Northeast Demonstration and Deployment of FCRx200

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Subcontractor:
Nissan North America, Inc., Franklin, TN

Project Start Date: September 1, 2016
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) 2018 Objectives

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

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]:

(A) Durability

(B) Cost

(C) Performance

- Cell Issues
- Stack Water Management
- System Thermal and Water Management
- System Air Management
- System Start-Up and Shutdown Time and Energy/Transient Operation.

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)
- Milestone 1.12: Complete test and business case analysis for onboard fuel cell rechargers for battery electric vehicles. (1Q, 2015)

The FCRx200 features Nissan's Li-Ion battery, which is entirely housed under the cargo floor. This project meets U.S. 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

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

transport, and dispatch utility operations where electric drive transportation systems are beginning to be introduced commercially.

FY 2018 Accomplishments

- Completed comprehensive vehicle component placement and packaging designs.

INTRODUCTION

US Hybrid utilized an in-house-fabricated fuel cell power plant (FCRx) to hybridize and range-extend the modified e-NV200 drivetrain prototype. Fuel cell stack sizing, balance of plant, and its configuration with the battery were designed in detail during the project's design phase. The fuel cell will be powered and refueled with pressurized hydrogen gas stored in on-board tanks. The integrated design with innovative balance of plant technology enables robust performance with reduced system complexity, weight, and volume to extend operation life and provide lower total cost of ownership (TCO). With a compact volume, the FCPx (Figure 1) is engineered specifically for an automotive application and was designed to be installed under the hood of conventional vehicles. The FCPx offers more than 50% efficiency over wide load range.

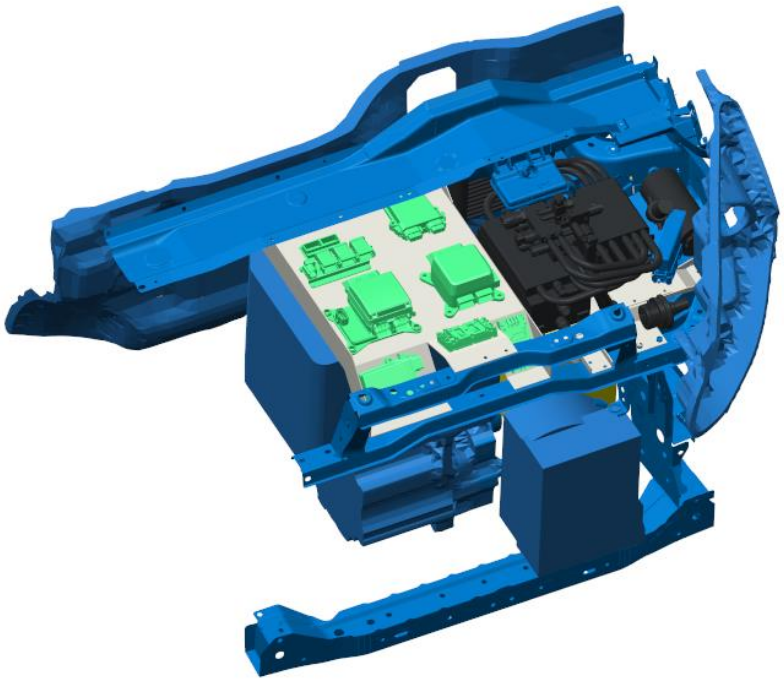

Figure 1. US Hybrid range extender fuel cell system

APPROACH

US Hybrid led the design and development of the FCRx200. It was responsible for the design, development, and manufacturing of the fuel cell power plant range extender subsystem, fueling (storage and fill), and planned integration of the vehicle. US Hybrid also led the controls integration and battery hybridization work.

RESULTS

In FY 2018, US Hybrid continued work on modeling and optimization, FCPx and balance of plant design, and vehicle packaging. This included hydrogen tank placement and packaging, fill port component location, system radiator location, cooling package, and range extender system enhancements and packaging (Figures 2–4).

After discussing limits of Nissan's cooling package, it was decided that installing another radiator directly in front of Nissan's existing cooling package would detrimentally impact the performance of Nissan's cooling package. Installing two auxiliary radiators behind daytime running light holes will allow for fresh air to flow through radiators and not introduce any detrimental heat rejection problems. Nissan confirmed no problem with removing daytime running lights. Also, they are not needed according to transportation laws.

