Northeast Demonstration and Deployment of FCRxNV200

Project ID# TA012

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US Hybrid

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Overview

Timeline

- Project start date: Sept. 2016
- Budget Period 1 / Phase 1 end date 6/30/2019
- Project end date: Feb. 2022

Budget

Total project cost:	$6,004,260
DOE share:	$2,999,760
Non-Federal Cost Share.	$3,004,500

Barriers & Targets

- Evaluate technology viability
- Evaluate technology user acceptance
- Data collection and analysis

Partners

- Argonne National Lab
  Powertrain & energy Mgmt.. modeling
- Nissan North America
  OEM Partner
- National Grid
  Fleet deployment partner
- US Hybrid
  Technology Provider and Integrator

Northeast Demonstration and Deployment of FCRxNV200

Project Concept and Teams

- Fuel cell hybrid drivetrain significantly extends zero-emission driving range vs. battery only
- Project Team: US Hybrid (prime), Nissan, ANL, and National Grid (fleet operator)

Project Scope

- Phase 1: development phase to build & test prototype range-extended delivery van
- Phase 2: two-year demo of multi-unit fleets at host site under "real world" operating environments

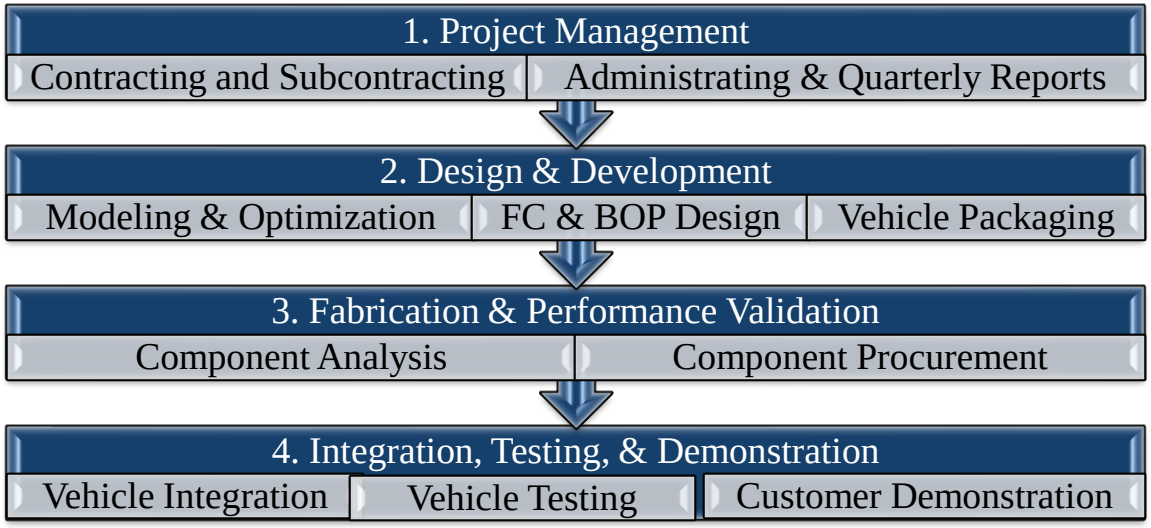
Proposed Technical Specifications:

- Nissan e-NV200 base vehicle platform
- 5 kW fuel cell powerplant
- 2-3 kg H2 storage @ 700 bar
- 250 miles extended usable range (vs. BEV @ 100 miles)
- 24 kWh lithium-ion battery

Project Approach/Scope

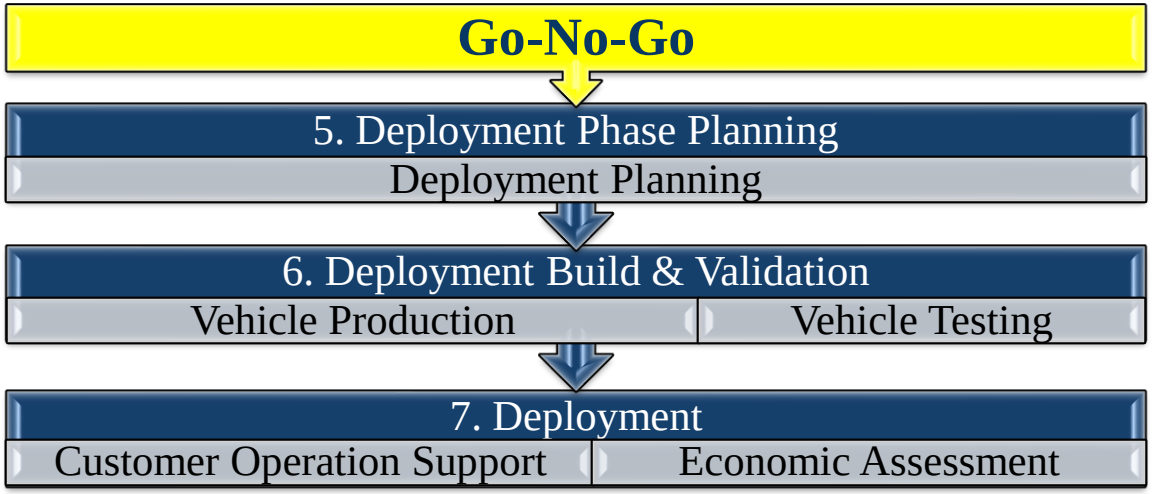
1. Design and develop a FC range extender vehicle based on Nissan eNV200 utility van (FCRxNV200)
2. Fabricate a total of 21 utility Van (one-demonstration and 20 deployment)
3. Road operation testing to validate vehicle performance and operate the vehicles during demonstration and deployment
4. Collect and analyze performance and operational data

