



REV Demonstration Project:
Electric School Bus V2G
2019 3Q Quarterly Progress Report

Dated: October 31, 2019

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1.0 EXECUTIVE SUMMARY

Consolidated Edison Company of New York, Inc. (“Con Edison” or the “Company”) submits this quarterly report on the progress of the Electric School Bus V2G REV Demonstration Project (the “Project”) it is implementing as part of the Reforming the Energy Vision (“REV”) proceeding, as required by the Order Adopting Regulatory Policy Framework and Implementation Plan, issued by the New York State Public Service Commission (“Commission”) on February 26, 2015.¹

1.1 PROGRAM ACHIEVEMENTS

On June 8, 2018, Con Edison submitted the Project for approval by Department of Public Service Staff (“DPS Staff”). On June 20, 2018, DPS Staff approved the Project. Con Edison filed an implementation plan for the Project with the Commission on November 13, 2018. In Q3 2019, the Company focused on the implementation of the Project, specifically integration of vehicle to grid technology.

1.2 CYBERSECURITY AND PERSONALLY-IDENTIFIABLE INFORMATION PROTECTION

Consistent with Commission policy related to cybersecurity and the protection of personally-identifiable information (“PII”), each partner agreement executed for the implementation of the Project includes, where applicable, specific protections related to cybersecurity and PII. This protection is critical in encouraging customers to sign up with new and innovative services offered by utilities.

1.3 ACCOUNTING PROCEDURE ESTABLISHED

On February 16, 2016, in Case 15-E-0229, Con Edison filed an accounting procedure for the accounting and recovery of all REV demonstration project costs.² This accounting procedure establishes a standardized framework that will govern how the Company categorizes and allocates the costs of the REV demonstration projects and will facilitate analyzing each project to determine the overall financial benefits of the program to customers.

¹ Case 14-M-0101, *Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision*, Order Adopting Regulatory Policy Framework and Implementation Plan (issued February 26, 2015).

² Case 15-E-0299, *Petition of Consolidated Edison Company of New York, Inc. for Implementation of Projects and Programs that Support Reforming the Energy Vision*, General Accounting Procedure.

1.4 COSTS, BENEFITS, AND OPERATIONAL SAVINGS

Budget information for all of the Company's REV demonstration projects is being filed confidentially with the Commission, concurrently with the filing of this document. All costs filed are incremental costs needed to implement the projects. To reduce overall project costs, Con Edison worked closely with NYSERDA to take advantage of an expiring grant program.³ Due to the early stage of implementation for the Project, there are no operational savings to report at this time.

1.5 ELECTRIC SCHOOL BUS V2G

The Project is designed to examine the technical and operational viability of using school buses as both a grid resource and transportation asset. Key tests include determining whether electric school buses function well for transportation purposes, are reliable as grid assets, and that their use as grid assets does not cause excessive wear and tear on the equipment. Con Edison has partnered with First Priority Green Fleet ("First Priority"), who is responsible for project management, design and construction of vehicle and site hardware, and vehicle to grid (V2G) operations and analysis.

In Q3 2019, Con Edison, First Priority, Nuvve Corp ("Nuvve") and Lion Electric ("Lion") achieved several major milestones regarding site construction, V2G vehicle implementation, and site interconnection approval. The completion of these milestones reflects the project partners' determination and technical skills.

³ The federally funded NYT-VIP program.

2.0 ELECTRIC SCHOOL BUS V2G – QUARTERLY PROGRESS

2.1 DEMONSTRATION HIGHLIGHTS

2.1.1 Q3 2019- Major Task Completion

- Project Planning:
 - All major project planning complete
- Phase 1: Electric Bus Operations & Analysis:
 - Buses operational for 310 school days with 98% uptime
- Phase 2: Design and Construction of Charging & V2G Infrastructure
 - Relay and contactor installed, marking completion of site construction
 - Revised interconnection plan approved
 - V2G prototype test completed in Montreal, leaving only one major step left in V2G commissioning

2.1.2 Activities Overview

Project Planning: In Q4 2018 the Project team entered into partner agreements with First Priority, the project implementor, and National Express, the bus owner and operator.

Phase 1: Electric Bus Operations and Analysis

The Project team is in the final stage of preparing the buses for V2G deployment. All site infrastructure is complete. Con Edison approved First Priority's initial interconnect requirements application and the revised interconnect submission that reflects the new use of invertors on board the vehicle.

