Southern California – LAX (non-DOE)**

- Technical Data: hydrogen produced by on-site electrolysis, capacity of about 25 kg/day
- Accomplishments: in operations since early 2006, serving a number of Daimler/Chrysler vehicles on a regular basis, and other OEM's (Ford, Toyota, Honda, etc.) vehicles



Accomplishments and Progress Infrastructure



- **Michigan – DTE**

- Technical Data: hydrogen produced by electrolysis, storage capacity of 140 kg, capable of dispensing 15 kg/day
- Accomplishments: operational since 2004, only one of a handful of stations in cold weather areas

- **Michigan – Next Energy**

- Technical Data: hydrogen produced by remote SMR, usable capacity of 50 kg, 10-15 kg/day
- Accomplishments: safety processes coordinated with NEC, successful community outreach, inclusion of DCC in all safety assessment processes



Future Work Plans for 2009

- Fuel Cell Vehicles Gen I and Gen II
 - Maintain smooth operation of the fuel cell vehicles with on-going service, maintenance and customer support
 - Further operation of Gen I F-Cell customer fleet and accumulation of mileage until end of program
 - Lifetime test of Gen II fuel cell system on test bench to simulate real life conditions
 - Internal operation of Gen-II vehicle under different climatic conditions
- Hydrogen Infrastructure
 - Continue operation of the NextEnergy, LAX and the PG&E mobile unit end of contract
 - Complete site development of the City of Burbank station with projected completion 4th quarter 2008
- Safety and Data Reporting
 - Maintain project safety through continued inter-team communication, vehicle and infrastructure training, employee and customer education, "tabletop" crisis management drills
 - Participate in safety and risk assessment activities with the construction of new 70 MPa Burbank station
 - Maintain the high quality of technical vehicle and infrastructure data reporting to NREL/DOE
- Outreach / Media Events
 - Pursue novel approaches toward outreach and media events to raise public knowledge of hydrogen technology and demonstration projects

Conclusion

- Continued to accumulate miles over a full range of driving patterns and in a variety of terrain, traffic and climatic conditions with F-Cells (A-Class and Sprinter vans) that were operated and fueled by external customers
- Finalized all performance vehicle testing including dynamometer, acceleration, gradeability and 'power at' hot temperatures
- Optimized Gen-I vehicles with new software algorithm and verified 10% improvement in fuel economy
- Increased driving range by 60% by upgrading the fuel tank system to 70MPa
- Successfully drove in cold weather conditions with Gen-II vehicles
- Planning to commission City of Burbank hydrogen fueling station in November 2008
- Conducted over 100 media and outreach events to raise public knowledge of hydrogen technology and demonstration project.
- Standards being developed by SAE, CSA and ASTM were significantly advanced
- Amended ICC, International Fire Code to include fueling pad resistance requirement
- Published hydrogen best practices manual