Approach: Phase 1 Milestones



Phase 1 Milestones

Phase2 Milestones



Go/No-Go Decision Criteria:

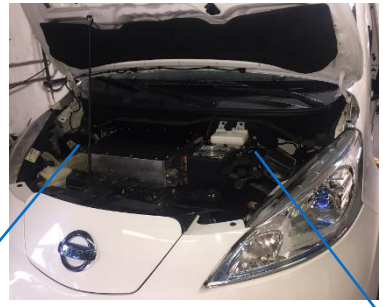
1. The prototype vehicle must be proven capable of daily operation of 8 hours without hydrogen refueling and electric recharging.
2. A minimum of one week of cold weather testing.
3. Actual energy efficiency and range of the prototype vehicle must be measured.
4. An updated production and deployment schedule (Deliverable D5.1) must be submitted to DOE.

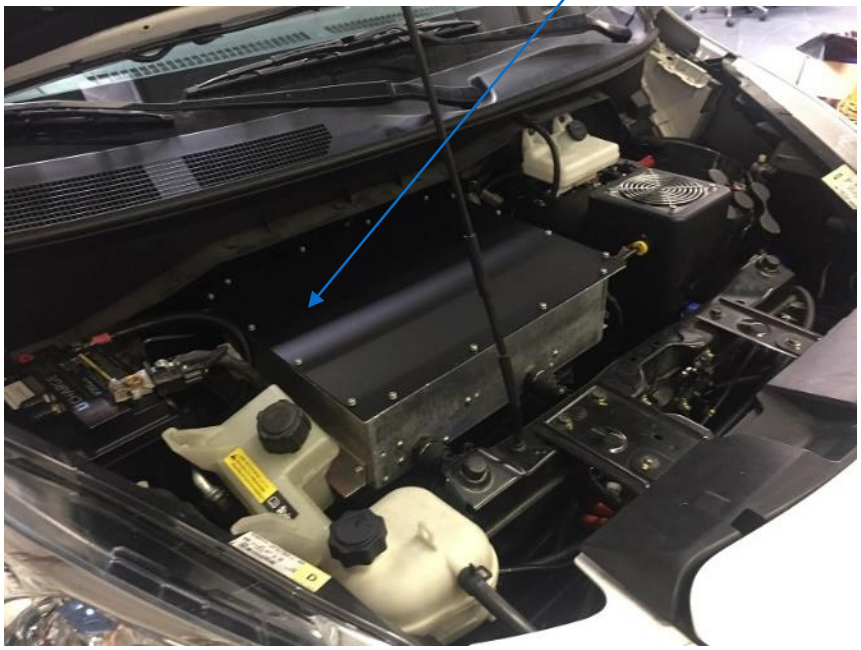
"Any proposed future work is subject to change based on funding levels."

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 H2-fueled fuel cells for range extenders used in commercial operations

FC engine Vehicle Integration and Packaging (Under Hood)





Vehicle Integration and Packaging (Cargo and fuel port)

Front FC engine Radiator

H2 Fueling , Passenger side (fueling location)

H_2 Tank Integration

Cargo Space Rear View (5" Floor raised)

Cargo Space Front View

Under Body Rear view

Under Body front view

Proposed Future Work

Remainder of 2019

- Vehicle testing by Nissan
- Go-No-Go
- Vehicle Test by Argonne National Lab.
- Vehicle Testing by end-user

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Safety Plan / Hazard Analysis

US Hybrid has completed Safety Plan/Hazard Analysis including, Scenario Description, Scenario Impact, Mitigation Strategies and Strategy Integrity for the following components, sub-system and system level;

1. FCe™10 Fuel Cell engine Hazard Analysis
2. Hydrogen storage and fueling Safety plan
3. Vehicle Safety Plan

Collaboration and Coordination

- Argonne National Lab:
  - Vehicle model and energy management
  - Economic assessments including comparisons of lifetime GHG and fleet ownership costs.
- Nissan North America
  - Provide the supporting vehicle specification
  - CAD models and CAN messages
  - Energy management and conduct on-road vehicle testing

Commercialization Challenges and Barriers

1) Vehicle model (eNV200) has been changed to larger EV with 40kWh of battery
2) There is no plan for OEM to deploy the FCRx200 with new eNV200 platform in North America.
3) Commercial deployment of phase II has high risk as following;
    i. Lack of OEM support for parts and service impacting quality of service
    ii. Fueling Infrastructure development in North East has been limited
    iii. Duel Fueling Infrastructure (Hydrogen and electric charging) complicates operation.
    iv. End-user is limited to use public fueling infrastructure not on site fueling.

