

X.5 FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles

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Contract Number: DE-EE0006522

Subcontractors:

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

Project Start Date: October 15, 2015

Project End Date: October 10, 2019

Overall Objectives

- Convert an existing electric parcel delivery unit (PUD) into an extended range electric vehicle by utilizing hydrogen fuel cell.
- Demonstrate and deploy hydrogen fuel cell technologies in a real world environment.

Fiscal Year (FY) 2016 Objectives

- As part of the first budget period, optimize, test, and complete the integration between the fuel cell and the electric vehicle (EV).
- Identify and analyze the proper route and location for the assets placement.
- Determine the optimal hydrogen storage quantity and location.

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].

- (B) High hydrogen fuel infrastructure capital costs for polymer electrolyte membrane (PEM) fuel cell applications

- (D) Market uncertainty around the need for hydrogen infrastructure versus timeframe and volume of commercial fuel cell applications
- (F) Inadequate user experience for many hydrogen and fuel cell applications
- (J) Insufficient numbers of trained and experienced servicing personnel
- (L) Lack of qualified technicians for maintenance
- (M) Lack of certified service providing organizations for installation and maintenance

Technical Targets

The target is to achieve a driving range of 150 miles. No additional targets have been set.

FY 2016 Accomplishments

- Identified replacement EV original equipment manufacturer.
- New EV sub-recipient has experience with range extension.
- Technical kick-off meeting held among program partners at a manufacturing facility to discuss component requirements and placement.
- Program kick-off meeting held among program partners at Memphis headquarters.
- Site and product review visit to Workhorse.
- Analyzed the 150-mile drive cycle with up to 60-mile stem length at beginning and end.
- Planning in process for dyno testing.
 - Variable payloads
 - Temperature effects
 - Parasitic loads
- Integration activity kick off.
- Integration hardware identified and tested.
- Upcoming testing planned and finalized.
- PUD placement location identified.
- Fueling challenges discussed and mitigated.
- Hydrogen tank location and storage finalized.
- Design integration between the partners was launched (Figure 1).

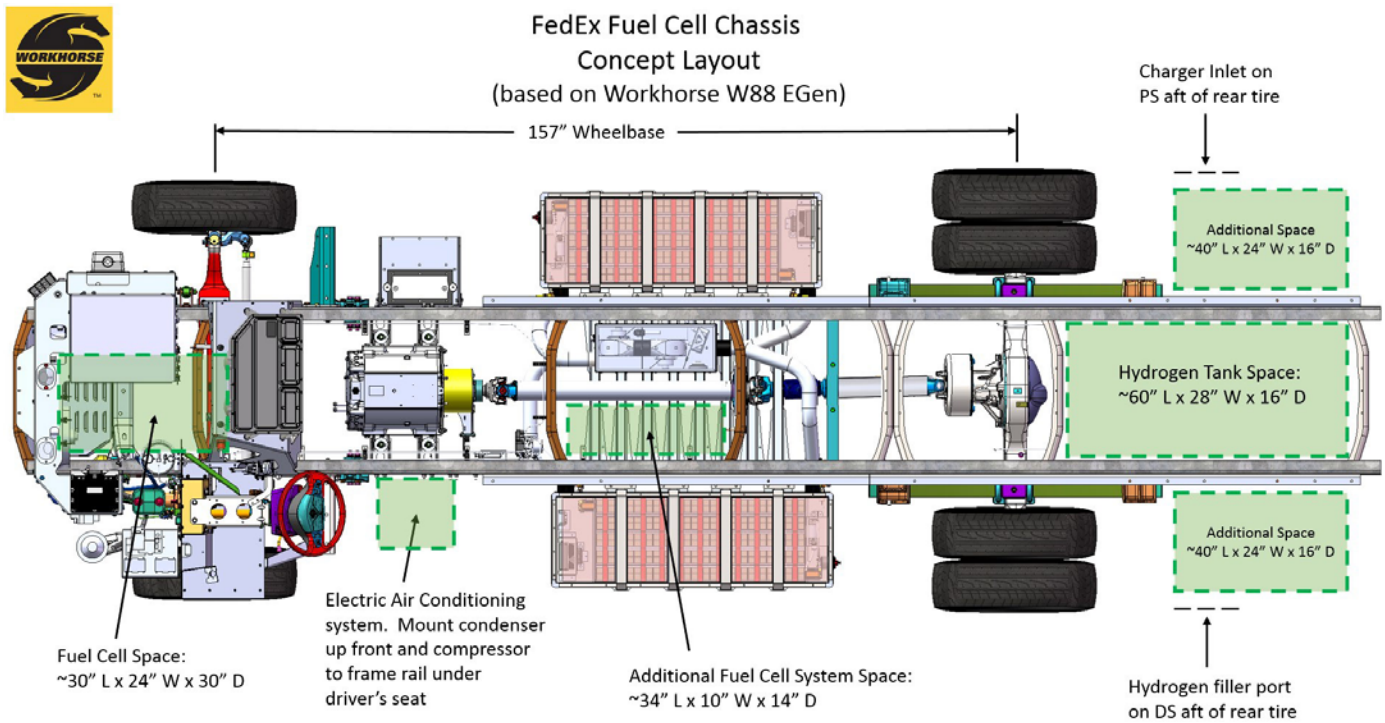


FIGURE 1. Usage profile baseline electric vehicle



INTRODUCTION

The ability to reduce fuel consumption and emissions while delivering packages is an immense challenge, particularly with the existing technology. This is further complicated by the diversity of the different duty cycles utilized by the PUDs at FedEx. The possibilities and opportunities for an electric PUD that can have its range extended without producing any emissions are enormous. This is exactly what this project aims to achieve.

