Clean Transportation Market Evaluation: EV Innovation and Public Transportation and Electrified Rail Market Characterization

Final Report

Prepared for:

New York State Energy Research Development Authority

Albany, NY

Kartik Pilar
Project Manager

Prepared by:

Industrial Economics, Inc.

Cambridge, MA

Cynthia Manson

Principal

With subcontractors:

Dr. David Keith

Mobilyze.ai

Cheng Solutions

Sunrail Consulting

Research & Marketing Strategies, Inc.

Report Number NYSERDA Contract #151662 September 9, 2022

NYSERDA Record of Revision

Document Title
Clean Transportation Market and Impact Evaluation: EV Innovation and Public Transportation and Electrified Rail Market Characterization

Revision Date	Description of Changes	Revision on Page(s)
September 2022	Original Issue	Original Issue

Notice

This report was prepared by Industrial Economics, Inc. (IEc) in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority (hereafter "NYSERDA"). The opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, NYSERDA, the State of New York, and the contractor make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. NYSERDA, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

NYSERDA makes every effort to provide accurate information about copyright owners and related matters in the reports we publish. Contractors are responsible for determining and satisfying copyright or other use restrictions regarding the content of reports that they write, in compliance with NYSERDA's policies and federal law. If you are the copyright owner and believe a NYSERDA report has not properly attributed your work to you or has used it without permission, please email print@nyserda.ny.gov.

Information contained in this document, such as web page addresses, are current at the time of publication.

Table of Contents

List of Figures

List of Tables

1 Introduction to the EV Innovation and Public Transportation and Electrified Rail Programs

NYSERDA's Clean Energy Fund (CEF) Electric Vehicles Initiative consists of two programs, an Electric Vehicle (EV) Rebate program and an EV Innovation program.[1] Combined, the primary goal for both programs is to expand market adoption of EVs. This report addresses the market assessment of the EV Innovation program, which seeks to achieve its goals by overcoming financial and technological barriers to development and demonstration of new EV-enabling technologies (e.g., smart charging), and growing consumer awareness of EVs through direct outreach and engagement. This report also addresses the Public Transportation and Electrified Rail Initiative, also funded by the CEF.

The Public Transportation and Electrified Rail Initiative's goal is to advance products and strategies that increase the energy efficiency of subway, commuter rail, and bus systems and improve transit agency operations and ridership statewide. The CEF Clean Transportation Chapter outlines several testable hypotheses and goals for the EV Innovation program. The Market Evaluation Team systematically aligned the hypotheses and goals with NYSERDA's evaluation objectives and questions and developed approaches to gathering and analyzing data required to address them.

EV Innovation Program

The EV Innovation program is focused on supporting lower-risk opportunities to test new technologies and business models that may just be emerging in a rapidly evolving market such as the market for EVs. The EV Innovation program supports a range of product development and demonstration projects focused on technologies that are designed to facilitate EV adoption, as well as supporting pilots of innovative business models and approaches to EV market participation. In addition, the program supports a number of research efforts that can provide market information and test outreach approaches to ensure that consumers have the information they need to enter the market.

The projects supported by the innovation program are directed at reducing a broad array of real and perceived barriers to EV adoption in the market. These include: the real (and perceived) cost of EVs and lack of accessible EV supply equipment (EVSE) such as charging stations; potential grid impacts associated with high penetration of EVs; complex and varied local and state regulations that increase the

[1] The *EV Rebate Program Market Evaluation* is discussed separately. A more comprehensive discussion of equity-related findings and cross-cutting examination of issues from all sources used for this Clean Transportation program market and impact evaluation is provided in a separate report, the *Market Level and Cross-Cutting Insights Report*.

cost of EV adoption; and relevant to all of these, difficulty coordinating key stakeholders, including utilities, automakers, car dealers, employers, and municipalities.

NYSERDA's EV Innovation investments are designed around a set of hypotheses that certain types of investment will address or reduce these barriers (see **Table 1** below). Specifically, the Investment Plan hypothesizes that demonstration efforts (including products, business models, market data, and outreach strategies) will encourage rapid adoption of EVs and deployment of EVSE. Demonstration efforts should reduce the cost of ownership for EVs and the cost of EVSE installation, improve the ease of use and grid-integration of EVs, showcase the effectiveness of collaborative consumer outreach, and provide market data on costs and cost savings that clarify the value proposition for utilities. Demonstrations are anticipated to work together with effective policy, utility pricing and consumer outreach efforts.