The electric school buses performed their primary student transportation function well. This was the key phase one goal. National Express reported 98% average operational uptime last quarter and this quarter. Reliability has been stable and excellent. The drivers that used to operate the non-electric school buses have continued to operate the electric vehicles and continue to report high vehicle satisfaction, according to the quarterly survey of National Express performed by First Priority.

In December 2018, First Priority successfully installed cellular data loggers that are intended to capture miles travelled, energy per trip, state of charge (SoC), and energy per mile. These data help detail the cost of operating an electric vehicle and

the range in real world driving and weather conditions. The data loggers are accurately reporting miles travelled and vehicle location but do not currently calculating energy metrics accurately. This issue has been identified by First Priority and Lion and will be addressed after the V2G integration is completed. In the interim, National Express has shared their additional electric costs determine financial impacts of bus charging.

Phase 2: Design and Construction of Charging and V2G Infrastructure

The development of V2G is ongoing. Former subcontractor BTC did not deliver the computer boards necessary for the communication platform to communicate with the school bus. Lion and FPGF mitigated the issue through a new integration partner, Nuvve. Nuvve assisted in achieving several major V2G milestones. They: integrated a new two-way inverter onto the vehicle, added Nuvve's "Vehicle Smart Link" into the Lion bus and created all the communication commands necessary for discharge. The only remaining step for enabling V2G on the school buses requires attaching the inverter and Nuvve equipment into the vehicle. This requires ensuring that they can handle the long-term vibrations and jostling of road travel. Lion is in the process of completing this.

Site construction is complete.

A complication and long-term impediment to scalability are meeting the New York State distributed generation interconnect requirements. Distributed energy resources must meet certain standards to ensure that they are safe for utility workers and can work within normal power fluctuations. The initial plan used off-board inverters that had UL 1741 certification to meet these standards, but on-vehicle inverters, which the Nuvve solution uses, may not even be capable of obtaining this certification. This project includes a relay and a 600-amp contactor, which meets the safety requirements, but adds cost and requires space.

2.1.3 Key Metrics

The following data supports the Phase 1 goals of reliability and bus performance.










- E-school bus days of operation: 310
- Vehicle failures due to out of specification range: 0

- Misleading range data provided to driver: 0




2.1.4 Next Quarter Forecast

In Q4 2019, the Project team aims to complete V2G commissioning, including operating a V2G test vehicle on site and having the buses be fully upfitted. The necessary V2G hours for the test will be preserved by discharging during school vacation and weekends.

2.1.5 Checkpoints/Milestone Progress

Checkpoint/Milestone	Timing*	Status
Buses Perform as Expected as Transportation	Phase 1 Midpoint / End	  
Network integration and System testing	Phase 2 Midpoint / End	  
Battery and vehicle impacts evaluated and documented	Phase 3 Midpoint / End	  

Legend

 On Schedule	 Delayed w/out Major Impact	 Delayed or Stopped – Project Goals Impacted
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2.1.6 Planned Activities

2.1.6.1 Customer Acquisition

Status: **Green**

Expected Target by Phase 1 Midpoint: No vehicle failures due to below specification range or misleading data provided to driver.⁴

⁴ Maximum range for these vehicles is 80 miles per charge. Use of heating, air-conditioning and regenerative braking are all factors that can affect range. An example of misleading data provided to the driver would be the bus reporting 40 miles of driving range when in fact only 20 is available. This would make the vehicle unreliable from the driver's perspective.

Actual by Phase 1 Midpoint: No vehicle failures due to below specification range or misleading data provided to driver.

Solutions/strategies in case of results below expectations: Use diagnostic data to determine cause of failures. Work with customer (National Express) to pursue any out of specification vehicle failures with manufacturer.

2.1.6.2 Construction/Commissioning and Integration

Status: **Yellow**

Expected Target by Phase 2 Midpoint: Inverter hardware works 100% of the time after pre-summer V2G period diagnostic testing. Software responds to all communication signals and control V2G discharge.

Actual by Phase 2 Midpoint: N/A

Solutions/strategies in case of results below expectations: Software troubleshooting methodology from past V2G projects, onsite testing, and potential hardware replacement. Testing of onsite hardware separate from vehicle integration to isolate problem.

2.1.6.3 Battery and vehicle impacts evaluated and documented

Status: **Green**

Expected Target by Phase 3 Midpoint: V2G use expected to have little quantitative or perceived impact on the vehicle's primary transportation asset value. Performance targets are .3%-2% per season.

