



---

REV Demonstration Project:  
Electric School Bus V2G  
2020 Q1 Quarterly Progress Report

---

Dated: April 30, 2020

## Table of Contents

<b>1.0</b>	<b>Executive Summary .....</b>	<b>2</b>
1.1	Program Achievements.....	2
1.2	Cybersecurity and Personally-Identifiable Information Protection.....	2
1.3	Accounting Procedure Established.....	3
1.4	Costs, Benefits, and Operational Savings.....	3
1.5	Electric School Bus V2G .....	3
<b>2.0</b>	<b>Electric School Bus V2G – Quarterly Progress .....</b>	<b>5</b>
2.1	Demonstration Highlights .....	5
2.2	Changes to the Project Design.....	8
2.3	Work Plan & Budget Review .....	8
2.4	Conclusion.....	11

---

## 1.0 EXECUTIVE SUMMARY

---

Consolidated Edison Company of New York, Inc. (“Con Edison” or the “Company”) submits this 1<sup>st</sup> 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.<sup>1</sup>

### 1.1 PROGRAM ACHIEVEMENTS

**1.2 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. ALTHOUGH , THE COMPANY CONTINUED TO FOCUS ON THE IMPLEMENTATION OF THE PROJECT, SPECIFICALLY INTEGRATION OF VEHICLE TO GRID TECHNOLOGY DURING Q1 2020, THE PROJECT HAS BEEN IMPACTED BY SOCIAL DISTANCING GUIDELINES AND EXECUTIVE ORDERS ISSUED BY THE FEDERAL GOVERNMENT AND THE STATE OF NEW YORK IN RESPONSE TO THE COVID-19 PANDEMIC.<sup>2</sup> 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.

---

<sup>1</sup> 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).

<sup>2</sup>See “*Proclamation on Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak*” ([www.whitehouse.gov](http://www.whitehouse.gov)) issued March 13, 2020; “*30 Days to Slow the Spread*” *The President’s Coronavirus Guidelines for America* ([www.whitehouse.gov](http://www.whitehouse.gov)) (issued March 30, 2020); and “*New York State on PAUSE*” executive order issued by New York Governor Andrew Cuomo ([www.coronavirus.health.ny.gov](http://www.coronavirus.health.ny.gov)) (effective March 22, 2020).

### **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.<sup>3</sup> 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.

### **1.4 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.<sup>4</sup>

### **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 whether 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 Q1 2020, Con Edison, First Priority, Nuvve Corp ("Nuvve") and Lion Electric ("Lion") continued to make progress on V2G implementation, overcoming several technical setbacks. The first V2G bus has been retrofitted with the V2G hardware. Software issues that are preventing the two way inverter from charging are being isolated by Nuvve, Lion and the inverter supplier.. Currently, the first or second charge attempts fail and all subsequent charge attempts succeed. The project partners' hypothesis is that the cold weather prevents the inverter from starting. After the first attempt, the inverter is warmer and subsequent charging succeeds. The test

---

<sup>3</sup> 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.

<sup>4</sup> The federally funded NYT-VIP program.

vehicle is outside in Quebec where temperatures are below 0 degrees Celsius. With a pre-warmed vehicle parked inside, charging succeeds on the first attempts. This hypothesis still needs to be proven with more testing and hardware or software solutions created.

Other charging system challenges are solved. Previously, charging failed because of software voltage sensitivity and an incorrect shutdown sequence. CurrentWays and Nuvve fixed those problems with software changes. The initial start error is the only identified hurdle to deployment.

---

## **2.0 ELECTRIC SCHOOL BUS V2G – QUARTERLY PROGRESS**

---

### **2.1 DEMONSTRATION HIGHLIGHTS**

#### **2.1.1 Q1 2020- Major Task Completion**

- Project Planning:
  - All major Project planning complete
- Phase 1: Electric Bus Operations & Analysis:
  - Buses operational for over 332 school days (2018-2019).<sup>5</sup>
- Phase 2: Design and Construction of Charging & V2G Infrastructure
  - All V2G site hardware completed
  - V2G retrofit of first bus primarily complete

#### **2.1.2 Activities Overview**

##### **Phase 1: Electric Bus Operations and Analysis**

The electric school buses performed their primary student transportation function well. This was the key Phase 1 goal. Due to the “New York State on PAUSE” executive order, National Express did not have staff on site to report uptime for the other vehicles.