Public Transportation and Electrified Rail Initiative

The Public Transportation and Electrified Rail Initiative's goal is to advance products and strategies that increase the energy efficiency of subway, commuter rail, and bus systems and improve transit agency operations and ridership statewide. As New York State has more public transportation riders than any other state on a per capita basis and overall, electrification and efficiency improvements present a key opportunity to decrease GHG emissions. To accomplish this, the Public Transportation and Electrified Rail Initiative invests in the development and demonstration of new energy-efficient products and operating strategies for the State's public transportation systems. The investments focus on bringing new products to market, conducting in-service testing, and removing barriers to adoption. Intervention strategies outlined for the Clean Energy Fund include developing and supporting developments for both public transportation and electrified rail that improve energy use for operations and system-level load management.

Table 1 displays the testable hypotheses, goals, and data sources covered by this evaluation report. This report updates and expands upon the Market Evaluation Team's initial efforts to report on progress towards these hypotheses, originally presented in the *2021 NYSERDA Clean Transportation Market and Impact Evaluation: Early Findings Report*.[2] The market research in that report leveraged NYSERDA program data and additional market research conducted by the Market Evaluation Team.

This current report relies predominantly on the following: a series of discussions with NYSERDA Program Staff (4), interviews with EV Innovation Partners (14) and EVSE installers (2), a survey of NYS

[2] IEc. 2021. *Clean Transportation Market and Impact Evaluation: Early Findings Report.* Prepared on behalf of NYSERDA. *To request a copy of the Early Findings Report, please contact evaluation.questions@nyserda.ny.gov.*

Transit Operators (24 responses), follow-up interviews with five Transit Operators, Department of Transportation (DOT) Federal Transit Administration (FTA) National Transit Database (NTD) data, US Census data, US DOE Alternative Fuels Data Center (AFDC) charging station data, and additional market research.

Additional detail on methods is available in Methods Section of this report. The Market Characterization and Assessment Results Section of this report presents the results by evaluation question. In some cases, there are multiple metrics per evaluation question.

Table 1. Testable Hypotheses, Goals, and Evaluation Questions for the EV-Innovation and Public Transportation and Electrified Rail Programs.

EV Innovation
Hypothesis: If new technologies and policies that enable easier, cheaper off-peak EV charging are offered to consumers, then more drivers will shift charging to off-peak hours
• **Goal/Test:** Smart charging technologies are introduced into the consumer market and one or more NYS utilities encourage customers to use them **Method and Data sources:** Technology company interviews, EVSE installer interviews, charging station event data • EV Innovation Program Data (EV Innovations Contract Commitments Spreadsheet, Salesforce) • Interviews of EV Innovation partners - companies/technology developers directly funded • Interviews of Charging Station Installers
Hypothesis: If NYSERDA can aggregate EV charging station purchases to lower prices and simplify purchasing, then average hard and soft costs of the equipment will fall and more installations will be completed, leading to further EV market expansion
• **Goal/Test:** Charging station owners can reasonably achieve a three to five-year return on investment for installing a charging station (an improvement of at least 50 percent from current conditions) and have multiple options for ways to purchase, finance, or lease a charging station **Method and Data sources:** Primary interviews, supported by secondary data on soft costs. • EV Innovation Program Data • Interviews of EV Innovation partners - companies/technology developers directly funded • Interviews of Charging Station Installers • Spatial charging station model: https://www.mobilyze.ai/
Hypothesis: If NYSERDA quantifies and demonstrates ways that utilities (and generators, NYISO, other electricity market participants) can benefit from greater EV adoption, then these stakeholders will urge their customers to buy EVs more aggressively and possibly invest greater resources in supporting EV adoption
• **Goal/Test:** Charging station owners can reasonably achieve a three to five-year return on investment for installing a charging station (an improvement of at least 50 percent from current conditions) and have multiple options for ways to purchase, finance, or lease a charging station **Method and Data sources:** Primary surveys and benchmarking, supported by secondary data on soft costs. • Interviews of EV Innovation partners - companies/technology developers directly funded • EV Innovation Program Data • **Goal/Test:** Groups of stakeholders (industry, municipalities, employers, etc.) host regular (at least quarterly) EV education and awareness-building events in NYS's major metropolitan areas **Method and Data sources:** Primary data collection/documentation

