VI.0 Manufacturing R&D Program Overview

INTRODUCTION

The Manufacturing Research and Development (R&D) 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 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 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) 2013, manufacturing projects continued in the following areas: novel electrode deposition processes for membrane electrode assembly (MEA) fabrication, reduction in the number of assembly steps for MEAs, use of scatterfield microscopy and in-line diagnostics for cell and component quality control to measure catalyst loading and detect defects in catalyst-coated membranes and gas diffusion electrodes, and fabrication technologies for high-pressure composite storage tanks.

GOAL

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 stack assembly and testing at high volume (500,000 units/year) from the 2008 value of $38/kW to $21/kW by 2017.
- Develop processes that will reduce the fabrication and assembly costs for compressed-hydrogen storage systems by 12% from the current high-volume costs of $18/kWh by 2017.
- Support efforts to reduce the cost of manufacturing components and systems to produce hydrogen at $2–$4/gge (2007 dollars) (untaxed, delivered, and dispensed) by 2020.

FY 2013 TECHNOLOGY STATUS

Presently, fuel cell systems are fabricated in small quantities. The cost of 10 kW, low-temperature proton exchange membrane (PEM) fuel cell systems for backup power is projected to be ~$2,200/kW$_{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 2013 KEY ACCOMPLISHMENTS

FY 2013 saw a number of advancements in the manufacture of fuel cells and hydrogen storage systems, including:

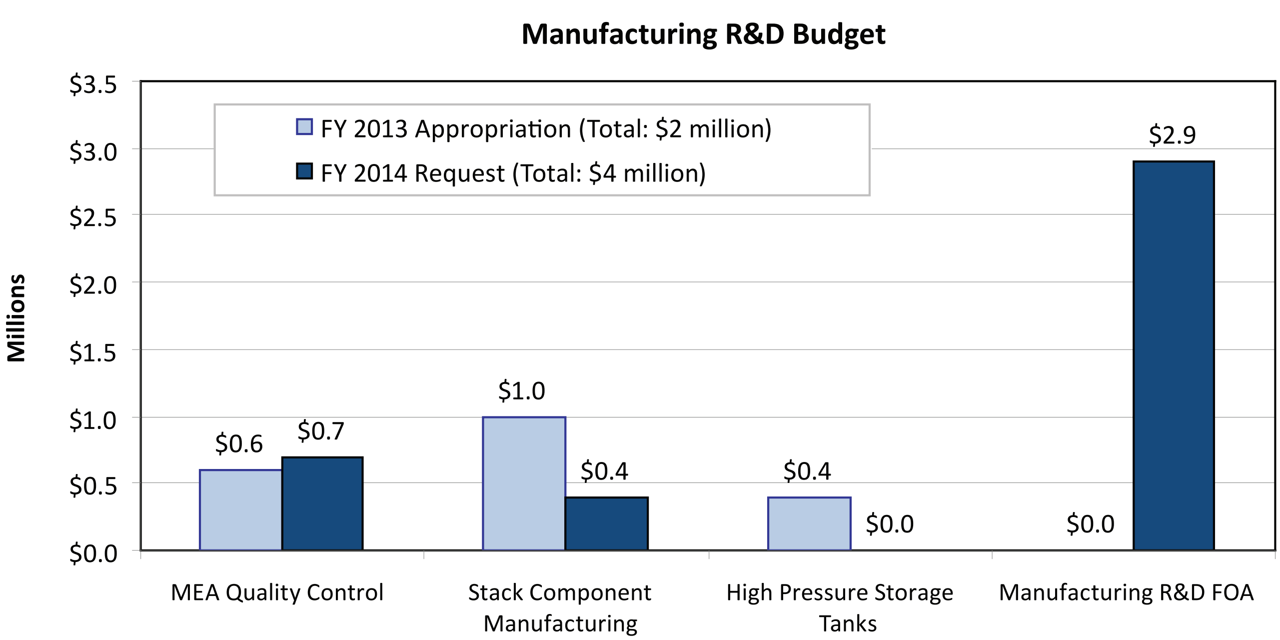
- **Electrode Deposition:** A cost analysis by Strategic Analysis predicts that W.L. Gore's MEAs would have similar costs to 3M's nanostructured thin film /membrane catalyst-coated membrane because the materials costs are about the same (dominated by Pt cost). Gore processing costs are expected to be lower due to non-vacuum processing and faster line speeds.

