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# X.0 Market Transformation Program Overview

## INTRODUCTION

The purpose of the Market Transformation program is to spur market growth for domestically produced hydrogen and fuel cell systems. The Market Transformation program is conducting activities to help promote and implement commercial and pre-commercial hydrogen and fuel cell systems in real-world operating environments and to provide feedback to research programs, U.S. industry manufacturers, and potential technology users. By supporting increased technology operations testing and use in key early applications, this program helps to identify and overcome non-technical barriers to commercial deployment and to reduce the life cycle costs of fuel cell power by helping to achieve manufacturing economies of scale. These early market deployments will also address other market acceptance factors, resulting in further expansion of technology opportunities.

The Market Transformation program aims to replicate past successes in material handling equipment (MHE) (e.g., lift trucks) and emergency backup power applications that were part of The American Recovery and Reinvestment Act of 2009 (Recovery Act). For example, Market Transformation has projects in applications like fuel cell powered airport ground support baggage tractors and fuel cell electric medium-duty hybrid trucks for parcel delivery applications. These projects are highly leveraged, with an average of more than half of the projects' funds being provided by DOE's partners. Partners providing resources and financial investment to these projects show their high level of interest in continuing to explore these applications and markets, and this level of industry interest is very promising for the potential growth of the domestic fuel cell industry. Market Transformation also partners with other federal agencies and various stakeholders to deploy new applications, such as auxiliary power for ships in port and on board ocean-going vessels in collaboration with the U.S. Department of Transportation's Maritime Administration.

## GOAL

Market Transformation activities provide financial and technical assistance for the use of hydrogen and fuel cell systems in early market applications, with the key goals of achieving sales volumes that will enable cost reductions through economies of scale, supporting the development of a domestic industry, and providing feedback to testing programs, manufacturers, and potential technology users.

## OBJECTIVES

The objectives of the Market Transformation program are to:

- Evaluate status against target performance metrics for commercially available emergency backup, MHE, and other systems and provide feedback to component suppliers regarding cost reduction opportunities.
- Test emerging approaches to grid management using renewable hydrogen.
- Advance the knowledge and expertise of waste-to-energy fuel cells, shipboard and truck auxiliary power units (APUs), fuel cell electric truck parcel delivery, and aviation ground support applications through targeted testing and evaluation efforts in coordination with the Technology Validation program and in partnership with the U.S. Navy, the U.S. Marine Corps, and civilian agencies such as the U.S. Department of Transportation's Maritime and Federal Aviation Administrations.
- Identify lessons learned from promulgated policies and regulations and promote the development of the most effective and applicable incentives for hydrogen and fuel cell technologies.
- Conduct market transformation deployment projects to enable life cycle cost and performance of early market applications such as fuel cell powered lift trucks and emergency backup power systems to be on par with conventional technologies.

## FISCAL YEAR (FY) 2016 TECHNOLOGY STATUS AND ACCOMPLISHMENTS

Fuel cells have been enjoying growing success in key early markets, particularly in MHE and backup power applications. The program's early market deployment efforts—including Market Transformation funding and Recovery Act funding—have successfully catalyzed a significant level of market activity in these areas, which has

been accompanied by substantial reductions in the price of fuel cells. For example, material handling and backup power orders are up 32% and 24% respectively this year (see DOE Records 16012 and 16013) from the cumulative total orders in 2009 through 2014. Ongoing activities and additional areas of interest include the following.