• EV Innovation partners - companies/technology developers directly funded
• EV Innovation partners - industry stakeholders for consumer engagement efforts
• EV Innovation Program Data
• Additional market and policy research

Hypothesis: If NYSERDA supports the development and demonstration of new products and business models that make EVs easier to use and more grid-friendly, then market participants, including utilities, will expedite deployment of these offerings

- **Goal/Test:** Smart charging technologies are introduced into the consumer market and one or more NYS utilities encourage customers to use them

  Method and Data sources: market research to document progress relative to baseline and comparative regions.

  • EV Innovation Program Data
  • Interviews of EV Innovation partners - companies/technology developers directly funded
  • Interviews of EV Innovation partners - industry stakeholders for consumer engagement efforts

Public Transportation and Electrified Rail Initiative

Hypothesis: If NYSERDA engages public transit agencies' operations divisions in product development and demonstration efforts from the start, then it will result in easier logistics for demonstration projects, shorter development timelines, and more successful product adoptions.

- **Goal/Test:** Technology providers have performed successful in-service demonstrations of products that achieve the efficiency gains targeted through this program (25 percent or more improvements in rail and bus efficiency)

  Method and Data sources: Primary and secondary data collection; benchmarking.

  • Survey of transit agencies
  • Public Transportation and Electrified Rail Initiative program data
  • Interview of Public Transit Operators

Hypothesis: If NYSERDA supports product refinements by technology providers who have products that need to be adapted to specific and unique procurement requirements of NYS transit operators, then this will help them introduce the products into NYS more quickly and at a more competitive price.

Goal/Test: One or more transit agencies have been able to integrate these new technologies into their operations and logistics such that there is still a reasonable return on investment for the transit agency

Method and Data sources: Primary and secondary data collection; benchmarking.
• Survey of transit agencies
• Public Transportation and Electrified Rail Initiative program data
• Interview of Public Transit Operators

Hypothesis: If NYSERDA supports the development of innovations that increase bus reliability and convenience through introducing new technologies and improving system performance, then transit agencies that implement these innovations will increase their per-bus ridership rate and generate GHG emission reductions

- **Goal/Test:** One or more transit agencies have been able to integrate these new technologies into their operations and logistics such that there is still a reasonable return on investment for the transit agency (See above
- **Goal/Test:** Technology providers have performed successful in-service demonstrations of products that achieve the efficiency gains targeted through this program (25 percent or more improvements in rail and bus efficiency) (See above)

Hypothesis: If NYSERDA works with partners to design well-planned, rigorous demonstrations of new technologies, then transit agencies will be more likely to accelerate adoption.

- **Goal/Test:** One or more transit agencies have been able to integrate these new technologies into their operations and logistics such that there is still a reasonable return on investment for the transit agency (See above)

Hypothesis: If projects conduct in-service demonstration and validation of the benefits and ease of operation of transit technologies that are in use elsewhere, such as electric buses and lightweight train cars, then they will be able to find more willing buyers at NYS transit agencies and increase adoption in NYS.
• **Goal/Test:** These energy-efficient products are cost-competitive with other products as part of regular transit agency procurements and are commercially available **Method and Data sources:** Market research; interview validation • Survey of transit agencies • Public Transportation and Electrified Rail Initiative program data • Interview of Public Transit Operators
Hypothesis: If transit agencies try alternative REV-like business models for the purchase and operation of energy-saving transit investments, such as third-party ownership of assets that can provide outside revenue streams or participation in microgrids/power delivery on transit agencies' rights of way, then this will reduce payback periods and eliminate operational obstacles for energy efficient technologies.
• **Goal/Test:** NYPA or other third-party financiers are willing to finance transit agencies' purchases of the demonstrated energy-efficient products **Method and Data sources:** Direct data collection; benchmarking • Survey of transit agencies • Public Transportation and Electrified Rail Initiative program data • Interview of Public Transit Operators

2 Summary of Market Characterization and Assessment Metrics

This section of the report provides a summary of the outcome metrics findings by evaluation question. **Table 2** reports the year-to-year progress made towards each EV Innovations program and Public Transportation and Electrified Rail initiative indicator as specified in the evaluation methodology. It also outlines the data sources that the Market Evaluation Team used to measure progress and other relevant notes.

