

## VIII.A.2 Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

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*Subcontractor:*  
*BP America Inc., Naperville, IL*

*Start Date: November 17, 2004*  
*Projected End Date: June 2009*

### Objectives

#### DOE:

- By 2009, validate hydrogen vehicles that have greater than 250-mile range, 2000-hour fuel cell durability and hydrogen infrastructure that results in a hydrogen production cost of less than \$3.00/gge (untaxed), and safe and convenient refueling by trained drivers

#### Ford:

- Gain vehicle operational data in differing climate conditions, to direct and augment future design efforts
- Provide input to the industry-government efforts to define a future hydrogen economy

#### BP:

- Establish an initial hydrogen infrastructure network to fuel small fleets of fuel cell vehicles (FCVs) across a metropolitan area
- Develop retail-compatible hydrogen refueling systems
- Evaluate emerging hydrogen technologies that have the ability to meet DOE cost and performance targets
- Explore cost and commercial feasibility of renewable-based hydrogen generation

### Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- A. Vehicles
- B. Storage

- C. Hydrogen Refueling Infrastructure
- D. Maintenance and Training Facilities
- E. Codes & Standards

### **Contribution to Achievement of DOE Technology Validation Milestones**

This project will contribute to achievement of the following DOE technology validation milestones from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

#### ***Milestone 2: Demonstrate FCVs that achieve 50% higher fuel economy than gasoline vehicles (3Q 2005)***

*Progress to date:* Dynamometer testing, the most accurate way to do comparative fuel economy assessments, has been completed on the Phase I Ford Focus FCV. Data indicates City drive cycle fuel consumption of 48 mi/kg H<sub>2</sub> (49 MPG gasoline equivalent) and Highway fuel consumption of 53 mi/kg H<sub>2</sub> (54 MPG gasoline equivalent). The comparable gasoline internal combustion engine version of the Focus model (LX Base 4 Door, automatic transmission) is published in the 2004 Environmental Protection Agency Fuel Economy Guide as 26 MPG City and 32 MPG Highway. This represents an 88% improvement in the City cycle and a 68% improvement in the Highway cycle. This finding accomplishes the target set in this program milestone.

#### ***Milestone 5: Validate fuel cell demonstration vehicle range of ~200 miles and durability of ~1,000 hours (year-end, 2006)***

*Progress to date:* The Focus FCV carries 4 kg of hydrogen at 350 bar (5000 psi). Using the demonstrated highway fuel economy, cited above, of 50 mi/gge, the calculated range of 200 miles has been demonstrated. Mileage data from placements in fleets will be accumulated throughout the project and will recognize the variability associated with drive cycle and operator habits.

Durability of 1000 hours has been demonstrated on first engineering test vehicles in accelerated on-road durability testing. Fleet use data will be accumulated for reporting by year-end, 2006. It is unlikely that any of the 18 fleet vehicles will have accumulated 1000 hours of use by that target date. Assuming an average drive speed of 22.5 mph, these vehicles are projected to have accumulated between 400 and 600 hours of use by the end of 2006.

#### ***Milestone 6: Validate vehicle refueling time of 5 minutes or less (year-end, 2006)***

*Progress to date:* On the Focus model, 4 kg of hydrogen are carried at 5000 psi. Fill times of 5 minutes or less have been demonstrated for 'full' fills using vehicle-to-station communication (non-communication 'full' fills take more than 5 minutes). All planned permanent station installations with communications are expected to deliver a full fill in less than 5 minutes. Data will be generated, by the fleet users, during the deployment period.

#### ***Milestone 8: Demonstrate (on a vehicle) 2.0 kWh/kg and 1.2 kWh/L compressed gas tank (2Q 2008)***

*Progress to date:* Ford presented a Technology Demonstrator Vehicle plan on May 3, 2005, that provides a progressive design-level approach to demonstrating improved range and performance. This plan has been reviewed and approved by DOE.

In order to properly compare accomplishments to this 2008 milestone, it will be necessary to work with DOE to define an operating condition or cycle under which this assessment is to be completed.

#### ***Milestone 9: Validate FCVs with 250-mile range, 2000-hour fuel cell durability, and a hydrogen cost of \$3.00/gge (based on volume production) (3Q 2009)***

*Progress to date:* Ford presented a Technology Demonstrator Vehicle plan on May 3, 2005, that provides a progressive design-level approach to demonstrating improved range and performance. This plan has been reviewed and approved by DOE.

