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) 2016, manufacturing projects continued progress in the following areas: use of rolled goods quality control to detect defects in membrane electrode assembly materials and modeling of the effect of defects on fuel cell material performance. We ramped up new efforts to assess the global supply chain. In addition, we launched HFCNexus.com, the U.S. Hydrogen and Fuel Cell Directory, showcasing commercial hydrogen and fuel cell products.

GOAL

Reduce the cost of manufacturing hydrogen production, delivery, storage, and fuel cell component systems through research, development, and demonstration.

OBJECTIVES[1]

Key objectives for Manufacturing R&D include the following:

- Develop manufacturing techniques to reduce the cost of automotive fuel cell stacks at high volume (500,000 units/year) from the 2008 value[2] of $38/kW to $20/kW by 2020.
- Develop fabrication and assembly processes to produce compressed hydrogen pressure vessels to enable a total onboard storage system cost of $10/kWh for widespread commercialization of hydrogen fuel cell vehicles across most light-duty platforms by 2020, with an ultimate target of $8/kWh.
- Support efforts to reduce the cost of manufacturing components and systems to produce hydrogen at <$4/gge (2007 dollars, untaxed, delivered, and dispensed) by 2020. Current cost estimates for producing, delivering, and dispensing hydrogen in the near-term market are between $13/kg and $16/kg (untaxed) without incentives.[3]

FY 2016 TECHNOLOGY STATUS

Presently, fuel cell systems are fabricated in small quantities. The cost of a 10-kW, low-temperature polymer electrolyte membrane (PEM) fuel cell system for combined heat and power (CHP) is projected to be ~$1,720/kW at a volume of 50,000 systems/year.[4] For automotive applications, the cost of an 80-kW PEM fuel cell system is projected to be $53/kW for high-volume manufacturing (500,000 systems/year).[2] Projected costs include labor, materials, and related expenditures, but do not account for manufacturing R&D investment.

FY 2016 KEY ACCOMPLISHMENTS

Advancements in the manufacture of fuel cells and hydrogen storage systems in FY 2016 include the following:

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

[2] http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/mass_production_cost_estimation_report.pdf

[3] https://www.hydrogen.energy.gov/pdfs/15011_low_volume_production_delivery_cost.pdf

[4] http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/mass_production_cost_estimation_report.pdf

- Establishment of four regional Technical Exchange Centers to collect and categorize hydrogen and fuel cell information that will be included in a national web-centered database to facilitate purchases of hydrogen and fuel cell components and systems. (Ohio Fuel Cell Coalition)
- Launch of www.hfcnexus.com website (Figure 1) to provide a database of supplier information for hydrogen and fuel cell technologies as well as matchmaking capabilities to introduce suppliers and integrators. (Virginia Clean Cities)
- Development of a detailed questionnaire with current DOE cost target and process assumptions; input was gathered at four vehicle volumes (1,000, 10,000, 100,000, and 500,000 units/year). Seven original equipment manufacturers were interviewed and three visited. (GLWN)
- Generation of drawings and specifications for five key components (bipolar plate, membrane, gas diffusion layer, catalyst, and hydrogen storage vessel). The drawings were sent out to suppliers to obtain price quotations at four vehicle volume levels (1,000, 10,000, 100,000, and 500,000 units/year). (GLWN)