Most quantitative findings in **Table 2** are consistent with the *2021 Early Findings Report*,[3] in which the Market Evaluation Team examined a suite of 15 metrics that document both market change and program-specific activities. Many of the metrics are simple counts of investment activities and impacts. In some cases, the data specific to NYSERDA's program initially presented a partial or incomplete picture of the effectiveness of NYSERDA's efforts. These metrics are marked as "updated" herein. This Market Evaluation report also provides new contextual information from in-depth interviews with EV Innovation partners and EVSE installers, including impacts from the COVID-19 pandemic (**Section 3.1.13**); and results from a survey of NYS public transit agencies and follow-up interviews with transit operators about their fleets, impacts from the COVD-19 pandemic, and plans for electrification (**Sections 3.2.3** and **3.2.4**). **Table 2** denotes which metrics are updated.

[3] IEc. 2021. *Clean Transportation Market and Impact Evaluation: Early Findings Report*. Prepared on behalf of NYSERDA. *To request a copy of the Early Findings Report, please contact evaluation.questions@nyserda.ny.gov*.

Table 2. Market Evaluation Indicators for EV Innovation and Public Transportation and Electrified Rail Program.

NA = Not Available, IP = Investment Plan. Table 2 also refers to sections where each metric is discussed. Progress is cumulative unless otherwise specified.

Evaluation Question	Metric/Indicator	Metric from IP?	Baseline	2019 Progress	2020 Progress-To-Date	2022 Target	Data Sources	Updated from *2021 Early Findings*?
EV-Innovation								
How many charging station aggregation products or programs are available in NYS? (**Section 3.1.1**)	Number of aggregate charging station purchase participants	Y	0	186	**433**	400	Charge Ready NY	N
How has installed cost of charging stations changed over time? (**Section 3.1.2**)	Average installed cost of Level 2 charging station per port	Y	$8,744	NA	**$6,749**	$6,500	Data from Charge Ready NY invoice history (2019 – 2020).	N – contextual info added
How many business models have monetized the second lives of batteries or enabled charging station finance? (**Section 3.1.3**)	Number of business models monetizing second lives of batteries or enabling charging station finance	N	NA	NA	**0**	NA-	NYSERDA Program Staff	Not measured
How many bench-scale prototypes of economically viable technologies that enable smart charging have been demonstrated in NYS? What is the scale (e.g., number of participants, charging stations enabled) and maturity level of smart charging demonstration projects? (**Section 3.1.4**)	Number of product development and demonstration companies supported	Y	0	17	**19**	30	EV Innovations Contract Commitments Spreadsheet; Salesforce; Interviews	N – contextual information added
How many in-service demonstrations of EV-enabling technologies have been demonstrated in NYS? (**Section 3.1.5**)	Number of product development and demonstration projects initiated	Y	0	19	**20**	50	EV Innovations Contract Commitments Spreadsheet; Salesforce	N – contextual information added