[1] Note: Targets and milestones were recently revised; therefore, individual project progress reports may reference prior targets.
[2] Wei, M., et al., http://www.hydrogen.energy.gov/pdfs/review13/fc098_wei_2013_o.pdf.
[3] James, B.D., et al., http://hydrogen.energy.gov/pdfs/13012_fuel_cell_system_cost_2013.pdf.

- **High-Pressure Storage:** Quantum improved the in-house computer program, mWind, which allows more composite shell layer options using advanced fiber placement methods, to generate finite element analysis models of composite shells; Quantum verified and confirmed the accuracy of the models with strain gage and optical strain measurements; measurements at the transition area between aft dome cap and cylinder section were within 10 to 25% of values obtained from strain gages at the same location. Quantum completed the latest hydrogen pressure vessel design with mWind to incorporate advanced fiber placement dome caps and baseline fiber.
- **MEA Manufacturing:** BASF demonstrated "one pass" microporous layer and catalyst coating on carbon paper, reduced labor and material costs by >30% for paper structures compared to best cloth gas diffusion electrodes, and demonstrated a 30% reduction in platinum loading compared to best cloth-based anodes without losing performance. All of its customers upgraded to new, more uniform, higher performing product (Celtec® P1100 W) based on this DOE project.
- **Component and Stack Measurement:** Using its optical reflectometry technique, the National Renewable Energy Laboratory detected surface defects and morphology in electrode layers, in both catalyst-coated membrane and gas diffusion electrode configurations, as well as surface defects in tubular solid oxide fuel cells. The National Renewable Energy Laboratory reached an agreement to demonstrate its optical reflectometry technique on Ion Power's catalyst coating line.
- **Ultrasound sealing of High Temperature MEAs:** Rensselaer Polytechnic Institute successfully demonstrated that the performance of a 10-cell stack consisting of MEAs bonded in less than 5 seconds using an ultrasonic bonding manufacturing approach is the same as MEAs bonded in 30 seconds using the traditional thermal bonding manufacturing approach. In addition, large area cells (140 cm^2) produced via ultrasonic bonding performed the same as those produced via the traditional thermal bonding approach.
- **Metrology for fuel cell manufacturing:** Based on the optical design work conducted in FY 2012, NIST constructed a new large aperture projection scatterometer specifically for fuel cell manufacturing metrology research. Using the new large aperture projection scatterometer instrument, NIST made dynamic (as a function of velocity or web-line speed) Pt loading measurements on Gore-provided catalyst-coated membrance samples; NIST collected data that showed good sensitivity and repeatability with no apparent dependence on velocity (1-4 ft/min). The tool will enable NIST to measure larger format samples at typical webline speeds (30 ft/min).

BUDGET

The President's FY 2014 budget request for the Fuel Cell Technologies Office includes $4 million for Manufacturing R&D. The FY 2013 appropriation for Manufacturing R&D was $2 million.



FOA - Funding Opportunity Announcement

FY 2014 PLANS

In FY 2014, activities in the Manufacturing R&D program will:

- Continue to use predictive modeling and single- and segmented-cell test methods to assist diagnostic development.
- Study the effect of as-manufactured defects on MEA lifetime using standard or modified accelerated stress tests.
- Work toward the implementation of techniques on industry production lines.

The Fuel Cell Technologies Office plans to work with other offices within Energy Efficiency and Renewable Energy to develop a cross-cutting workshop on quality control/metrology to leverage diagnostic capabilities and identify synergies and opportunities across other technology offices. The Office also plans to issue a request for information followed by a funding opportunity to be released in FY 2014, with awards subject to appropriation and announced later in the fiscal year. The Office 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.

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