VII.0 Technology Validation Program Overview

INTRODUCTION

The Technology Validation program demonstrates, tests, and validates hydrogen and fuel cell technologies and uses the results to provide feedback to the Fuel Cell Technologies Office's research and development (R&D) activities.

Continuing efforts include the real-world evaluation and monitoring of fuel cells in stationary power, backup power, buses, and material handling equipment applications. In Fiscal Year (FY) 2013, the program awarded new projects in which data are collected to track technological progress in the performance, durability, and reliability of refueling stations, advanced refueling components, and fuel cell electric vehicles (FCEVs). The program also solicited proposals on the topics of fuel cell hybrid electric medium-duty trucks, rooftop backup power, and advanced hydrogen refueling components.

GOAL

Validate the state of the art of fuel cell systems in transportation and stationary applications as well as hydrogen production, delivery, and storage systems. Assess technology status and progress to determine when technologies should be moved to the market transformation phase.

OBJECTIVES[1]

- By 2017, validate commercial stationary fuel cells (100 kW to 3 MW) against 2015 system targets (50,000 h, 45% electrical efficiency).
- By 2017, validate durability of auxiliary power units against 2015 fuel cell system target (15,000 h, 35% electrical efficiency).
- By 2019, validate hydrogen FCEVs with greater than 300-mile range and 5,000 hours fuel cell durability.
- By 2019, validate a hydrogen fueling station capable of producing and dispensing 200 kg H_2/day (at 5 kg/3 min; 700 bar) to cars and/or buses.
- By 2020, validate large-scale systems for grid energy storage that integrate renewable hydrogen generation and storage with fuel cell power generation—operating for more than 10,000 hours, with a round-trip efficiency of 40%.

FY 2013 TECHNOLOGY STATUS

FCEV Evaluation

The National Renewable Energy Laboratory (NREL) is validating light-duty FCEV performance and durability through analysis of dynamometer and real-world vehicle performance data. Multiple real-world sites and customers are included in this demonstration project. Data (operation, maintenance, and safety) are collected onsite by project partners for the fuel cell system(s) and infrastructure. NREL receives the data quarterly and stores, processes, and analyzes the data. An internal analysis of all available data is completed quarterly and a set of technical composite data products (representing aggregated data) is published every six months. The prior light-duty FCEV validation effort—the National Learning Demo—concluded in FY 2012. Much of the activity in FY 2013 focused on getting projects started—preparing data templates and security procedures, interacting with project partners, and prioritization of data to be collected.

Fuel Cell Bus Evaluation

NREL has been collecting and analyzing data from fuel cell buses from three transit agencies; AC Transit (Oakland, CA), CTTRANSIT (Hartford, CT), and SunLine (Thousand Palms, CA). The objective of this effort is to determine the status of fuel cell systems for buses and to aid other fleets with the implementation of next-generation

[1] Note: Targets and milestones were recently revised; therefore, individual project progress reports may reference prior targets.

fuel cell buses. New fuel cell bus designs demonstrated improved fuel economy over diesel and compressed natural gas buses. NREL reported on fuel cell power plants that had accumulated fuel cell stack operating hours in excess of 10,000. A measure of reliability—the miles between road call—has room for improvement, but the highest percentage of road calls realized was not associated with the fuel cell system itself. The majority of road calls were due to bus-related issues such as problems with doors, air conditioning, and windshield wipers, while fuel cell-related issues made-up approximately 22% of the road calls.

Hydrogen Component Validation

The main objectives of this project include the independent validation and systems integration of commercial and advanced prototype hydrogen production, compression, dispensing, and fuel cell technologies. In FY 2013, the project focused on performing accelerated life testing of both diaphragm and piston hydrogen compressors. NREL has formed agreements with different manufacturers and will track and evaluate performance of multiple piston-type gas boosters from these manufacturers under an accelerated duty cycle. The project work scope also includes quantifying, under near-real-world operating conditions, operation and maintenance, durability, and reliability of renewable electrolysis systems as they are applied to energy storage and vehicle refueling. NREL will monitor system faults and maintenance, and also analyze the performance of renewable electrolysis.

Hydrogen Station Analysis

The objective of this project is to collect data from state-of-the-art hydrogen fueling facilities, such as those operated by the California Air Resources Board (CARB), Proton OnSite, and GTI, providing valuable feedback on sensitive data related to hydrogen infrastructure for industry and the Office.