Evaluation Question	Metric/Indicator	Metric from IP?	Baseline	2019 Progress	2020 Progress-To-Date	2022 Target	Data Sources	Updated from *2021 Early Findings*?
How widely available are EV charging stations in NYS? Assess Availability by geography (including in LMI communities) and charging station type. (**Section 3.1.6**)	Number of charging stations installed in NYS	Y	1,639	3,300	**7,208**	4,500	AFDC	N – contextual information added.
	Geographic availability of (non-Tesla) DC fast charging stations	N	29 cities	42 cities	**44 cities**	-	AFDC	N – contextual information added.
What new programs and products have utilities introduced that enable smart EV charging? (**Section 3.1.7** and **3.1.8**)	Number of new products enabling smart charging	N	NA	NA	**5**	-	EV Innovations Contract Commitments Spreadsheet; Salesforce; Interviews with EV Innovation Partners	N – contextual information added.
What stage of development are these programs and which customer or market segments do they target? (**Section 3.1.7** and **3.1.8**)	Number of new utility programs enabling smart charging	N	NA	NA	**7**	-	Interviews with EV Innovation Partners	N – contextual information added.
What industry stakeholders have ongoing consumer awareness programs? (**Section 3.1.9**)	Number of industry stakeholders engaged in consumer awareness programs	Y	0	38	**53**	50	EV Innovations Contract Commitments Spreadsheet; Drive Change Drive Electric: https://driveelectricus.com/about-us/	N – contextual information added.
What percent of NYS municipalities have adopted standard policies related to each of the following: • EV-friendly zoning, • Building codes • Planning Procedures • Permitting (**Section 3.1.10**)	Number of standard policies adopted by NYS municipalities to streamline EV adoption	N	NA	NA	**16 instances of building codes adopted**	-	2020 Energetics Report, "snowball" Interviews	Y

Evaluation Question	Metric/Indicator	Metric from IP?	Baseline	2019 Progress	2020 Progress-To-Date	2022 Target	Data Sources	Updated from *2021 Early Findings*?
How widespread are coordination activities for encouraging adoption of standardized policies and programs? (**Section 3.1.11**)	Occurrences of coordination activities with other entities ongoing by type	N	NA	NA	**Low evidence of cross-stakeholder coordination of outreach encouraging adoption.**	-	Interviews with NYSERDA Program Staff, EV Innovation Partners	Y
How many products were commercialized? (**Section 3.1.12**)	Number of products commercialized	Y	0	0	**0**	4	EV Innovations Contract Commitments Spreadsheet; Salesforce Data; Interviews	N – contextual information added
	Revenue from sales of commercialized products	Y	$0	$0	**$0**	$5 million	EV Innovations Contract Commitments Spreadsheet; Salesforce Data	N – contextual information added
How many projects were replicated? (**Section 3.1.14**)	Number of replications from demonstration projects	Y	0	0	**0**	6	EV Innovations Contract Commitments Spreadsheet; Salesforce Data	N – contextual information added
Public Transportation and Electrified Rail								
How much private investment went into electrified transit each year? Among firms that received capital support from NYSERDA, estimate the leverage ratio (**Section 3.2.1.1 - 3.2.1.3**)	Private investment/leveraged funds	Y	$0	$14.4 million	**$8.8 million**	$42 million	CEF Transit Projects Data; Salesforce Data	N
	Number of companies supported	Y	0	11	**16**	28	CEF Transit Projects Data; Salesforce Data	N
	Number of projects initiated	Y	0	14	**19**	47	CEF Transit Projects Data; Salesforce Data	N

Evaluation Question	Metric/Indicator	Metric from IP?	Baseline	2019 Progress	2020 Progress-To-Date	2022 Target	Data Sources	Updated from *2021 Early Findings*?
How many products were commercialized? (**Section 3.2.1.4**)	Number of products commercialized	Y	0	1	**1**	4	CEF Transit Projects Data; Salesforce Data	N
How much revenue did newly commercialized products generate? (**Section 3.2.1.5**)	Revenue	Y	$0	$240,000	**$240,000**	$5 million	CEF Transit Projects Data; Salesforce Data	N
How many replications of NYSERDA-demonstrated projects have taken place? (**Section 3.2.1.6**)	Number of replications from demonstration projects	Y	0	0	**0**	10	CEF Transit Projects Data; Salesforce Data	N – contextual information added.
Estimate the number of in-service demonstrations and purchases of electric transit buses in NYS. (**Section 3.2.1.7** - 3.2.1.8)	Number of in-service demonstrations and purchases of electric transit buses	N	NA	NA	**72**	-	Press Articles	N
	Number of transit procurements assisted	Y	0	0	**4 (20 buses)**	5	Press Articles	N
Report the percent of penetration of in-service demonstrations and purchases across NYS transit agencies. (**Section 3.2.1.9**)	Percent of penetration of in-service demonstrations and purchases across NYS transit agencies	N	NA	NA	**1%**	-	Press Articles	N
Estimate the number of novel financing or partnership models demonstrated in NYS. (**Section 3.2.1.10)**	Number of third-party partnerships facilitated	Y	0	1	**1**	5	CEF Transit Projects Data; Salesforce Data	N
How do novel financing or partnership models influence uptake of electric	Examples of uptake of electric transit buses attributed to novel	N	NA	NA	0	-	Interviews	Y