Actual by Phase 3 Midpoint: N/A

Solutions/strategies in case of results below expectations: Reduce depth of discharge and peak state of charge to see if battery wear impacts can be brought to within expected parameters. Explore cell temperature controls.

2.2 CHANGES TO THE PROJECT DESIGN

Nuvve’s solution utilizes on-board invertors as opposed to off-board invertors has required site design changes, including the addition of a relay and contactor common in CHP distributed generation.

2.3 WORK PLAN & BUDGET REVIEW

2.3.1 Phase Review

The Project team has completed its Project Planning and made progress on Phase 1 (Bus Operations and Analysis) and major progress on Phase 2 (Design and Construction of Hardware and V2G Infrastructure).

Phase Progress

2.3.2 Work Plan

Phase 1 – Electric Bus Operations and Analysis (Completed)

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
Timeframe: April 1, 2018 – December 31, 2018						
1.1	Delivery of buses to FPGF/NJ	Sales transaction completed; full payment rendered by NELLC; buses shipped from The Lion Electric Company in Montreal	X		X	
1.2	Pre-inspection and preparation	Buses pre-inspected, customized, detailed and prepared for delivery	X		X	
1.3	Bus delivery to White Plains Bus Company (“WPBC”)	Buses arrive at WPBC and pass inspection by DMV	X		X	
1.4	Training	FPBS provides operational and technical training to WPBC personnel	X		X	
1.5	Buses operational	Buses deployed on designated routes and fully functional	X		X	
1.6	Performance analytics	Initial data collected from charging stations, bus telematics, and data loggers	X			

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
1.7	Quarterly reports initiated	Initial performance data analyzed, findings produced and reported	X	X		

Phase 2 – Design and Implementation of Charging and V2G Infrastructure (Underway)

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
Timeframe: July 1, 2018 – May 31, 2019						
2.1	Pre-installation Engineering plan	Site assessments, engineering drawings	X			
2.2	Electrical service request	Con Ed receives service request from FPGF	X			
2.3	Service plan	Assessment by Con Edison, issuance of service upgrade plan		X		
2.4	EVSE installation plan	Assessment by Healy Electricity, issuance of EVSE site plan	X			
2.5	Equipment ordering	EV Connect orders BTCPower hardware/equipment	X			
2.6	EVSE installation	BTCPower charging stations installed without V2G capability or smart charging capability	X			
2.7	EVSE testing	Testing on “BTCPower dumb chargers” to ensure charging functionality	X			
2.8	Chargers operational and networked	Chargers able to charge buses and connected to ChargePoint Energy Management Platform (EMP)	X			
2.9	Commissioning and training	EV Connect and ChargePoint provide training on charger operations to WPBC personnel	X			
Timeframe: June 1, 2019 – September 30, 2019						
2.10	Charging station swap	Nuvve orders and delivers 5 PowerPort charging stations to WPBC in place of BTCPower chargers	X			X
2.11	Charging station swap	FPGF contracts Healy Electric to swap/install Nuvve chargers with BTCPower chargers and relays and disconnects.	X			X
2.12	Activation and Training	Nuvve confirms that charges are fully functional and commissions “charging only” functionality				X
2.13	Bus modifications	Lion NRE design and development: Lion completes schematics, wire selections, harness assemblies, enclosures and connectors			X	
2.14	Bus modifications	Lion decommissions existing onboard charger			X	
2.15	Bus modifications	Lion purchases and installs new inverters and CurrentWays onboard chargers			X	
2.16	Bus modifications	Lion creates new interface program to enable power rates and V2G charging schedules			X	X
2.17	Bus modifications	New Lion configuration retrofitted on all buses			X	

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
2.18	Bus modifications	Road testing successfully completed all buses			X	
2.19	Bus modifications	Repair of data logger connections			X	
2.20	Bus modifications	Nuvve configures and places Nuvve VSL onboard Lion vehicle			X	X
2.21	Bus modifications	Nuvve develops and configures required CAN messages between VSL, charger, and vehicle systems			X	X
2.22	Commissioning	Nuvve charging stations commissioned to communicate with Nuvve platform in place of ChargePoint EMP				X
2.23	Bench Test	Bench test of V2G discharge at Lion facility by August 2019			X	X
2.24	Commissioning	Nuvve configures WPBC buses on Nuvve aggregator for grid services				X
2.25	Integration full fleet	Complete installation of equipment and commission five buses			X	X
2.26	Commissioning and training	Nuvve and Lion test charging and discharging, conduct troubleshooting and ensure V2G full functionality; provide training to WPBC			X	X

