VI.0 Manufacturing R&D Sub-Program Overview

INTRODUCTION

The Manufacturing R&D sub-program supports research and development (R&D) 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. R&D activities address the challenges of moving today's laboratory-produced technologies to high-volume, pre-commercial manufacturing to drive down the cost of hydrogen and fuel cell systems. This sub-program focuses on the manufacture 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) in existing technologies, as well as reducing the cycle times of the processes being developed. Progress toward goals 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) 2012, 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, flow field plate manufacturing variability and its impact on performance, and fabrication technologies for high-pressure composite storage tanks.

GOAL

Research and develop innovative technologies and processes that reduce the cost of manufacturing fuel cell systems 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—to enable widespread commercialization of fuel cell electric vehicles across most light-duty vehicle platforms 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) in 2020.

FY 2012 TECHNOLOGY STATUS

Presently, fuel cell systems are fabricated in small quantities. The cost of 5-kW, low-temperature polymer electrolyte membrane (PEM) fuel cell systems for stationary applications is projected to be ~\$3,100/kW_{net} at a volume of 1,000 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 $47/kW for high-volume manufacturing (500,000 systems/year) and

[1] Note: Targets and milestones were recently revised; therefore, individual project progress reports may reference prior targets. Some targets are still currently under revision, with updates to be published in FY 2013.

[2] James, B. D., et al., "Low Temperature PEM Stationary Fuel Cell System Cost Analysis: Preliminary Results", NREL Subcontract Report, Subcontract number AGB-0-40628-01, May 2011.

about $220/kW at manufacturing volumes of 1,000 systems/year.[3] Projected costs include labor, materials, and related expenditures, but do not account for manufacturing R&D investment.

FY 2012 KEY ACCOMPLISHMENTS

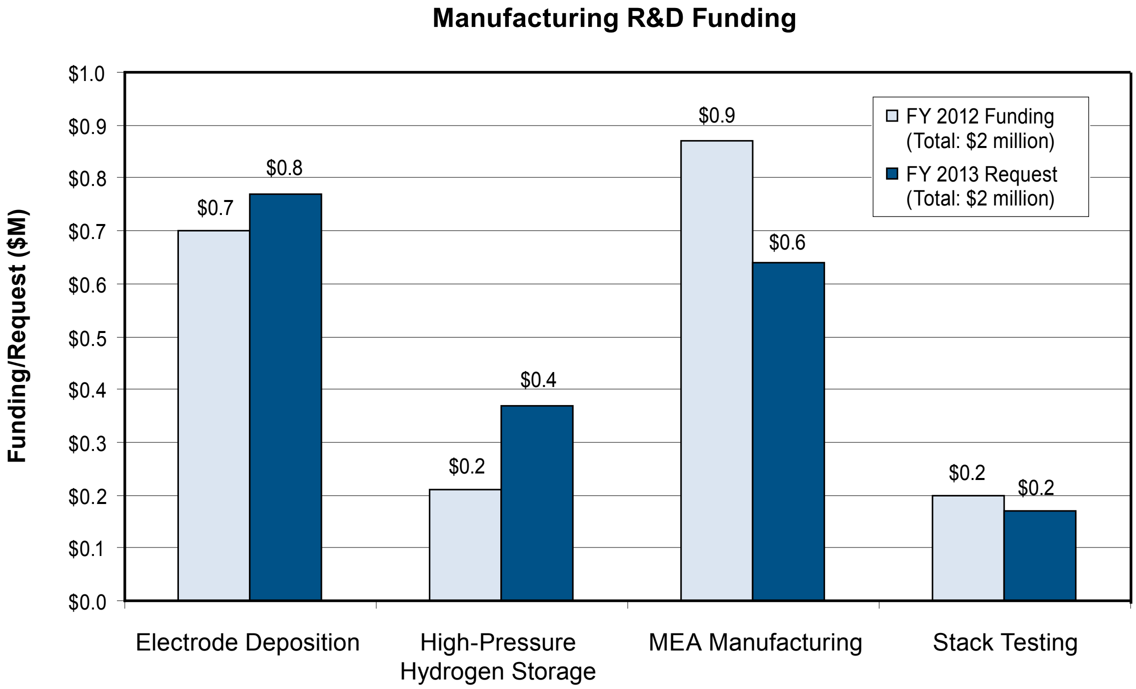
FY 2012 saw a number of advancements in the manufacture of fuel cells and hydrogen storage systems, including:

- **Electrode Deposition:** W.L. Gore improved the performance of an MEA containing a direct-coated cathode to be comparable to an MEA containing a non-direct coated cathode by adjusting the ink formulations. Using direct coating, Gore projects a 25% reduction in MEA cost.
- **High-Pressure Storage:** Quantum used lower-strength and higher-modulus fiber on the outer layers of the hydrogen storage vessel, where the vessel experiences lower stress; this allows those layers to take the load earlier before the inner layers fail. The result is a greater than 5% cost savings with less than 2% increase in weight over the 2011 vessel.
- **MEA Manufacturing:** By modifying additive and processes, BASF reduced the cost of the microporous layer by 37% compared with the benchmark and increased the capacity 3x against the benchmark.
- **Component and Stack Measurement:** Using optical diagnostics on a full-scale webline, NREL detected defects on the order of ~10–100 μ in membranes at standard web speeds of 30 feet per minute.
- **Ultrasound Sealing of High Temperature MEAs:** Besides the time and energy savings provided by the ultrasound method, Rensselaer Polytechnic Institute found that performance is slightly higher for MEAs bonded with the ultrasound method, increasing from an average of 0.64 ± 0.13 V at 0.2 A/cm^2 to 0.65 ± 0.01 V at 0.2 A/cm^2.
- **Bipolar Plate Metrology:** The National Institute of Standards and Technology (NIST) developed a technique using laser spot triangulation probes to measure channel height and width on fuel cell bipolar plates, with errors of less 2 μ. Compared with traditional coordinate measuring machines, this rapid dimensional measurement technique developed by NIST is nearly as accurate, yet significantly faster. As a result, this technique offers the potential for 100% part inspection on an assembly line, compared with traditional techniques that take hours to complete measurements on a single part.
- **Manufacturing Workshop:** The report from the National Renewable Energy Laboratory/DOE Hydrogen and Fuel Cell Manufacturing R&D Workshop was published. The workshop identified strategies and R&D needs for lowering the cost of manufacturing hydrogen production, delivery, and storage systems and fuel cell systems and components. The top priorities identified at the workshop, and outlined in the report, are:
  - Facilitate a manufacturing group for DOE to expand the supply chain for PEM fuel cells/electrolyzer balance of plant.
  - Develop dual-direct coating of catalyst coated membranes.
  - Develop high-volume stack assembly processes—improving automation and reducing labor costs.
  - Develop methods of identifying coating defects on a moving web, then rejecting single pieces downstream.
  - Develop methods for defect detection after MEA assembly when defects may no longer be visible.
  - Develop manufacturing processes to enable multi-layer/component sintering of solid oxide fuel cells.

BUDGET

The President's FY 2013 budget request for the Fuel Cell Technologies Program includes $2 million for Manufacturing R&D. The FY 2012 appropriation for Manufacturing R&D was $2 million.

[3] Hydrogen and Fuel Cells Program Record #12020, "Fuel Cell System Cost – 2012," http://hydrogen.energy.gov/pdfs/12020_fuel_cell_system_cost_2012.pdf



FY 2013 PLANS

In FY 2013, activities in the Manufacturing R&D sub-program will:

- Continue to refine the configuration and optimize the performance of diagnostics on webline as well as assess industry needs and begin to evaluate other diagnostic techniques.
- Initiate work on MEA conditioning and low-cost MEA process scale up.
- Continue to investigate applicability of optical scatterfield microscopy for online inspection of catalyst coated membranes.
- Demonstrate a non-woven microporous layer platform reducing total cost by an additional 30% (materials and labor) over the best woven scenario.
- Complete a final cost model analysis of new hydrogen storage vessel designs.

The input from the Hydrogen and Fuel Cell Manufacturing R&D workshop will be used to identify topics for a funding opportunity planned to be released in FY 2013, with awards subject to appropriation and announced later in the fiscal year. The sub-program will also coordinate with other agency activities (including DOD and NIST) and with Energy Efficiency and Renewable Energy's Advanced Manufacturing Office to identify synergies and leverage efforts.

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