---

<sup>5</sup> Q1 2020 operational data unavailable because National Express cannot retrieve information from its workplace

## Phase 2: Design and Construction of Charging and V2G Infrastructure

The development of V2G is ongoing. The Project partners are using an on-board alternating current inverter that has required additional development from Lion and Nuvve. On-board V2G offers several advantages. In comparison to off-board V2G, one on-board inverter replaces the work of two inverters (one is utilized on the vehicle for charging, and one is utilized off the vehicle for discharging). At scale, this solution reduces fundamental cost and on-site space requirements. During Q1 2020, the Project team researched pathways for on-board V2G to become a scalable solution, including ways to gain Underwriter Laboratories (UL) and state interconnection (SIR) certification. The technical pathway for V2G became clearer—UL certification would lead to more, more economic deployment options. This pathway will be pursued further once the buses are operational.

### 2.1.3 Key Metrics



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




- E-school bus days of operation: N/A (see 2.1.2)
- Vehicle failures due to out of specification range: 0
- Misleading range data provided to driver: 0

### 2.1.4 Next Quarter Forecast




In Q2 2020, the Project team aims to have the test bus at Lion’s facility completely operational. Due to the COVID-19 pandemic, current work and travel restrictions make it difficult to forecast whether or not vehicle retrofits will be possible. 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	

Checkpoint/Milestone	Timing*	Status
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
---	--	---

## 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.<sup>6</sup>

**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

---

<sup>6</sup> 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.



communication signals and control V2G discharge. This milestone is delayed, but the stakeholders will make up for the lost summer 2019 period by doing additional V2G during holidays and weekends.

**Actual by Phase 2 Midpoint:** V2G accomplished on-site with non-school bus test vehicle. V2G integration in progress at Lion testing facility

**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 reduced to expected parameters. Explore cell temperature controls.

## **2.2 CHANGES TO THE PROJECT DESIGN**

Nuvve's use of 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 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) – see implementation plan for more detail.

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

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
<b>Timeframe: July 1, 2018 – May 31, 2019</b>						
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			
<b>Timeframe: June 1, 2019 – September 30, 2019</b>						
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 replace BTCPower chargers with Nuvve units, 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	

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
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	
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
<b>Timeframe: October 1, 2019 – September 30, 2021</b>						
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

	Activity	Description	Responsibility			
			FPGF	Con Ed	Lion	Nuvve
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 electric buses function well in providing transportation. The buses are meeting expectations. Phase 2 has demonstrated that the V2G can be compatible with the SIR process, using either off-board invertors, the original plan, or on-board invertors, the revised plan.

Other lessons are market-based. Optimal V2G design depends on the accessible revenue streams. In Markets with smaller discharge windows outputting at higher power levels creates more revenue, DC-based V2G, though more expensive upfront, can have a higher net present value (NPV). In other situations, lower-cost, lower power AC V2G may have the highest NPV. This could be true for vehicles with smaller batteries or ones operating in markets with longer discharge windows. National success will require a variety of solutions.

### 2.4.2 Recommendations

None at this time.

## Electric School Bus V2G REV Demo Project

The **School Bus V2G** (vehicle to grid) demonstration project (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 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. Project partners make progress towards implementing a scalable V2G model.

Project Inception: June 2018  
 Project Launch: September 2018  
 Project End Date: September 2020  
 Budget: \$1.08M  
 Q1 2020 Spend: *Filed confidentially*  
 Cumulative Spend:



### 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-busses 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
- UL has a standard for on-board AC V2G that may be able to be revised expeditiously

**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. This delayed the first summer discharge period. Project partners have been managing the problem and have an alternative that maintains the Project’s fundamentals. Inverter integration has been more challenging than initially thought.

**Recent Milestones:** *Increasing reliability with on-board vehicle inverter to get closer to deployable solution.*

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