X.6 Northeast Demonstration and Deployment of FCRx200

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Project End Date: February 28, 2022

Overall Objectives

- Design, develop, test, and demonstrate one fuel cell range extended plug-in hybrid utility vehicle (FCRx200) at the operator's site.
- Given a DOE "go" approval, deploy and operate a minimum of 20 FCRx200s for at least 5,000 hours per vehicle at the operator's site.
- Conduct an economic assessment, including a payback analysis cost per unit, and payback time concerning the use of hydrogen-fueled fuel cells for range extenders used in commercial operations.

Fiscal Year (FY) 2017 Objectives

- Complete fuel cell power plant design.
- Initiate final procurement of all system components.
- Develop vehicle model.
- Receive vehicle computer-aided design files and Controller Area Network data.
- Release vehicle system interface (mechanical, electrical, and communications).
- Electronic packaging of the integrated isolated direct current to direct current converter
- Balance of plant component design, packaging, and testing.
- Fuel cell engine controller.
- Fuel cell engine vehicle packaging.
- Hydrogen storage tanks selection and integration.
- Hydrogen fill interface.
- Hydrogen sensors and safety system.

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.

(A) Inadequate standards and complex and expensive permitting procedures

(B) High hydrogen fuel infrastructure capital costs for Polymer Electrolyte Membrane (PEM) fuel cell applications

(E) A lack of flexible, simple, and proven financing mechanisms

Technical Targets

This project directly addresses the Market Transformation program targets described in Section 3.9.4 of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan. The FCRx200 features Nissan's lithium-ion battery, which is entirely housed under the cargo floor. This project meets United States customer duty cycles using proven Nissan LEAF battery technology in the FCRx200 and UTC derived proton exchange membrane fuel cell technology. The FCRx200's 24 kWh battery is similar to the Nissan LEAF's, but with a revised module layout for packaging requirements and with the addition of an active battery cooler to accommodate the higher quick charging and driving load demands expected in commercial usage. By more than doubling the range, the FCRx200 will be a deployment that can demonstrate fuel cell range extenders for battery-based electric vehicles in Class 1 vehicle platforms. It is an enabling technology that makes electric-powered cargo vehicles a viable solution for a wide range of applications, including passenger transportation services, light freight transport, and dispatch utility operations where electric drive transportation systems are beginning to be introduced commercially.

FY 2017 Accomplishments

- Developed model for powertrain optimization.
- Designed fuel cell auxiliary power unit and balance of plant.
- Finalized concept for cell stack assembly prototype and validated testing.
- Performed short stack performance testing.
- Defined the vehicle packaging boundaries.
- Tested the initial scaled isolated direct current-to-direct converter.

INTRODUCTION

Although battery-electric vehicles emit zero tailpipe emissions and are less expensive to operate than conventional vehicles, the range of battery-electric vehicles is severally limited. Short driving range and charging time reduces the usefulness of these vehicles, especially for commercial use and/or long trips. Also, the use of heating, ventilation, and air conditioning will reduce the battery-electric vehicle range, making it not practical for cold climates. While some vehicles extend range through internal combustion engine-based generators, these decrease fuel efficiency and increase emissions. Alternatively, fuel cell generators can be used to extend range with zero emissions and reduce the need for charging. In the long-term, fuel cell electric systems may offer lower costs, shorter payback times, and a higher return of investments all the while providing additional benefits such as better performance. In this project, US Hybrid and other strategic project partners collaborate to build a fuel cell range extended plug-in hybrid utility vehicle and demonstrate it in real-world operation.

- US Hybrid: prime contractor
- Nissan North America: original equipment manufacturer partner
- Argonne National Laboratory: national laboratory partner
- National Grid: end user, fleet operator

APPROACH

US Hybrid is the prime contractor. It leads the design and development of the FCRx200. It is responsible for the design, development, and manufacturing of the fuel cell power plant range extender sub-system, fueling (storage and fill) and the integration of the vehicles. US Hybrid also leads the controls integration and battery hybridization work. US Hybrid is responsible for end user training and service and maintenance of the vehicles as they operate in the field.

RESULTS

US Hybrid began the process of developing the model for the powertrain optimization as well as designing the fuel cell auxiliary power unit and balance of plant. Fuel cell design iterations for flow field design, platform sizing, sealing, as well as axial loading structure were performed. An initial concept of the cell stack assembly for prototype and validation testing was finalized and the initial power plant packaging concept started. Fuel cell full-size test stand preparation was started to enable testing of the new system (Figure 1). A new load bank was installed to enable cell stack assembly voltage range and power limits, as well as fuel, air, and water test stand systems to provide required flows. US Hybrid also worked on the 3-D modeling component performance specifications as well as control constraints. A process and instrumentation diagram for the fuel cell power plant and thermal management system initial concept was released and components were added to 3-D model (Figure 2 and Figure 3).

FIGURE 1. Fuel cell stacks at test stand

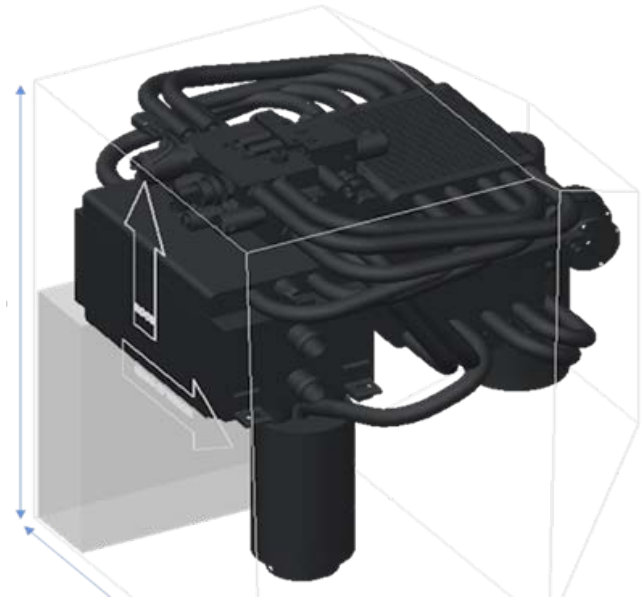

FIGURE 2. Fuel cell engine concept

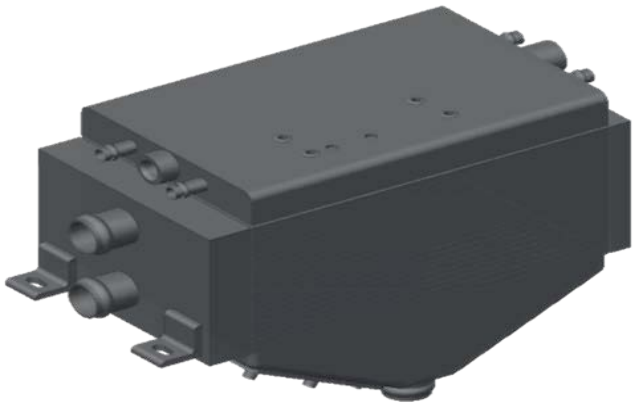

FIGURE 3. Thermal management system

UPCOMING ACTIVITIES

The following work is proposed for FY 2018.

- Complete design and integration of prototype vehicle.
- Validate vehicle's performance.
- Demonstrate FCRx200 at operator's site.