



REV Demonstration Project:
Electric School Bus V2G
Q4 2020 Quarterly Progress Report

Dated: February 1, 2021

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1.0 EXECUTIVE SUMMARY

Consolidated Edison Company of New York, Inc. (“Con Edison” or the “Company”) submits this fourth quarterly report for 2020 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 Budget information is being filed confidentially with the Commission.

1.1. Project Background

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. The project is the first deployment of new, full-sized electric school buses in New York State. It is also the first to use school buses to perform “vehicle to grid” (V2G) charging, where the buses can discharge their batteries into the grid. The five e-buses serve the school district of White Plains and are operated by National Express.

The project includes the operation of the buses and adding new vehicle to grid technology. The buses have been operating since 2018. V2G reached a major milestone this quarter as the buses have successfully output power to the grid. When distributed generation utility interconnect approval is complete, the project will enter phase III: V2G operations.

Covid-19 has impacted two aspects of the project. Because of travel restrictions, Lion Bus Company cannot send technicians to the site. Three buses have been shipped to Lion, retrofitted, and returned to White Plains. The other two buses are doing less intensive V2G and can be retrofitted when travel restrictions ease. Additionally, National Express, the operator, has not been using the buses for regular service since the PAUSE orders were issued in March 2020. These impacts do not materially impact the project ability to test the demonstration hypothesis because V2G operations can be scheduled to provide adequate cycling of the vehicle batteries.

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).

1.2. Project Overview



Electric School Bus V2G REV Demo Project

The **School Bus V2G** (vehicle to grid) demonstration project (the “Project”) examines 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 used as transportation assets since September 2018. The buses have tested preliminary V2G operations on site and completed Con Edison’s interconnection process in preparation for V2G operations.

Project Start Date: June 2018
Project End Date: September 2021
Budget: \$1.08M
Q4 2020 Spend: *Filed Confidentially*
Cumulative Spend: *Filed Confidentially*



Lessons Learned: Customers (bus operator)

- Reliable operation of the bus to date helped prove the technology to the bus owner/operators including the maintenance staff and drivers that use the buses
- The operator is building experience with the e-bus that it can leverage competitive advantage

Lessons Learned: Market Partner

- V2G is custom built requiring several partners and disciplined project management for success
- Locally, NY-area operators need an e-bus provider that can provide the transportation, electrical infrastructure, and any V2G integration

Application of Lessons Learned: *The Company is working to operationalize V2G and reduce deployment costs.*

Issues Identified: The subcontractor required to provide the charger hardware and communication chips to enable V2G was replaced with Nuvve. Project partners developed an alternative that maintains the Project’s fundamentals.

Recent Milestones: Project completed interconnection process October 2020 and is cleared for V2G operations. .

Upcoming Milestones: Final two school bus V2G upfit installations (2Q). .

2.0 QUARTERLY PROGRESS

2.1 Activities Overview and Updates

The partners have successfully commissioned V2G on three of the five buses.² The system works reliably, can be controlled through Nuvve's dispatch system, and produces high quality power.³ To the best of the partners knowledge, this is the first original manufactured AC V2G project. AC V2G offers scalable market potential because it can minimize the additional equipment necessary to provide V2G.

The White Plains site completed Con Edison's Standard Interconnection Request process for distributed energy resources in early October 2020. The completion confirms the project can safely discharge to Con Edison's distribution system.

2.2 Key Metrics

I. Electric bus operations

The Lion buses continue to operate well. Technical and operational challenges resulted in decreased availability of buses in December. These disruptions range from technical issues with hardware components to operator error. The project team is addressing the disruptions with a combination of technical troubleshooting and operator training.

II. V2G Operations

The project cleared final requirements for V2G operations in October 2020 after which Nuvve began limited discharging of buses 770, 772, and 773 to the distribution grid during weekends and school holidays. Including V2G discharge during the school year is intended to meet the V2G targets for energy and cycles in the remaining project term. The partners determined that these metrics are most important to the project goal of observing impact on vehicle batteries.

² The remaining two buses have fewer planned discharge events. They are planned to be retrofit either when COVID travel restrictions ease, or when it is necessary for the project's schedule.

³ Nuvve Corporation is the vehicle to grid technology provider

2.3 Lessons Learned and Recommendations

The project has overcome technology integration challenges. While each component of the solution are existing mature products, having them perform in this new way required major engineering efforts on the part of Nuvve and Lion.

The lesson of project phase II is that V2G requires customer vehicle retrofits including a group of hardware and software solution providers, and technicians. The Company's goal is to prove its viability so that developers will improve the technology and standard V2G integration can be a feature on vehicles going forward.

3.0 NEXT QUARTER FORECAST

3.1 Planned Activities

The next major phase is to begin discharging the buses and monitor V2G impacts on the batteries. This will be accomplished through Lion's battery management system, which reports on pack voltage, a battery health indicator. V2G power quality will be observed through Nuvve's monitoring system, which provides a histogram of grid behavior with one second granularity.

The partners are operating V2G discharge on weekends and school holidays during the year to mitigate for the time lost to technical difficulties. The current schedule leads to the project reaching intended energy discharge goals.

