VI.0 Manufacturing R&D Sub-Program Overview

INTRODUCTION

The Manufacturing Research and Development (R&D) sub-program supports activities needed to reduce the cost of manufacturing hydrogen and fuel cell systems and components. Manufacturing R&D will enable the mass production of components in parallel with technology development and will foster a strong domestic supplier base. The sub-program's R&D activities address the challenges of moving today's technologies from the laboratory to high-volume, pre-commercial manufacturing to drive down the cost of hydrogen and fuel cell systems. The sub-program focuses on the manufacturing of components and systems that will be needed in the early stages of commercialization. Research investments are focused on reducing the cost of components currently used or planned for use, as well as reducing overall processing times. Progress toward targets is measured in terms of reductions in the cost of producing fuel cells, increased manufacturing processing rates, and growth of manufacturing capacity.

In Fiscal Year (FY) 2014, manufacturing projects continued in the following areas:

- Reduction in the number of assembly steps for membrane electrode assemblies (MEAs)
- Use of component quality control to measure catalyst loading and detect defects in catalyst-coated membranes
- Fabrication technologies for high-pressure composite storage tanks

GOAL

The goal of the Manufacturing R&D sub-program is to develop innovative technologies and processes that reduce the cost of manufacturing fuel cells and systems for hydrogen production, delivery, and storage.

OBJECTIVES[1]

Key objectives for Manufacturing R&D include:

- Develop manufacturing techniques to reduce the cost of automotive fuel cell stacks at high volume (500,000 units/year) from the 2008 value of $38/kW to $20/kW by 2020.
- Develop fabrication and assembly processes to produce onboard vehicle hydrogen storage systems achieving: 1.8 kWh/kg (5.5 wt% H_2) and 1.3 kWh/L (40 g H_2/L) at a cost of $12/kWh ($400/kg H_2 stored) or less by 2017.
- Support efforts to reduce the cost of manufacturing components and systems to produce hydrogen at <$4/gasoline gallon equivalent (2007 dollars) (untaxed, delivered, and dispensed) by 2020.

FY 2014 TECHNOLOGY STATUS AND ACCOMPLISHMENTS

Presently, fuel cell systems are fabricated in small quantities. The cost of 10-kW, low-temperature polymer electrolyte membrane (PEM) fuel cell systems for backup power is projected to be ~$3,700/$kW_{net}$ at a volume of 100 systems per year.[2] For automotive applications using today's technology, the cost of an 80-kW PEM fuel cell system is projected to be $55/kW for high-volume manufacturing (500,000 systems/year).[3] Projected costs include labor, materials, and related expenditures, but do not account for manufacturing R&D investment.

FY 2014 saw a number of advancements in the manufacture of fuel cells and hydrogen storage systems, including:

Electrode Deposition

MEA materials were coated on a roll-to-roll process following minor equipment modifications to direct coat a membrane layer on top of a cathode layer using a modified backer over 100 meters of intermediate. Optimization of a direct-coated 3-layer MEA is in progress. Gore's state-of-the-art thin, durable reinforced membranes have been demonstrated in a roll-to-roll 3-layer process. (W. L. Gore & Associates, Inc.)

[1] Note: Targets and milestones were recently revised; therefore, individual project progress reports may reference prior targets.
[2] http://www.hydrogen.energy.gov/pdfs/review14/fc098_wei_2014_o.pdf
[3] http://hydrogen.energy.gov/pdfs/14014_fuel_cell_system_cost_2014.pdf

High-Pressure Storage

Composite weight was reduced by 5.7% from the previous design by reducing automated fiber placement (AFP) dome cap layers and optimizing filament winding layup. The Aft AFP dome cap design had a dip, potentially causing composite voids, and the burst pressure was 90% of the requirement, exceeding 157.5 MPa (2.25 x 70 MPa). Quantum filled the dip on the AFP dome cap of Vessel 15 with carbon fiber woven fabric rings, and the vessel achieved 103% of required burst pressure in mid cylinder. Quantum confirmed that the in-house software is sufficient for hybrid design. Vessel 16 achieved a target cycle test count of 15,000. (Quantum Fuel Systems Technologies Worldwide, Inc.)

