FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles

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Contract Number: DE-EE00006522

Subcontractors:
- Workhorse Technologies Inc., Loveland, OH
- Plug Power Inc., Latham, NY

Project Start Date: October 15, 2015
Project End Date: September 30, 2020

Overall Objectives

- To convert an existing electric parcel delivery unit into a zero-emission extended range electric vehicle by utilizing hydrogen fuel cell technology.
- Understand, demonstrate, and deploy hydrogen fuel cell technologies in a real-world environment.

Fiscal Year (FY) 2018 Objectives

- Create fueling strategy for vehicle in Latham, New York.
- Work with Menands station on route selection, charging, and maintenance.
- Complete integration of fuel cell and electric vehicle communication.
- Prepare vehicle for on-road testing and implementation.
- Complete and submit safety plan.
- Conduct durability testing.
- Deliver vehicle to station.
- Train FedEx drivers and maintenance technicians on hydrogen safety.
- Start and continue data collection through Budget Period (BP) 1.
- Transmit data to the National Renewable Energy Laboratory (NREL) regularly.

Technical Barriers

This project addresses the following technical barriers from the Market Transformation section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan[1]:

- High hydrogen fuel infrastructure capital costs for polymer electrolyte membrane fuel cell applications
- Market uncertainty around the need for hydrogen infrastructure versus timeframe and volume of commercial fuel cell applications
- Inadequate user experience for many hydrogen and fuel cell applications
- Insufficient numbers of trained and experienced servicing personnel
- Lack of qualified technicians for maintenance
- Lack of certified service providing organizations for installation and maintenance.

Contribution to Achievement of DOE Market Transformation Milestones

This project will contribute 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 1.8: Complete deployment and evaluation of short haul/drayage trucks and range extenders. (1Q, 2014)

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

FY 2018 Accomplishments

- Proposed plans for truck fueling at Plug Power Latham.
- Build plans for hydrogen dispenser in Latham.
- Planned route selection, driver selection, charging, and maintenance with Menands management.
- Installed fuel cell systems and converter in truck engine compartment.
- Created control strategy for battery charging.
- Created software for communications between fuel cell system and truck.
- Installed/debugged remaining items on truck.
- Provided electric vehicle supply equipment charger for truck to Menands ship center.
- Registered vehicle.
- Submitted safety plan to DOE.
- Conducted durability test.
- Received permit for hydrogen dispenser at Plug Power.
- Installed outdoor hydrogen dispenser at Plug Power.
- Delivered truck to Menands ship center.
- Trained FedEx employees on hydrogen safety.
- Started data collection.
- Sent first set of data to NREL.
- Sent request for extension of BP 1 to DOE.
- Extended BP 1 to the end of February 2019.
- Continuing with data collection and working with NREL to determine how to analyze the data.

INTRODUCTION

The ability to reduce fuel consumption and emissions while delivering packages is an immense challenge, particularly with the available technology. This is further complicated by the diversity of the different duty cycles utilized by the pick-up and delivery vehicles (PUDs) at FedEx. This has created enormous opportunities for an extended-range, zero-emission electric PUD.

As a part of this project, we will be converting 20 existing electric vehicles (EVs) into hydrogen fuel cell powered extended-range electric vehicles (eREVs) in two different phases/BPs.

Successful utilization of fuel cell technologies in real world environments will help foster a better understanding while providing the opportunity to identify and utilize additional duty cycles, eventually reducing costs by achieving economies of scale, while providing clean, safe, secure, and affordable energy.

APPROACH

The first step was to find industry partners that had the experience, capabilities, and knowledge to collaborate with us in embarking on this project. As a result, we are collaborating with Workhorse, the EV manufacturer, Plug Power, the fuel cell manufacturer, and Morgan Olson, the body manufacturer for the eREV.

The project is divided into two separate phases/BPs (BP 1 and BP 2). The first period concentrates on the conversion of just one asset. This will enable the project team to test, analyze, and measure the performance. BP 2 will only be launched if the first phase is considered successful and the team will utilize the lessons learned and implement those in the second phase.