4.0 APPENDICES

The following appendices are included at the end of this Quarterly Progress Report:

Appendix A: Description of Phases

Appendix B: Work Plan

Appendix C: Checkpoints and Milestone Progress

Appendix D: Procedures and Policies

Appendix A: Electric School Bus V2G Description of Phases










Phase	0. Project Planning	1. Electric Bus Operations & Analysis	2. Design & Construction of Charging & V2G	3. V2G Operations
Milestone (Stage Gate to Next Phase)	<p><i>Agreements Completed</i></p> <ul style="list-style-type: none"> • DPS approval • Partner contracts signed 	<p><i>Buses perform as vehicular transportation</i></p> <ul style="list-style-type: none"> • Operating metrics measured by data collected by a diagnostic device installed on bus controller area network port 	<p><i>Design, install, and commission V2G</i></p> <ul style="list-style-type: none"> • Retrofit buses with on-board inverter • Complete site work for Con Edison approval 	<p><i>Operate EV buses as grid assets</i></p> <ul style="list-style-type: none"> • Project ends
Key Elements	<ul style="list-style-type: none"> • Con Edison – First Priority Agreement • Con Edison – National Express Agreement • DPS approval of project proposal and implementation plan 	<ul style="list-style-type: none"> • Meet minimum range requirement of 65 miles for 80 kWh during peak HVAC use • Provide necessary information to the drivers so that bus range and readiness could be reasonably anticipated • Achieve vehicle uptime of 95% or greater 	<ul style="list-style-type: none"> • Install the bi-directional charging stations • Complete the charger-side software • Modify the buses' battery management systems • Meet Con Edison SIR requirements 	<ul style="list-style-type: none"> • Perform vehicle range analysis before and after V2G periods • Vary V2G discharge protocols to provide data on V2G impacts on battery range.
DER Categories	N/A	<ul style="list-style-type: none"> • Electric vehicles 	<ul style="list-style-type: none"> • Electric vehicles • Battery energy storage 	<ul style="list-style-type: none"> • Electric vehicles • Battery energy storage

Appendix B: Work Plan

Note: these work plans do not account for delays due to COVID-19, as those are not possible to capture accurately at this time.




Activity Description	Lead	2018				2019				2020				2021			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 0: Demonstration Planning	Con Edison																
Obtain Commission Approval	Con Edison																
Finalize contract with NELLC	Con Edison																
Finalize contract with FPGF	Con Edison																
Phase I: Electric Bus Operations and Analysis	FPGF																
Buses shipped to NJ from Montreal	FPGF																
Buses pre-inspected, customized, detailed, prepped	FPGF																
Buses delivered and inspected	FPGF																
FPGF provides operational/technical training	FPGF																
Buses operational	WPBC																
Buses generate performance analytics	FPGF																
Quarterly Data analysis, measurement and evaluation	FPGF																
Phase II: Design and Construction of Charging and V2G Infrastructure	FPGF, Nuvve, Lion																
Site assessments and engineering drawings	FPGF, OLA Consulting																
Electrical service request	FPGF, OLA Consulting																
Utility assessment and service plan	ConEd																
EVSE assessment and site plan	Nuvve, Healy Electric																
Ordering of equipment/hardware	Nuvve																
Installation of networked charging stations (without V2G)	Healy Electric																
Testing of interface with buses	Nuvve, Lion																
Chargers operational	Nuvve																
EVSE operational training	Nuvve																
Electricity consumption patterns analysis	Nuvve, Lion																
Design and software coding	Nuvve, Lion																
Charging stations upgrade with inverters and software	Nuvve, Lion																
Buses modified (BMS modifications and SAE Combo plugs)	Lion																
Network integration and system beta testing	FPGF, Nuvve, Lion																
Phase III: V2G Operations and Analysis																	
V2G battery baselining	Nuvve, Lion																
V2G launch	Nuvve																
Bi-monthly V2G data analysis	Con Edison, Nuvve																
V2G battery closeout	Nuvve, Lion																
Final V2G analysis report	Con Edison																
Data collection from Energy Management Platform	Nuvve																
Quarterly Data analysis, measurement and evaluation	Con Edison, FPGF, Nuvve																

Appendix C: Checkpoints and 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	  

*Detailed descriptions of the Phases can be found in the Appendices.

Legend

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

.1.1.1 Planning

None

.1.1.2 Electric Bus Operations & Analysis

- Delivery of EVSE product

Status: Green

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

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.

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.

.1.1.3 Design and Construction of Charging and V2G

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: This milestone delayed due to technical integration issues and re-engineering of protection system. Completed milestone with approved Con Edison interconnection process in first week of October 2020.

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.

.1.1.4 V2G Operations

Status: **Yellow**

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: This milestone delayed due to technical integration issues and re-engineering of protection system.

Solutions/strategies in case of results below expectations: V2G dispatch schedule will use weekends and school holidays during the school year to reach the project V2G dispatch goals within a compressed time period. May extend time period as needed to meet goals.

Appendix D: Procedures and Policies

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 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.

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.⁵ 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.

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 date, no tax credits or grants have been available to reduce the net costs of the projects, but Con Edison will take advantage of such offsetting benefits when, they are available. Due to the early stage of implementation for the Project, there are no operational savings to report at this time.

⁵ 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 (issued February 16, 2016).