Component and Stack Quality Control Measurement

Infrared/direct current equipment was assembled on an industrial electrode coating line at Ion Power. The National Renewable Energy Laboratory (NREL) collected data on three coating runs (defects created in wet coating, defects created in semi-dry coating, and simulated process defects) and it successfully detected defects at speed at the drying oven exit. The defects included die line, scratches (tens of μm wide x few mm long), added material (~1 mm droplet/lump), as well as start/stop operation. NREL demonstrated its new Infrared/Reactive Impinging Flow technique with a moving gas diffusion electrode sheet. (NREL)

Workshop

The Fuel Cell Technologies Office along with other Offices within Energy Efficiency and Renewable Energy, held a cross-cutting workshop on quality control/metrology to leverage diagnostic capabilities and identify synergies and opportunities across other technology offices.[4]

Funding Opportunity Announcement (FOA)

EERE/FCTO released a FOA focused on "*Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies*" on May 20, 2014. DOE funding is up to $2M. The topics included outreach to develop strategies and new approaches to facilitate development and expansion of the domestic supply chain of hydrogen and fuel cell related components in the U.S. and global manufacturing competitive analysis for hydrogen and fuel cell-related technologies.

BUDGET

The FY 2015 budget request for the Fuel Cell Technologies Office includes $3 million for Manufacturing R&D. The FY 2014 appropriation for Manufacturing R&D was $3 million (see chart next page).

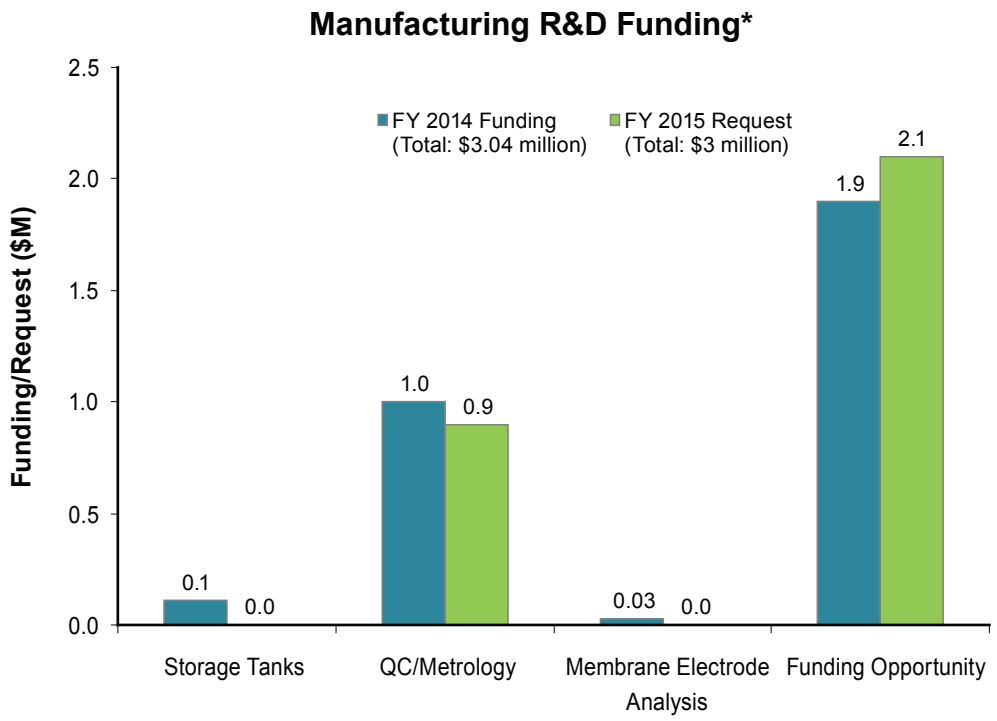
FY 2015 PLANS

In FY 2015, the Manufacturing R&D sub-program will:

- Initiate new projects on supply chain development and global manufacturing competitiveness analysis in collaboration with the DOE's Clean Energy Manufacturing Initiative
- Correlate size of defects generated during membrane and/or MEA fabrication to loss of fuel cell performance
- Build and test a fuel cell stack with a cell fabricated using a new 3-layer MEA manufacturing process
- Continue to use predictive modeling and single and segmented cell test methods to assist diagnostic development
- Develop novel defect detection and infrared detection of the thermal response of material
- Expand implementation of defect diagnostic techniques on industry production lines to original equipment manufacturers

The Fuel Cell Technology Office plans to release an FOA that includes topics on hydrogen and fuel cell R&D manufacturing in FY 2015, with awards subject to appropriation and announced later in the fiscal year. The sub-program will continue to coordinate with other agencies (including the National Institute of Standards and Technology and the U.S. Department of Defense) and with other technology offices within Energy Efficiency and Renewable Energy to identify synergies and leverage efforts.

[4] http://energy.gov/eere/fuelcells/eere-quality-control-workshop



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

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