Evaluation Question	Metric/Indicator	Metric from IP?	Baseline	2019 Progress	2020 Progress-To-Date	2022 Target	Data Sources	Updated from *2021 Early Findings*?
transit buses? (**Section 3.2.1.11**)	financing or partnership models							
	Examples of bus or rail efficiency efforts attributed to novel financing or partnership models	N	NA	NA	0	-	N/A	Not measured
Use federal transportation administration data to estimate the metrics listed below. Benchmark each metric against comparable non-NYS regions and over prior years (**Section 3.2.2**)	Average number of passengers per hour	N	NA	44.8	NA – 2019 data are most recent	NA	Department of Transportation (DOT) Federal Transit Administration (FTA) National Transit Database (NTD) data	New metric
	Total number of unlinked passenger trips	N	NA	~999 million	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric
	Total fuel use by buses (gal)	N	NA	~68.9 million	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric
	Average diesel fuel economy of buses (mpg)	N	NA	3.3	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric
	Average gasoline fuel economy of buses (mpg)	N	NA	9.5	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric
	Average compressed natural gas fuel economy of buses (mpg)	N	NA	2.6	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric
	Average bus speed in revenue service (mph)	N	NA	9.9	NA – 2019 data are most recent	NA	DOT/FTA NTD Data	New metric

3 Market Characterization and Assessment Results

3.1 EV Innovation Program

This report relies on NYSERDA's existing data collection efforts, external federal data sets, and primary data collection (interviews, surveys) to address both the specific evaluation questions and the testable hypotheses to the extent possible. The Market Evaluation Team conducted 20 primary data collection interviews: four NYSERDA Program Staff, two EVSE installers, and 14 Clean Transportation funding recipients, including technology developers, non-profits, one municipality, and one utility. Interviews with NYSERDA Program Staff were informal and open-ended, aimed at filling data gaps and providing context for understanding Clean Transportation projects to support interviews with funding recipients (EV Innovation Partners). Interviews with EVSE installers and Clean Transportation funding recipients were semi-structured, using a standard interview guide while allowing room to explore topics and ask follow-up questions.

Primary data collection interviews address the following:

1) **Understand how the EV Innovation partners define the market**: how the market has changed since the partner began working with NYSERDA, how they see the market now, where the market is going, and how market changes have affected their plans moving forward. Interview guides were designed to probe about the EV Innovation partner's initial goals in applying for NYSERDA funding and characterize both the types of outcomes to date and the role that NYSERDA played in helping to achieve those outcomes.
2) **Understand EV Innovation partner efforts to address equity.** One way that New York State's priorities are changing is to place increasing focus on equity. The Climate Leadership and Community Protection Act (CLCPA) has added an emphasis for NYSERDA to consider equity in its programs, including a focus on disadvantaged communities and the low and moderate income (LMI) segment. Although this is not a requirement under the Innovation Partners' current agreement(s) with NYSERDA, the Market Evaluation Team asked about these topics as they relate to the EV Innovation partner's work and/or broader changes in the market.[4]
3) **Understand follow-on business decisions**. The Market Evaluation Team made efforts to understand investment after the initial NYSERDA funding, steps toward commercialization

[4] Though outreach to LMI communities is covered briefly in this report, a more comprehensive discussion of equity-related findings requires an intersecting examination that considers all parts of the Clean Transportation program and all sources used for this evaluation and the *EV Rebate Program Market Evaluation* and *EV Rebate Impact Evaluation* and is therefore provided in a separate report examining cross-cutting issues.

(and/or current prospects for commercialization and broader market uptake), revenues from commercialized products, and replications. Where relevant, EV Innovation partners were asked about company efforts to reach disadvantaged communities and the LMI segment, or to engage community stakeholders in thinking about equity and access.

