HYDROGEN TO THE HIGHWAYS
Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Ronald Grasman
June 10, 2008

Project #: TV1

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Program Overview

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

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Partners</th>
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</thead>
<tbody>
<tr>
<td>Project Start Date: 01/07/04</td>
<td>Chrysler</td>
</tr>
<tr>
<td>Project End Date: 09/30/09</td>
<td>Daimler</td>
</tr>
<tr>
<td>Percent Complete: 85%</td>
<td>MBUSA</td>
</tr>
<tr>
<td></td>
<td>BP America</td>
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<tr>
<td></td>
<td>DTE Energy</td>
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<td></td>
<td>NextEnergy</td>
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<table>
<thead>
<tr>
<th>Budget</th>
<th>Barriers</th>
</tr>
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<tbody>
<tr>
<td>$88.8M Total Project Funding</td>
<td>A. Vehicles</td>
</tr>
<tr>
<td>$44.4M Federal Share</td>
<td>B. Storage</td>
</tr>
<tr>
<td>$44.4M Industry Share</td>
<td>C. Hydrogen Refueling Infrastructure</td>
</tr>
<tr>
<td>$5.1M FY05 Funding</td>
<td>D. Maintenance and Training Facilities</td>
</tr>
<tr>
<td>$6.3M FY06 Funding</td>
<td>E. Codes and Standards</td>
</tr>
<tr>
<td>$7.6M FY07 Funding</td>
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# 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)

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Units</th>
<th>2009 Performance Target</th>
<th>2015 Performance Target</th>
</tr>
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<tbody>
<tr>
<td>Fuel Cell Stack Durability</td>
<td>Hours</td>
<td>2000</td>
<td>5000</td>
</tr>
<tr>
<td>Range</td>
<td>Miles</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>Hydrogen Cost at Station; On- or Off-site Production</td>
<td>$/GGE (Gasoline Gallon Equivalent)</td>
<td>$3.00</td>
<td>$2.00-$3.00</td>
</tr>
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</table>
## Milestones

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

<table>
<thead>
<tr>
<th>Specifications</th>
<th>B-Class Fuel Cell</th>
</tr>
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<tbody>
<tr>
<td>Vehicle Type</td>
<td>Mercedes Benz B-Class (T245)</td>
</tr>
<tr>
<td>Body Style</td>
<td>4-Door Sport Tourer</td>
</tr>
<tr>
<td>Seating</td>
<td>4-Seats</td>
</tr>
<tr>
<td>Engine</td>
<td>Electric Motor</td>
</tr>
<tr>
<td>Net Power</td>
<td>136hp</td>
</tr>
<tr>
<td>Net Torque</td>
<td>215 lb-ft</td>
</tr>
<tr>
<td>Transmission</td>
<td>Single Speed</td>
</tr>
<tr>
<td>Fuel Cell System</td>
<td>PEM 108hp</td>
</tr>
<tr>
<td>Stability Control</td>
<td>Electronic Stability Program (ESP)</td>
</tr>
<tr>
<td>Fuel</td>
<td>Compressed Hydrogen (70MPa)</td>
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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
Accomplishments and Progress
Infrastructure

- Southern California – Burbank
  - Technical Data: on-site SMR hydrogen production; 240 kg, and up to 108 kg/day storage capacity
  - Hydrogen Delivery: 350 and 700 bar
  - Site utilization: planned as an open site for all OEMs, the purchase of a fuel cell bus Burbank will use 8 – 10kg/day of hydrogen
  - Status: Under development
    • Completed site selection
    • Ordered long lead-time equipment
    • Completed property survey and station layout approved
    • Began HAZOP, HAZID, and project safety reviews
    • Began CEQA and NEPA processes
    • Addressing local permitting requirements
    • Completed legal agreement with City of Burbank
    • Projected stated up date: November 1st
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