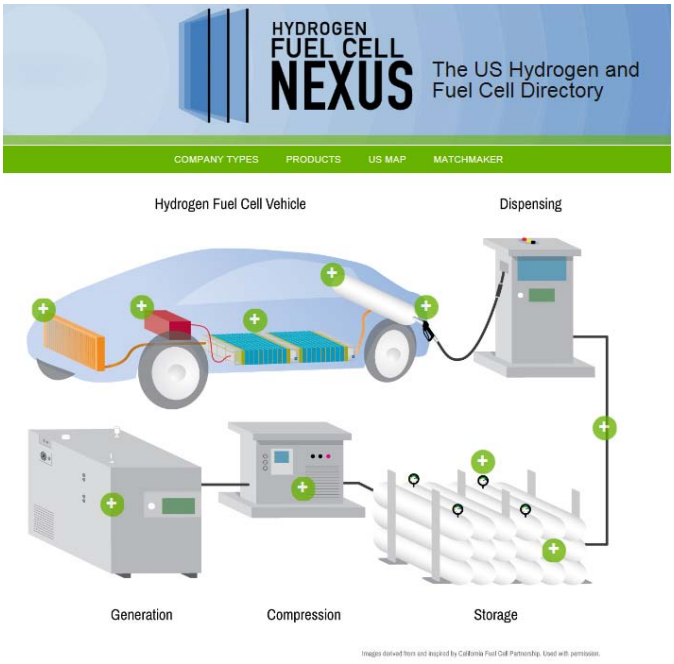


FIGURE 1. www.HFCnexus.com homepage

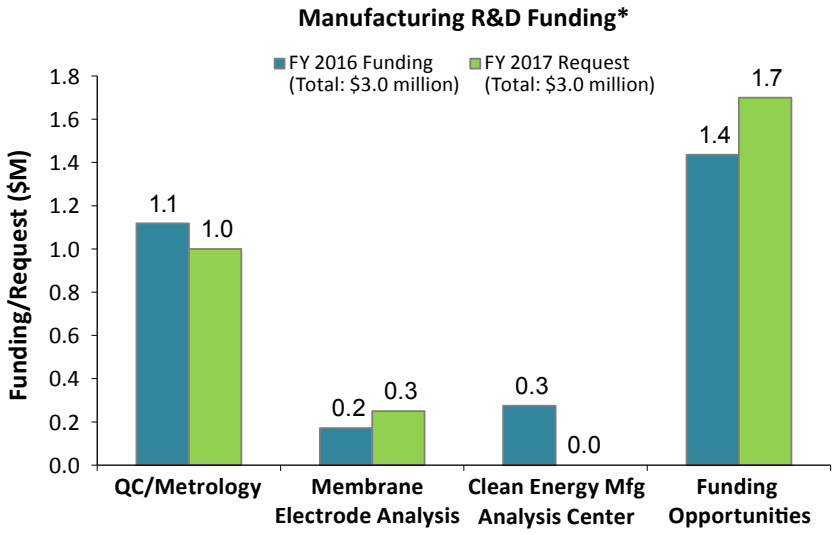
- Development of an innovative polymer composite hydrogen pipeline coupler. (Automated Dynamics)
  - Refined and developed the design specification with no metal parts to eliminate the possibility of hydrogen embrittlement. The design included mechanical loading, environmental effects, and leak rates.
  - Designed, manufactured, and tested electrofusion coupons with continuous fiber composite and established baseline bond strength expectations for adjacent coupler components.
  - Designed, manufactured, and tested the wire placement process for use on the design of an innovative coupler.
- Quality control of fuel cell materials following roll-to-roll processing. (National Renewable Energy Laboratory [NREL])
  - Identified the following defects in Nafion membranes (Figure 2): a 25-µm-diameter pinhole (smallest size tested), a 10-µm-wide scratch, and a 100-µm-wide fold. (NREL)

FIGURE 2. Membrane samples illustrating each of the main defect types, including pinholes, scratches, and folds taken edge-lit with a compact camera

- Demonstration of an optical system that detected forty out of forty 100-µm pinhole defects in real time on NREL's continuous roll-to-roll web line with Nafion211 membrane material at speeds of up to 30 ft/min. With post processing, all defects were successfully identified at web line speeds up to 100 ft/min. (Mainstream)

BUDGET

The FY 2017 budget request for the Manufacturing R&D program is $3 million. The FY 2016 appropriation for Manufacturing R&D was $3 million, as shown in Figure 3.



*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.

QC – quality control; Mfg – manufacturing

FIGURE 3. FY 2016 appropriations and FY 2017 budget request for the Manufacturing R&D program

FY 2017 PLANS

In FY 2017, the Manufacturing R&D program will:

- Complete projects on supply chain development (Ohio Fuel Cell Coalition and Virginia Clean Cities at James Madison University) and global manufacturing competitiveness analysis (GLWN – Westside Industrial Retention & Expansion Network) in collaboration with DOE's Clean Energy Manufacturing Initiative and NREL's Clean Energy Manufacturing Analysis Center.
- Engage a four-laboratory consortium to explore and improve manufacturing processes to produce roll-to-roll goods materials for fuel cells in collaboration with and leveraging investment by the Advanced Manufacturing Office.
- Continue a project to manufacture reliable joints (with very low leak rates) that connect fiber-reinforced pipeline for hydrogen delivery at 100 bar.
- Correlate size of defects generated during membrane and/or membrane electrode assembly fabrication to loss of fuel cell performance.
- Continue to use predictive modeling and single and segmented cell test methods to assist diagnostic development.
- Develop novel defect detection via infrared detection of the thermal response of material.

- Expand implementation of defect diagnostic techniques on industry production lines to original equipment manufacturers.

The FY 2017 funding opportunity announcement will include topics on hydrogen manufacturing R&D, 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 the Office of Energy Efficiency and Renewable Energy to identify synergies and leverage efforts.

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