- **Hydrogen Energy Storage Project:** This project is supporting the demonstration of a hydrogen energy storage system as a grid management tool. While hydrogen produced from the system could be used in a variety of value-added applications, the initial phase of the project will use the hydrogen in fuel cell buses operated by the County of Hawaii Mass Transportation Agency and the National Park Service. This year construction began, and initial operation is expected to begin in Spring 2017. (Naval Research Laboratory and the State of Hawaii)
- **Airport Ground Support Vehicles:** This project has a high potential to meet program goals and enable demonstration for a wide breadth of additional airport applications such as lift trucks and shuttle buses. The design has been completed, and the 15 units were assembled with the cargo tractor and tested in field operations. Failures in the stacks occurred, including leaking seals and crossover through the membranes. Analysis revealed that the stacks were not robust enough for the air cargo duty cycle. The stacks are now being replaced with a new design, and initial testing shows satisfactory operations. The next step is to complete stack replacements for all units and begin Phase 2 testing in field operations. (Plug Power)
- **Maritime Fuel Cell Generator Project:** Testing of a first-of-its-kind hydrogen fuel cell power generator for maritime applications was completed. The system was designed to replace pier side diesel generators for refrigerated containers on board ocean vessels. Initial operations testing at a pier-side site was completed with results showing energy efficiency improvements. However, many balance-of-plant components need to be redesigned and replaced. A Phase 2 project scope is now being prepared. (Sandia National Laboratories)
- **Fuel Cell Hybrid Electric Delivery Van Project:** In this project, a design is being developed for a battery electric powertrain system hybridized with fuel cell power to improve drive performance and range on a medium-duty cargo truck. The project has been awarded, and a prototype design effort is underway. A prototype vehicle will be tested on a dynamometer in the next year. (Federal Express Corporation)
- **Fuel Cell Auxiliary Power Unit Project:** This activity now includes a second awarded project that will design and develop a multi-temperature transportation refrigeration unit power system. The first awarded project to demonstrate a single-temperature power system will assemble the subsystems and test an integrated prototype next year. (Pacific Northwest National Laboratory)
- **Fuel Cell–Battery Electric Hybrid for Utility of Bucket Trucks Project:** This Small Business Innovation Research project’s Phase 1 design concept found that bucket trucks can be economically viable when using fuel cell power for the bucket’s boom motor and not as prime motive power. This was due to the long non-use time associated with the prime power system when the boom is in use at a work site. Other application user values identified include low noise and zero harmful air emissions when in use. (US Hybrid)
- **Light-Duty Utility Van Range Extender:** This project will design, build, test, and operate a fleet of fuel cell range extended plug-in hybrid light-duty utility vehicles. By adding a fuel cell and a few kilograms of hydrogen to a battery electric powertrain, the zero-emission driving range of the vehicles will be extended from ~100 mi up to as much as 250 mi before the batteries need to be recharged, greatly increasing the commercial potential of these all-electric utility vehicles. Upon the successful validation of one initial prototype vehicle, US Hybrid will deploy a fleet of 19 additional vehicles for use by National Grid, a leading utility fleet owner and operator in the northeastern United States. The project scope also includes collection and validation of performance data and a complete economic assessment of the value proposition. (US Hybrid)
- **Commercial Acceleration Training and Analysis:** Efforts this past year focused on enabling the commercialization process for various industries and organizations, including forums for investors and infrastructure developers; training of state and municipal staff on technology operations; and developing novel hydrogen and fuel cell business cases. In collaboration with H2USA, the Investor Forum was conducted in New York City, bringing together private hydrogen refueling developers and potential investors. Five developing organizations presented individually their business plans to potential investors. Based on positive private sector feedback, a second investor forum was held in Los Angeles, California, this past fall in collaboration with H2USA. To help the launch of fuel cell electric vehicles and hydrogen fueling infrastructure in the Northeast, training sessions were conducted to educate state and city officials and municipal authorities in New Jersey, New York, Connecticut, and Massachusetts on safe and effective business practices. Hundreds of building and fire code officials, first responders, and state and municipal agency staff attended these sessions. To help to accelerate the

commercialization of various fuel cell technologies and overcome technology cost barriers, the program supported various focused business case studies, such as car sharing and renewable hydrogen refueling scenarios.

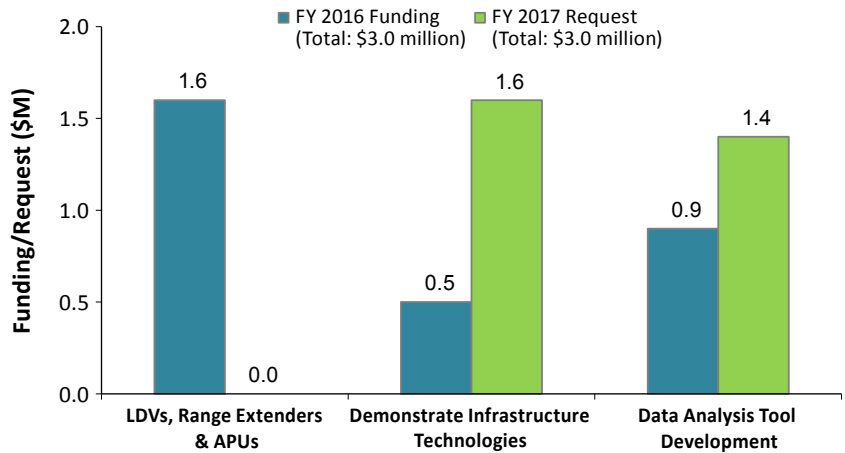
**BUDGET**

The FY 2016 appropriation for the Market Transformation program was \$3 million, and \$3 million was requested in FY 2017 (Figure 1).

**FY 2017 PLANS**

In FY 2017, the program will continue to collect and analyze early market project data that can be used to assess the performance of integrated hydrogen and fuel cell systems and to determine the economic viability of these applications. A new project will begin for the design and deployment of hybrid fuel cell–battery powered light-duty vehicles in dispatch utility applications. Strategies for road vehicle market entry and refueling station development, including risk management with respect to safety, environmental, and siting requirements, will continue to be a priority. Data will be made publicly available so that potential customers can become aware of the benefits of integrated hydrogen and fuel cell systems. In addition, collaboration with other federal agencies will continue in accordance with existing interagency cooperative agreements such as the DOE–U.S. Department of Defense memorandum of understanding. This effort aims to increase the use of fuel cells in market-ready applications and the awareness of the benefits of these deployments across the federal government. A potential new activity that could be initiated, subject to Congressional appropriations, is the development and deployment of novel renewable hydrogen refueling technologies to support the commercialization of fuel cell battery powered vehicles in various part of the country.

**Market Transformation R&D Funding\***



\*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.

**FIGURE 1.** FY 2016 appropriation and FY 2017 budget request for the Market Transformation program

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