

VIII.12 Texas Hydrogen Highway - Fuel Cell Hybrid Bus and Fueling Infrastructure Technology Showcase*

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Subcontractors:

- University of Texas (UT) at Austin, Center for Electromechanics (UT-CEM), Austin, TX
- Gas Technology Institute (GTI), Sugar Land, TX, and Des Plaines, IL
- Center for Transportation and the Environment (CTE), Atlanta, GA
- Houston Advanced Research Center (HARC), The Woodlands, TX

Project Start Date: September 1, 2008

Project End Date: September 1, 2009

*Congressionally directed project

- (A) Lack of Fuel Cell Vehicle Performance and Durability Data
- (B) Hydrogen Storage
- (C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
- (D) Maintenance and Training Facilities
- (E) Codes and Standards

Contribution to Achievement of DOE Technology Validation Milestones

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

- **Milestone 11:** Decision to proceed with Phase 2 of the learning demonstration (2Q, 2010)
- **Milestone 14:** Validate achievement of a refueling time of 3 minutes or less for 5 kg of hydrogen at 5,000 psi using advanced communication technology. (2Q, 2012)
- **Milestone 24:** Validate a hydrogen cost of \$3.00/gge (based on volume production). (4Q, 2009)
- **Milestone 25:** Validate refueling site compression technology provided by the delivery team (4Q, 2012)
- **Milestone 26:** Validate refueling site stationary storage technology provided by the delivery team. (4Q, 2012)
- **Milestone 32:** Validate the ability to produce 5,000 psi hydrogen from natural gas for \$2.50/gge, untaxed and with large equipment production volumes (e.g. 500 units/year) for 1,000 hours. (3Q, 2011)



Objectives

- To provide public outreach and education by showcasing the operation of a 22-foot fuel cell hybrid shuttle bus and Texas's first hydrogen fueling infrastructure.
- To showcase operation of zero-emissions vehicle for potential transit applications.
- To advance commercialization of hydrogen-powered transit buses and supporting infrastructure.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section 3.6 of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Approach

This project was originally developed to show that a skid-mounted, fully-integrated, factory-built and tested hydrogen fueling station could help simplify and lower the cost of fueling infrastructure for fuel cell vehicles. The project approach was to design, engineer, build, and test the integrated fueling station at the "factory", then install it at a site that offered educational and technical resources, and provided an opportunity to showcase both the fueling station and advanced hydrogen



FIGURE 1. Fuel Cell Plug-in Hybrid Shuttle Bus, Austin, Texas

vehicles. Through five years of project development, in coordination with various public and private sector sponsors, the site selected for a fuel cell bus and fueling station was Austin, Texas. Project participants are using these hydrogen technology assets in the current project for outreach and education to Texas target audiences on hydrogen and fuel cell application. This illustrates the potential for commercialization of hydrogen-powered transit buses, fueling infrastructure and related technologies. The project also showcases modeling techniques that can be used to design hydrogen vehicle and fueling solutions for other locations and applications.

The bus (Figure 1) and station (Figure 2) are housed at the Pickle Research Center, University of Texas at Austin located in north Austin. In addition to the fueling station, the project showcases a plug-in hybrid electric fuel cell transit bus that can operate in a real-world commercial application. It serves to validate the potential for transit agencies (and others) to operate similar vehicles thereby reducing emissions and the nation's dependency on foreign sources of energy for transportation fuels.

Accomplishments

- Preparation for commissioning fuel station in fall 2009:
 - The project team has expended considerable effort to prepare for start-up of the station in Austin.
 - Performance and safety checks have been conducted on the system during initial start-up and resulting in the following issues:
 - Pressure fluctuations in the system during automated start-up has led to on-site adjustment of the system controls.
 - Communications network link problems at the University of Texas led to a station



FIGURE 2. Hydrogen Fuel Station, Austin, Texas

computer system crash and subsequent need to reprogram the hydrogen station automated controls.

- The hydrogen station storage and dispensing system have been purged with hydrogen and test “fills” have been accomplished from the station to the fuel cell bus.
- Held station showcase events for limited, invited visitors which included bus rides and station tours.
- Planning for three to four Texas showcase events in fall 2009 and early 2010 in coordination with various target groups.
- Conducted briefing for Texas legislative staff on Texas Hydrogen Highway project.
- Collaborated on fuel cell bus and electrified transportation modeling:
 - UT-CEM collaborated with the UT Department of Mechanical Engineering on advanced energy storage and modeling techniques of electrified vehicles, including Powertrain System Analysis Toolkit (PSAT) model development of the Ebus and studies of ultracapacitor-assisted batteries.
 - UT-CEM assisted Georgia Tech on battery modeling method in PSAT for advanced, electrified transportation.
- Prepared two papers for publication (Institute of Electrical and Electronics Engineers [IEEE] and the Journal of Power Sources):
 - Paper accepted for the IEEE Vehicle Power and Propulsion Conference 2009 conference on PSAT modeling and evaluation of the Ebus.
 - A paper on the project was presented to the Texas Chapter of the American Society of Civil Engineers in Fall, 2008.
 - Paper under preparation in collaboration with Georgia Tech, for submission to the Journal of

Power Sources on advanced battery modeling for electric and hybrid electric vehicles.

Future Directions

- Finalize safety plan for submittal to DOE.
 - Continue preparation of fuel station for commissioning (late September 2009 to mid-October 2009).
 - Hold commissioning trials (3 months).
 - Conduct bus training for transit personnel.
 - Continue monitoring and evaluation of station and bus operations.
- Complete the final PSAT modeling of transit route to verify vehicle suitability for deployment.
 - Plan and conduct outreach and education events:
 - Station commissioning event.
 - Demonstration event in coordination with Austin, Texas event.
 - Review and selection of other outreach opportunities in Texas.
 - On-site demonstrations and education.