- CARB's Newport Beach, California station features onsite generation of hydrogen through a small-scale natural gas steam methane reformer, demonstrating the footprint and equipment arrangement of such a retail facility. Evaluation results will be used to make recommendations on how to optimize discrete station components.
- Proton OnSite's fully containerized station deployments (located in Wallingford, Connecticut and Braintree, Massachusetts) demonstrate advanced technologies, including 1) higher-pressure hydrogen generation with electrochemical compression, 2) higher-efficiency generation with lower resistance electrolyte and advanced catalyst, 3) higher addressable capacity composite storage, and 4) advanced packaging concepts for reduced footprint. This project goes beyond data collection; it aims to validate the first full-scale demonstration of a higher-pressure water electrolyzer.
- GTI has partnered with Linde to demonstrate deployments in five California locations, where new 900 bar ionic compression technology is utilized.

Sustainable Hydrogen Fueling Station

The California State University, Los Angeles (CSULA) is operating a hydrogen station based on electrolysis from renewable electricity on their campus to test, collect data, and validate hydrogen refueling architecture and individual components in a real-world operating environment. Performance evaluations data are being provided to NREL. The project also serves educational purposes, as it provides a living lab environment for engineering and technology students.

Stationary Fuel Cell Evaluation

This project informs the Office, the public, fuel cell manufacturers, and other stakeholders about the performance of stationary fuel cell systems operating under real-world conditions, while reporting on the baseline, progress, and technical challenges. Operation, maintenance, and safety data are collected and analyzed quarterly by NREL for stationary fuel cell systems. In FY 2013, installation data from California's Self Generation Incentive Program were collected from five companies, for 249 units (totaling 97 MW). Natural gas was seen as the most popular fuel choice, but renewable fuels (digester gas, landfill gas, etc.) accounted for 43% of capacity. Average installed cost was found to be $10,223/kW.

Early Markets Analysis

Early market application of fuel cell technologies includes validating material handling equipment (MHE) and backup power fuel cell performance through analysis and reporting of real-world operation and value proposition metrics. MHE were found to be operating with average availability of about 98% at eight end-user facilities, with most systems operating at least six hours a day. The American Recovery and Reinvestment Act had an objective to deploy approximately 1,000 fuel cell systems in key early markets, and this was met within two years from the first deployment. Early market end users are operating 1,326 fuel cell units at 407 sites in 22 states. By the first quarter of FY 2013, 504 MHE fuel cell units were deployed at eight facilities, and 820 backup power fuel cell units were operating at 398 sites. Among components related to the infrastructure, hydrogen compressors contributed the highest number of maintenance events and maintenance labor hours.

Hydrogen Recycling System Evaluation

This project involves the validation of a system of reclamation and recycling of hydrogen that is wasted (flared or vented) in various industrial operations. The main project objective is to demonstrate product readiness and to quantify the benefits and customer value proposition of H2Pump's Hydrogen Recycling System (HRS-100™) by installing and analyzing the operation of multiple prototype 100 kg hydrogen per day systems in real-world customer locations. Modified fuel cell technology is utilized, providing up to 90% recovery of hydrogen. All of the data acquired by the systems will be made available for NREL for analysis, including factors such as stack voltage and current, system power, and hydrogen flow rate, as well as maintenance and repair logs.

FY 2013 KEY ACCOMPLISHMENTS

Fuel Cell Vehicles and Hydrogen Infrastructure: Awarded $5.3M for five years to demonstrate advanced light-duty FCEVs, where data will be collected from approximately 70 vehicles. To develop hydrogen fueling infrastructure for FCEVs, $2.4M was awarded for evaluating hydrogen stations (in CA, MA, and CT) and advanced refueling components.