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Responses to 2018 Reviewer's Comments

Question 1: Approach to performing the work (rated 3.1 for identifying and addressing barriers, project design, feasibility, and integration with other efforts.)

Q: the current figures show $14,000 for a 10 kW system, which seems very low. However, to fully assess this, it would be necessary to understand the technology the fuel cells used, whether they were polymer electrolyte membrane fuel cells or solid oxide fuel cells. It was not possible to get the details on this.

A1: PEM fuel cell is used with porous carbon plate and integrated BOP and dc-dc converter operating at 100 kHz with high efficiency. We have a verified cost model for the unit for 10k quantities that validates the propose pricing.

Q: It is not clear how much attention was put into optimizing the system (in terms of range, durability, efficiency, etc.) during the design optimization phase to get the best performance possible. Cost and customer satisfaction are the key, if not only, parameters considered.

A2: Battery/fuel cell sizing was not optimized, due to existing EV platform. Fuel Cell was sized to provided sustained operation even if user does not plug the vehicle in. This is a charge sustained FC vehicle system.

Q: The presentation did not adequately demonstrate why these activities are good for the Program or the broader fuel cell community.

A3: The objective of demonstration is to reduce the FC engine size to reduce cost as a mean of commercial viability and ROI and cold climate operation. Consider the FC engine to be an on-board heater with electric bi-product for low duty cycle, long operating time utilization.

Question 2: Accomplishments and progress (Rated 3.0 for its accomplishments and progress toward overall project and U.S. Department of Energy (DOE) goals.

Q: Select technical data were presented; however, these were not compared to initial technical goals, making it difficult to understand whether the progress was in line with the plan.

A1: Project Technical goals were met. Commercial viability for Phase II is constrained due to vehicle Model change and availability by OEM and service and maintenance support.

Responses to 2018 Reviewer's Comments

Question 3: Collaboration and coordination (Rated **3.1** for its collaboration and coordination with other institutions)

Q: It is unclear whether the powertrain supplier fully owns the intellectual property rights of the powertrain to be integrated, and hence it is difficult to assess how relevant it would be to also target other OEMs at a later stage.

A1: Developer owns the intellectual property rights of the fuel cell engine, while OEM owns the EV powertrain on the vehicle.

Q: It is not clear that all project partners (Nissan, for example) are engaged or committed to the project's success.

A2: eNV200 platform has been changed to higher capacity range and Nissan has no plan to deploy the new platform in US market.

Q: This project does not seem to address the overall market projection for utility vans. It is unclear how many there are in the United States and whether successful demonstration of these vans could apply to other van markets.

A3: The development and lessons learned in this project has already been implemented in a commercial deployment of fuel cell engine Ford Transit for Para-Transit operation at SARTA.

Question 4: Relevance/potential impact (Rated **2.7)**

Q: how the project intends to build volumes beyond the 20-vehicle fleet remains unclear.

A1: The economic assessment of the project may result on a more optimized FC/Battery balance especially to reduce the curb weight of the vehicles for commercial vehicles for all climates, seasons and drive condition/cycles.

Q: it is unclear who else, besides the partners involved in the project, will be able to benefit from this activity.

A2: Currently a transit agency and port truck is utilizing similar approach.

Q: It is unclear how this project, if successful, would affect the total van market.

A3: See A2.

Responses to 2018 Reviewer's Comments

Question 5: Proposed future work

Q: It is also not clear which elements will be considered for the go/no-go decision.

A1: Go/No-Go Decision Criteria are;

1. **The prototype vehicle must be proven capable of daily operation of 8 hours without hydrogen refueling and electric recharging,**
2. **A minimum of one week of cold weather testing,**
3. **Actual energy efficiency and range of the prototype vehicle must be measured and**
4. **An updated production and deployment schedule (Deliverable D5.1) must be submitted to DOE.**

Q: The lack of a safety plan or hazards analysis suggests that the project is not well prepared for future work.

A2: Safety Plan has been completed along with system level FMEA

Summary

Objective/Relevance

- The project's goals are to; (1) test and demonstrate one FCRx200 at the operator's site;
- (2) 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; and
- (3) conduct an economic assessment, including a payback analysis, cost per unit, and payback time concerning the use of H2-fueled fuel cells for range extenders used in commercial operations.

Approach

- Design, Develop a FC range extender vehicle based on Nissan eNV200 utility van.
- fabricate a total of 21 utility Van (one-demonstration and 20 deployment)
- Road operation testing to validate vehicle performance and operate the vehicles during demonstration and deployment.
- Collect and analyze performance and operational data

Technical Accomplishments

- FC engine vehicle integration completed
- Hydrogen Tank Storage and fueling interface integration completed
- FC engine and vehicle interface verified
- Fueling test complete
- FC engine operation in Vehicle Verified

Future Work

- Vehicle Testing by Nissan
- Argonne National Lab Testing
- DOE GO-NO-GO

"Any proposed future work is subject to change based on funding levels."