**Milestone 11: Validate cost of producing hydrogen in quantity of \$3.00/gge untaxed (2Q 2008)**

*Progress to date:* BP has assessed, through meetings with suppliers, several technologies to understand their current status and potential of meeting the \$3.00/gge target untaxed by 2008. The following is a list of a few of the technologies reviewed to date: H2Gen 2000, Idatech combined heat and power technology, Air Products Harvester, Proton Energy high pressure proton exchange membrane system with electrochemical compression, and General Electric autothermal reformer. This work is ongoing.

**Milestone 12: Five fueling stations and two vehicle maintenance facilities constructed using advanced sensor systems and operating procedures (year-end, 2006)**

*Progress to date:*

- Vehicle Maintenance Facilities:
  - Ford has completed work on two service facilities for project vehicles in Dearborn, Michigan, and Sacramento, California. Preparation of a third service facility is underway in Orlando, Florida. The existing facilities utilize state-of-the-art hydrogen sensors, have service procedures established for hydrogen-fueled vehicles, and have operating procedures for personnel working in a hydrogen vehicle service facility.
- Fueling Stations:
  - In Michigan, the City of Taylor station is on target for station opening by the end of September, 2005. Planning and zoning permit approval has been given by the City of Taylor. Building permit documentation is being prepared for submission by July 14, 2005.
  - In California, the Sacramento station is on target for station opening by 4Q 2005. The airport supervisory board has approved planning and zoning. Building permit documentation was submitted during the week of June 20, 2005. Safety reviews are underway while the building permits are being reviewed by the local permit authorities.
  - In Florida, site selection for the Orlando area station is being finalized. Development of site-specific engineering is ongoing. Zoning and permit submittal is expected during August, 2005.

**Milestone 14: Validate \$2.50/gge hydrogen cost (1Q 2009)**









*Progress to date:* Please see response to Milestone 11 above.

**Approach****Ford Vehicle Demonstration Approach:**

Two vehicle demonstration components (Figure 1)

**Vehicle Component 1: developed technology installed in contemporary vehicles for real-world use**

- Ford Focus 4 Door
- Weight: 1600 kg (3520 lbs)
- Fuel Cell: Ballard Mark 902 fuel cell stack
- Power: 67 kW (87hp)
- Power train: Integrated--combines inverter module with AC electric motor transaxle
- Hybridized – 216 volt Battery Pack
- Regenerative Braking System
- Range: 260 - 320 km (200 miles)

Program Elements	Component 1	Component 2
Real World Data		
Maintenance & Training		
Hydrogen Storage & Interface		
Durability		
Economy		
Weight		
Cost		

**Figure 1.** Vehicle Demonstration Components Summary

- Max speed: 128+ kph (80+ mph)
- Fuel: 5000 psi (350 bar) Compressed Gaseous Hydrogen
- Emissions: Zero
- Component 1 Deliverables:
  - Real-World Data
  - Maintenance & Training
  - Hydrogen Storage & Interface

Vehicle Component 2: an in-house controlled demonstration of extended range, durability and operating temperature

- Component 2 Deliverables:
  - Hydrogen Storage & Interface
  - Durability
  - Economy
  - Cold Start
  - Weight
  - Cost

Automated data collection methodologies for effective data analysis

BP Infrastructure Approach:

Two-phase approach (Figure 2)

- Phase I: Test Infrastructure Deployment
  - Install H<sub>2</sub> delivered stations
  - Include electronic data collection for select sites
- Phase II: Meet Cost Targets
  - Install onsite H<sub>2</sub> production and/or 700 bar fueling at select sites

Station locations

- Orlando, Florida (1)
- Sacramento, California (up to 4)
- Taylor, Michigan (up to 2)

Location	Phase 1 Delivered H <sub>2</sub>	Phase 2 Electrolysis	Phase 2 SMR	Phase 2 700 Bar
<b>Orlando</b>				
<b>Sacramento</b>				
Station S1				
Station S2				
SMUD				
<b>Michigan</b>				
Taylor				
Station M2				

**Figure 2.** Infrastructure Demonstration Summary