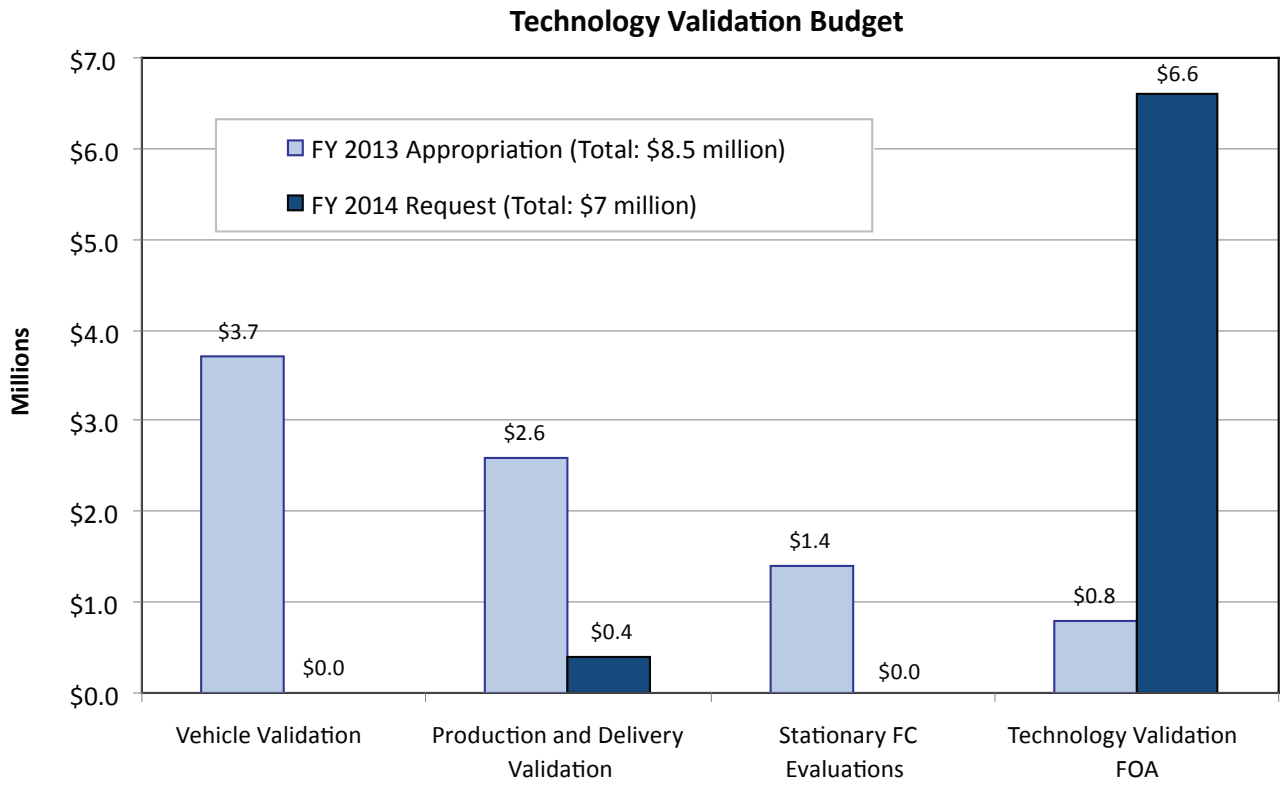
Fuel Cell Buses: New fuel cell bus designs were demonstrated to have approximately 1.9 times the fuel economy of diesel buses, and about 2.3 times the fuel economy of compressed natural gas buses. As of May 2013, the highest-hour fuel cell power plant had surpassed 13,000 hours, while several others accumulated significant hours, such as 10,686, 8,770, and 5,300 hours.

Early Markets: The number of fuel cell backup power systems deployed increased more than 18-fold from the beginning to the end of The American Recovery and Reinvestment Act, with start reliability reaching as high as 99.6%. One unit successfully demonstrated a continuous run time of 65 hours during the data collection period, while the average run time was 39 minutes. MHE fuel cell systems accumulated nearly 1.5 million hours by the end of 2012. High operation hours were observed on the 490 systems. The ultimate durability of fuel cell MHE is still being determined and will continue to be tracked by NREL. On an annualized cost per MHE per year, the fuel cell has approximately 10% savings for a Class I/II MHE.

BUDGET

The funding portfolio for Technology Validation enables the program to continue to collect and analyze data from fuel cells operating in transportation and stationary applications, as well as hydrogen production and delivery technologies. In FY 2013, $8.5 million in funding was appropriated for the Technology Validation program, and $7 million was requested for FY 2014 (subject to congressional appropriations).[2]

[2] The majority of the FY 2014 funding is likely to be focused on projects resulting from proposals submitted in response to a funding opportunity announcement that was issued for a variety of application areas.



FC - fuel cell; FOA - Funding Opportunity Announcement

* Subject to appropriations, project Go/No-Go decisions and competitive selections. Exact amounts will be determined based on R&D progress in each area and the relative merit and applicability of projects competitively selected through planned funding opportunity announcements.

FY 2014 PLANS

In FY 2014, the Technology Validation program will continue its detailed evaluations of hydrogen and fuel cell technologies in transit buses, next generation hydrogen fueling stations, stationary power deployments, and early market applications. The program will also award several new projects resulting from its funding opportunities issued in June 2013. Further funding opportunities may also be developed in FY 2014, subject to appropriations.

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