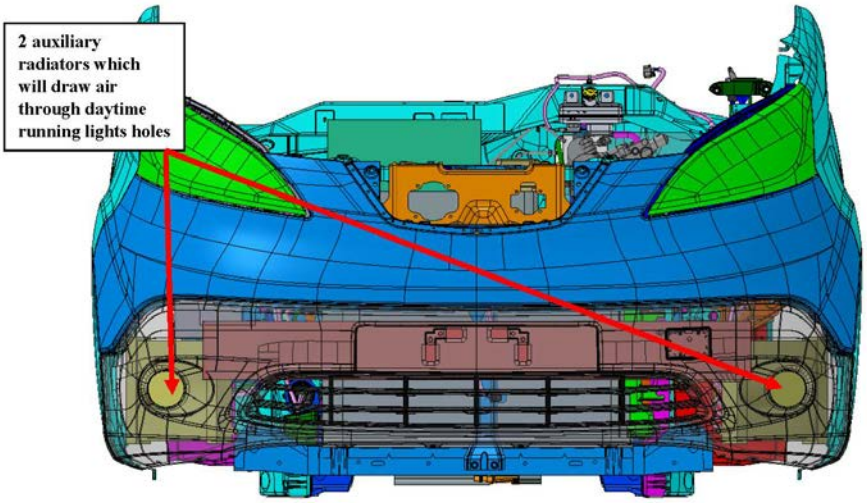

Figure 2. Cooling package

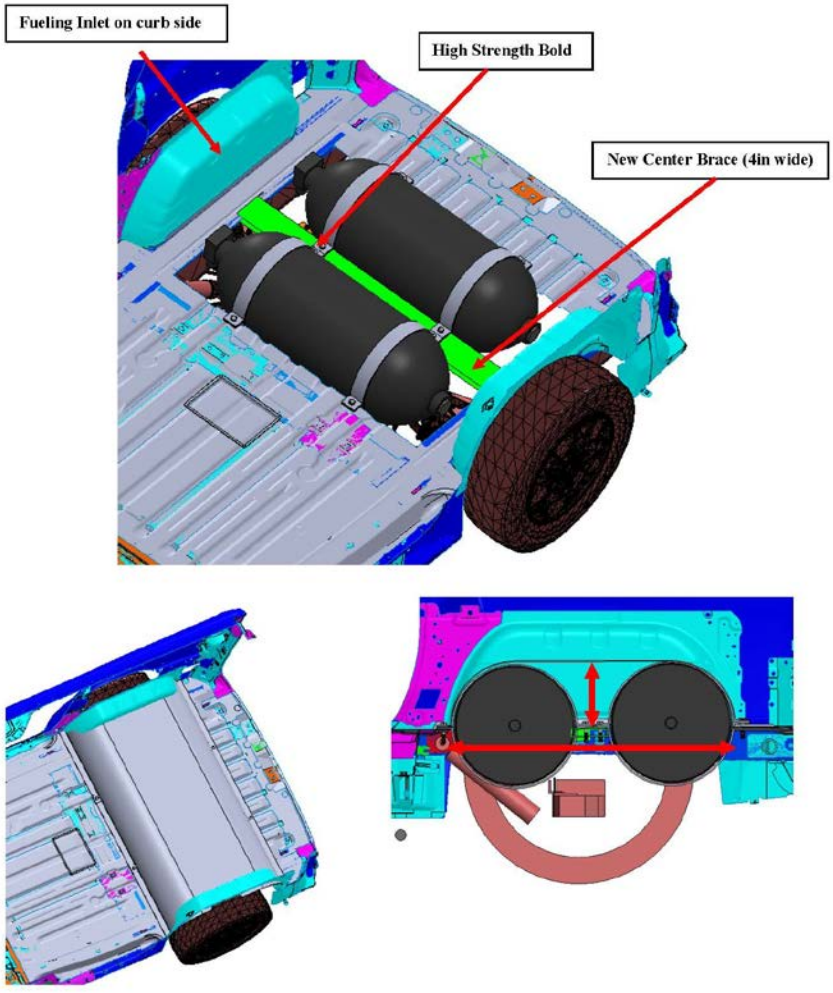

Figure 3. Hydrogen tank packaging and enclosure

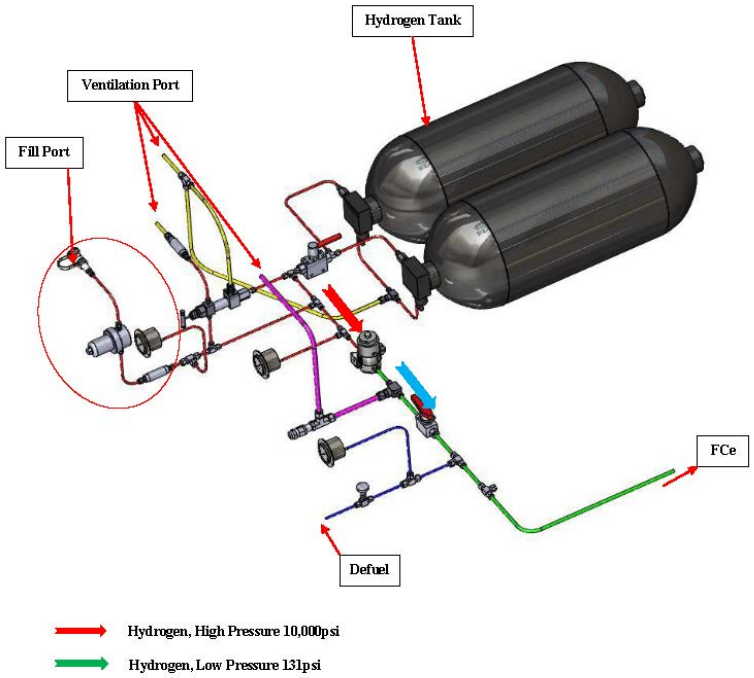

Figure 4. Piping and instrumentation diagram

CONCLUSIONS AND UPCOMING ACTIVITIES

FY 2019 proposed activities include:

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

Information that was gathered this year from designs will be utilized in wrapping up design and fabrication of the FCPx, DC-DC power converter, hydrogen storage, and other subsystem components. The components will then be integrated into the vehicle, tested, and validated for performance criteria.