
Fuel-Cell-Powered Airport Ground Support Equipment Deployment

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Project Start Date: January 2013
Project End Date: May 2018

Overall Objectives

- To create a hydrogen fuel cell-based solution for airport ground support equipment (GSE) that is cost competitive and more energy efficient compared to incumbent internal combustion engine-powered alternatives.
- To enable airport end users to accomplish daily tasks with a hydrogen fuel cell solution while reducing consumption of gasoline and diesel fuels, reducing U.S. demand for petroleum.
- To demonstrate lower carbon emissions with fuel cells.
- To demonstrate a value proposition that shows decreased energy expenditures when compared to diesel-powered airport vehicles.

Fiscal Year (FY) 2018 Objectives

- Complete redesign of fuel cell system to incorporate the Plug Power stack.
- Redeploy updated fuel-cell-powered cargo tractors at Memphis Airport to continue operation.

- Collect operational and performance data throughout FY 2018.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan¹:

- Lack of Fuel Cell Electric Vehicle and Fuel Cell Bus Performance and Durability Data.

It also addresses the following technical barriers from the Market Transformation section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Inadequate user experience for many hydrogen and fuel cell applications.

Contribution to Achievement of DOE Milestones

This project will contribute to achievement of the following DOE milestones from the Systems Analysis section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Milestone 1.16: Complete analysis of program performance, cost status, and potential use of fuel cells for a portfolio of commercial applications. (4Q, 2018)
- Milestone 1.17: Complete analysis of program technology performance and cost status, and potential to enable use of fuel cells for a portfolio of commercial applications. (4Q, 2018)
- Milestone 1.18: Complete life cycle analysis of vehicle costs for fuel cell electric vehicles compared to other vehicle platforms. (4Q, 2019)
- Milestone 1.19: Complete analysis of the potential for hydrogen, stationary fuel cells, fuel cell vehicles, and other fuel cell

¹ <https://www.energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22>

applications such as material handling equipment including resources, infrastructure and system effects resulting from the growth in hydrogen market shares in various economic sectors. (4Q, 2020)

It also contributes to achievement of the following DOE milestones from the Market Transformation section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

- Milestone 2.11: Develop installation and permitting templates for airport ground support equipment. (1Q, 2015)

FY 2018 Accomplishments

- Completed redesign of GSE fuel cell with Plug Power stack.
- Completed fleet redeployment of 14 fuel-cell-powered tractors at Memphis. One system was held at Plug Power for ongoing testing.
- Demonstrated performance of fleet at Memphis met objectives established in original statement of project objectives.
- Provided data set on performance through January 2018.
- Completed decommission of Memphis operation and hydrogen infrastructure.
- Received commitment from FedEx to relocate two fuel cell systems at Albany Airport for expanded weather testing.
- Established logistics between FedEx at the Albany Airport and Plug Power Headquarters to use Plug Power's hydrogen filling station for the remainder of the program.
- Installed the hydrogen filling station to support the FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles program (DE-EE00006522).
- Revised statement of project objectives and budget period 3 plans to reflect change to Albany Airport.
- Began preparations of fuel cells, GSE tractors, and hydrogen fueling station to be operational in the fourth quarter of calendar year 2018.

INTRODUCTION

The airside operations at an airport significantly contribute to the overall emissions and fuel consumption of an airport operator. Identifying alternative power solutions for airport GSE that reduce emissions while maintaining economic and productivity objectives is an ongoing challenge. Battery-powered GSE support improvements in emissions but introduce potential performance shortcomings as well as require a charging infrastructure.

Fuel cells have been identified as a potential solution to meet the demanding operational needs of airport GSE as well to address the need to reduce emissions. This program converted 15 battery electric GSE baggage tractors to hydrogen fuel cell power to demonstrate the simplicity and functionality of hydrogen as an alternate zero-emission solution.

APPROACH

The project approach was to design and test a fuel cell solution that effectively replaces a lead-acid battery pack for an existing electric-drive GSE unit. The project also required the participants to establish a hydrogen infrastructure that included compression, storage, and dispensing of 350 bar hydrogen. There will be 15 fuel-cell-powered GSE cargo tractors deployed in the FedEx operation allowing real world data to be collected with a reasonably large sample size.

Operational and maintenance data will be analyzed according to project objectives. The data will support both the fundamental evaluation of fuel cell technology in new applications as well as the commercial decision-making process of the project participants.

RESULTS

During FY 2018 the demonstration phase at the Memphis airport continued and data was compiled and submitted through January 2018. Unfortunately, in early calendar year 2018 the plans to decommission the hydrogen infrastructure brought a premature conclusion to the demonstration phase. In April 2018, the systems were decommissioned, and fuel cells were returned to Plug Power and the electric GSE baggage tractors were returned to Charlotte.

The performance criteria and results during the demonstration phase at the Memphis Airport are shown in Table 1. The performance objectives during budget period 2 were achieved once the fuel cell stacks and systems were upgraded by Plug Power.

Table 1. Fuel-Cell-Powered Ground Support Equipment—Year 1

Criteria	Metric	Demonstrated Performance
Power	Capable of 5,000 lb drawbar capacity	Tugs demonstrated the ability to pull 50,000 lb
Availability	>80%	90.5% (February to October 2017) (mitigation actions of all failures have been identified, leading to improved availability)
Run Time	>1 shift	Tugs achieved 304 shifts before running out of fuel
Reliability—Mean Time between Failures	>100 hours	218 hours (36 failures over 7,844 hours)

Plans were undertaken to relocate two of the baggage tractors to the Albany International Airport where FedEx operates a limited-scale freight operation. There were two main benefits of locating in Albany. First is that it provides a true northern winter climate to test and verify the fuel cell GSE during below-freezing weather. Second, the location did not require new hydrogen infrastructure as the Plug Power facility with a hydrogen dispenser is within 1.5 miles of the FedEx operation at Albany airport.

Activities from April 2018 to the end of FY 2018 have centered around the relocation and restart of the program. The go/no-go to move into budget period 3 was originally requested in January 2018. At the end of FY 2018 the approval to proceed to budget period 3 was still pending but expected soon in FY 2019.

CONCLUSIONS AND UPCOMING ACTIVITIES

- Completed the redesign and validation of the fuel cell systems with the Plug Power stack.
- Collected and reported on performance data that meets the objectives of the program.
- Completed and wrapped up operation at Memphis at the beginning of the third quarter of FY 2018.
- Finalized decision to move program to the FedEx cargo operation at the Albany International Airport and continue demonstration throughout budget period 3 using two of the fuel-cell-powered cargo tractors through the winter months.
- Began preparations for the move of equipment, including cold weather preparation and maintenance on both the cargo tractors and fuel cell systems.
- Defined and secured the hydrogen fueling plan using existing infrastructure at Plug Power’s headquarters.

The upcoming activities in budget period 3 include:

- Further work to enhance cold weather storage, starting, and operation of the fuel-cell-powered cargo tractors.
- Continued operational performance and climate data gathering.
- Preparation of reports, including updated technical and economic analysis, and project close out.

The original scope of the project included 15 fuel-cell-powered GSE; as such, Plug Power and our project partners will continue to investigate a suitable location to deploy the remainder of the fleet.

FY 2018 PUBLICATIONS/PRESENTATIONS

1. Larry Pitts, “Fuel Cell Powered Airport Ground Support Equipment,” presented at the DOE Annual Merit Review, Washington, DC, June 13–15, 2018.