Phase 3 Activities, Deliverables and Timeframe:

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
Timeframe: October 1, 2019 – September 30, 2021						
3.1	V2G commissioning and launch	Fall 2019 full launch of V2G	X	X	X	X
3.2	V2G baseline	Summer 1 2019 battery baseline established with assistance from ChargePoint	X			X
3.3	V2G analysis 1	Fall 2019; data collected from Nuvve platform, buses and charging stations compiled, analyzed and findings reported	X			X
3.4	V2G continues Summer 2	Summer 2020 V2G deployed for second evaluation period	X	X	X	X
3.5	V2G analysis 2	Fall 2020; data collected from Nuvve platform, buses and charging stations compiled, analyzed and findings reported	X			X
3.6	V2G continues Summer 3	Summer 2021 V2G deployed for third evaluation period	X	X	X	X
3.7	V2G analysis 3	Fall 2021 data collected from Nuvve platform, buses and charging stations compiled, analyzed and findings reported	X			X

2.3.3 Updated Budget

Budget information is being filed confidentially with the Commission.

2.4 CONCLUSION

2.4.1 Lessons Learned

Phase 1's primary goal was to determine whether the buses function well in providing transportation. The buses are meeting expectations. Phase 2 has demonstrated that the V2G can be compatible with the CESIR process. While using either an on-board or off-board inverter is possible, the lack of UL 1741 certification for on-board inverters may add cost and approval time. Using hardware that is UL 1741 certified provides the easiest interconnection path since it requires less engineering review and may avoid the need for additional hardware.

2.4.2 Recommendations

None at this time.

Electric School Bus V2G REV Demo Project

The **School Bus V2G** (vehicle to grid) demonstration project is designed to examine the technical and operational viability of using school buses as both a grid resource and transportation asset. Key tests include proving that electric school buses function well for transportation purposes, are reliable as grid assets, and that using them as grid assets does not cause excessive wear and tear on the equipment.

The buses have been performing as transportation since September 2018. A necessary v2g component was delayed by a subcontractor but project partners have adopted and implemented an alternative plan.

Project Inception: June 2018

Project Launch: September 2018

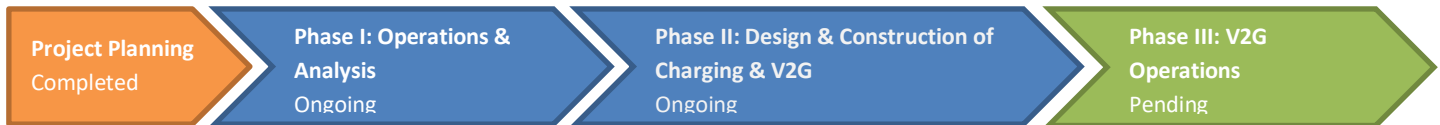
Project End Date: September 2021

Budget: \$1.08M

Q1 2019 Spend: *Filed confidentially*

Cumulative Spend: Filed

confidentially (on budget)



Lessons Learned: Customers (bus operator)

- Success requires embracing operational changes for maintenance staff and drivers
- The buses have succeeded because they have been reliable, with a minimum of fit & finish issues
- The company hopes to use e-buses as a competitive advantage

Lessons Learned: Market Partner

- Con Edison is one of the first test markets of V2G and they are uncertain of national demand
- Locally, NY-area operators need an e-bus provider that can provide the transportation, electrical infrastructure, and any V2G integration

Lessons Learned: Utility

- V2G, as designed in this project, can go through existing DG interconnect processes
- Having hardware comply with UL 1741 or other standard, will lower future project costs

Application of Lessons Learned: *Electric school buses can be successfully operated by a vehicle operator that is motivated, committed and sophisticated enough to accept the need for operational changes. The primary major hurdle for the next phase of adoption is vehicle and infrastructure cost.*

Issues Identified: The subcontractor required to provide the charger hardware and communication chips to enable V2G was replaced with Nuvve. This reduces the summer discharge period. Project partners have been managing the problem and have an alternative that maintain the project's fundamentals.

Recent Milestones: *a) No vehicle failures from technical causes or otherwise b) 310 days of school bus operations c) prototype V2G school bus tested in Montreal d) all major site work completed, including testing of site relay disconnect*

Upcoming Milestones: *Upfit existing school buses, initiate school bus discharge.*