As a part of this project we will be converting 20 existing electric vehicles into hydrogen fuel cell powered extended range electric vehicles (eREV), in two different budget periods (BP). We will be able to demonstrate the deployment and successful utilization of fuel cell technologies in real world environments. Lessons learned can be applied to additional duty cycles eventually reducing costs because of economies of scale, while providing safe, secure, and affordable energy.

APPROACH

The first step was to find industry partners that had the experience, capabilities and the knowledge to collaborate with us in embarking on this project. As a result, we are collaborating with Workhorse, the EV manufacturer, and

Plug Power, the fuel cell manufacturer; in addition, Morgan Olson is providing us the body for the asset. The project is split into two separate budget periods (BP1 and BP2). The first period concentrates on the conversion of just one asset. This will enable the project team to analyze and measure the performance. The second period is launched if the first phase is considered successful, and we will convert an additional 19 EVs into fuel cell eREV PUDs.

In BP1, we found the optimum route so an accurate performance and charge strategy could be established. Next, we will integrate the fuel cell system into the EV system. At the same time, the optimal hydrogen tank size, packaging, and compartmentation was finalized with body builder. Based on the tank sizes and locations, the interior of the body will be modified. Next, the eREV will be taken through a series of factory, dyno, and durability tests before it is placed in active service.

RESULTS

Since this is an ongoing project, the desired results have not been achieved, but our analysis of the drive cycle has enabled us to simulate the best performance and charge strategy (Figure 2). The size and capacity of the hydrogen tanks have been determined and the main components for the integration between the two systems are well underway.

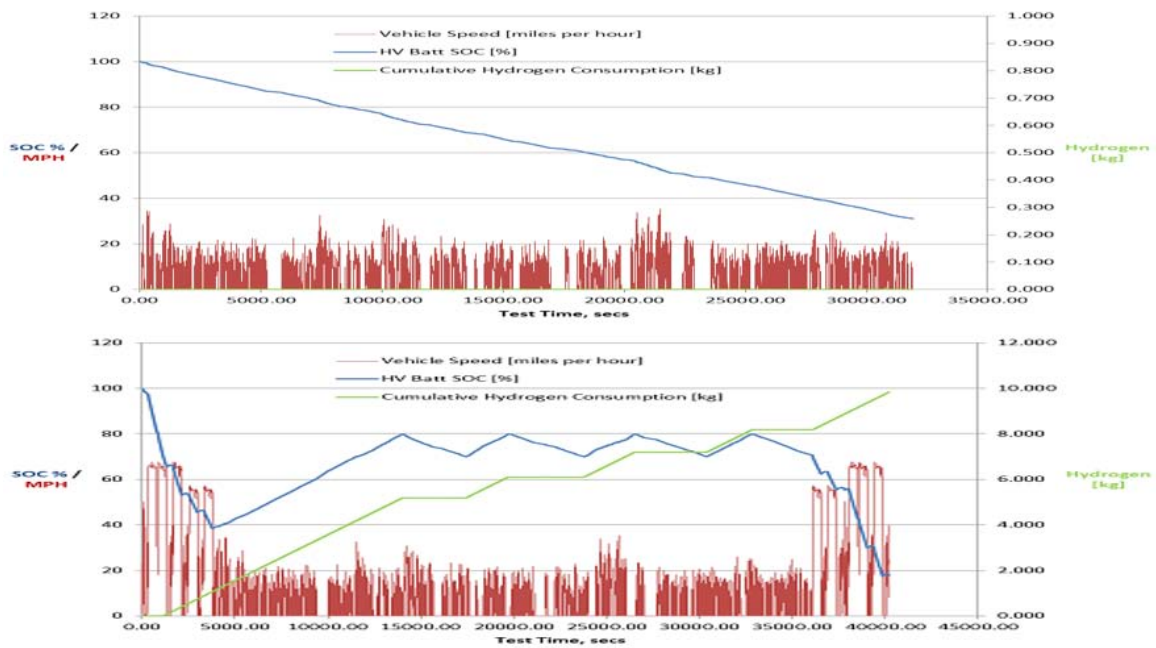


FIGURE 2. Simulated fuel cell eREV

CONCLUSIONS AND FUTURE DIRECTIONS

Based on the initial results, the fuel cell eREV PUD is proving to be a viable option when looking at the overall emission reduction requirements. This will be further clarified as the first unit is put into service and actual data from real life utilization is collected and evaluated.

Since the project is split into two separate BPs, the future direction is divided accordingly.

Budget Period 1

- Fuel system design
- Safety planning
- Design requirements
- Verify optimization analysis
- Communications and control strategies
- Leak detection and fuel isolation
- Integration of fuel cell into first truck
- Performance testing
- Shock and vibration testing
- Commissioning
- Place into revenue service
- Validation
- Prepare for BP2

FY 2016 PUBLICATIONS/PRESENTATIONS

1. Thomas Griffin, “Medium Duty Parcel Delivery Truck,” presented at the DOE Hydrogen and Fuel Cells and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting, Washington, D.C., June 6–10, 2016.

REFERENCES

1. Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan, Section 3.9 Market Transformation (n.d.). Retrieved September 13, 2016, from <http://energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22>.