We have made significant progress in BP 1 and are close to launching the first eREV PUD. The identification of the ideal route and location for the first PUD was completed. The optimized charge strategy and power generation for the fuel cell was implemented. The fabrication, validation, and testing of the fuel cells has successfully been completed. The various integration activities between the EV and fuel cell are completed. The ideal hydrogen tank size, packaging, and compartment locations are finalized and being utilized. The body for the PUD was installed on the electric chassis. The safety and venting testing has been initiated. Next, the eREV will be taken through a series of durability tests before it is placed in active service.

The second phase is launched if the first phase is considered successful and will convert an additional 19 EVs into fuel cell eREV PUDs.

RESULTS

This has been an ongoing project. There has been much accomplished to get the vehicle on the road for real-world testing. A fueling strategy was worked out with Plug Power to fuel the vehicle at the Plug Power facility. Durability testing was conducted by Plug Power for a couple of months. The vehicle was commissioned and put into service on January 30, 2018. There have been some challenges at the beginning of the real-world validation. In the first months, there were various problems with both the fuel cell and the electric vehicle. Figure 1 depicts out-of-service time by system, in days. The last three months of service, September not depicted, have been nearly perfect.

Figure 1. Availability by month

Figure 2 shows the overall availability of the vehicle by system. The target for the fuel cell and fuel cell integration reliability is less than 7% down time. Because of a few incidences we have not hit that target.

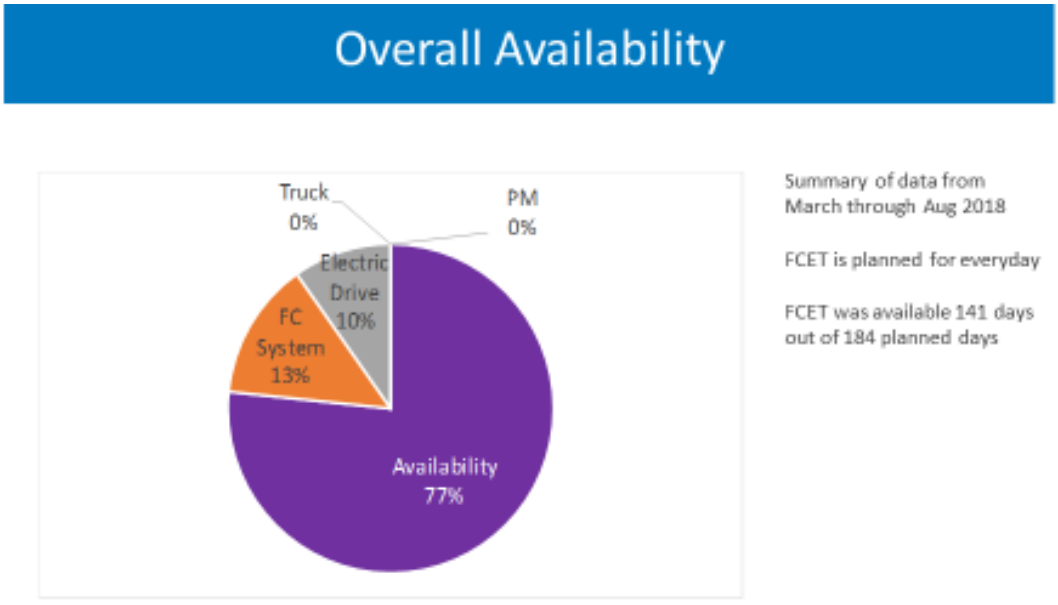

Figure 2. Overall availability

CONCLUSIONS AND UPCOMING ACTIVITIES

Because of the early issues and challenges, DOE has told us to extend BP 1 to collect more data and determine its reliability. We have requested an extension to collect data until February 28, 2019. This will give us a full year's worth of data to analyze before making a go/no-go recommendation.

FY 2018 PUBLICATIONS/PRESENTATIONS

1. Phillip Galbach, "FedEx Express Hydrogen Fuel Cell Extended Range Battery Electric Vehicles," presented at the DOE Annual Merit Review, Washington, DC, June 13–15, 2018.
2. Phillip Galbach, "FedEx Express—Fleet Logistical Considerations," presented at the H2@Scale DOE Truck Workshop, Chicago, IL, July 30–31, 2018.