4) **Charging station logistics**. EV Innovation partners were asked about their in-service demonstrations of EV-enabling technologies, barriers to permitting EVSE installations and the variation of barriers with geography (urban/rural contexts), successfully streamlined permitting processes or standardized EVSE installation policies, and the role utilities play in grid interconnection for EVSE installations. Interview guides also featured questions about efforts toward equitable distribution/access of EVSE.
5) **Influence of utilities on innovation.** The Market Evaluation Team sought information about programs, technologies, products, or business models to encourage smart charging and EV adoption. Interview questions included utility efforts to engage underserved communities and meet the needs of LMI customers.
6) **EVSE installation permitting.** The Market Evaluation Team sought information about permitting processes, policy standardization, and barriers. Specifically, questions about what types of permitting, EV-friendly zoning policies, building codes, and planning procedures municipalities are using or pursuing to streamline EV adoption were included in the interview guides.

The sections that follow provide the EV Innovation results from effort for each evaluation question, documenting key data sources, assumptions, and limitations.[5]

3.1.1 How many aggregate charging station products or programs are there available in NYS?

NYSERDA's Investment Plan identifies the number of charging station aggregation products (or programs) supported by NYSERDA as an important factor in reducing the overall cost of public EV charging stations. While this was part of the initial plan for supporting EV market expansion, conversations with NYSERDA Program Staff indicate that the rebate structure associated with Charge Ready NY was later deemed more appropriate to lower costs, and Charge Ready NY therefore represents NYSERDA's efforts in this area.

[5] The methods for identifying quantitative results for each of these questions are included in the *2021 Early Findings Report. To request a copy of the Early Findings Report, please contact evaluation.questions@nyserda.ny.gov.*

NYSERDA's Investment Plan indicates that aggregate charging station site owners may be businesses, municipalities, multi-family building owners, or anyone who operates visible sites for EV charging (such as large parking lots). As with the number of charging station aggregation products (above), the aggregate purchase structure appears to have been replaced by Charge Ready NY. The Market Evaluation Team identified a count of 433 charging station purchase participants, defined as unique Charge Ready NY projects.[6]The review identified 433 purchase participants with NYSERDA approved (for payment) or closed (complete, paid) projects with submission dates through 2020. While some public EV charging station projects are pre-approved (i.e., approval prior to completion, given 6 more months to complete the project), this is not true for all projects. Approved and closed projects is a more definitive threshold than pre-approved (or, more generally, open projects) because payment has been committed or completed.

3.1.2 How has the installed cost of charging stations changed over time?

NYSERDA's Investment Plan identifies the cost of purchasing and installing charging stations as a barrier to deployment. The plan establishes a goal of decreasing the average installed cost of Level 2 EV charging stations per port (plug) and identifies changes in cost as an important indicator of cost-competitiveness for EV stations. Here, total installed cost per plug is inclusive of both equipment cost per plug and installation cost per plug. Previous reports indicate the 2017 baseline total cost per port was greater than $8,000.[7] The average 2020 total cost per plug is $6,749, considerably lower than the 2017 baseline of $8,744, and close in value to the 2022 target of $6,500 per plug (**Table 3**).[8]

Table 3. Average Annual Installed Charging Cost per Plug Comparison (2019 – 2020)

Data Year	Equipment Cost per Plug	Installation Cost per Plug	Total Cost per Plug
2019	$3,225	$3,010	$6,235
2020	$3,233	$3,516	$6,749

Monthly average costs are plotted in **Figure 1**. While the Charge Ready NY invoice data are characterized by some variability (e.g., a decrease in price between 2018 and 2019), there is no notable change in the equipment cost year-over-year. There was a modest increase in the installation cost between

[6] NYS Charge Ready Projects 2018 - 2021 Spreadsheet provided by Adam Ruder, March 5, 2021.

[7]NYSERDA. 2018. *Public Transportation and Electrified Rail Indicator Tracking Report: 2017 Baseline*. Accessible from NYSERDA upon request.

[8] NYSERDA Program Staff. 2020. Charge Ready NY invoice history.

2019 and 2020, leading to an increase in total installed cost per plug during the same period.[9] An interview with ChargePoint (see below) provided context for understanding charger costs.

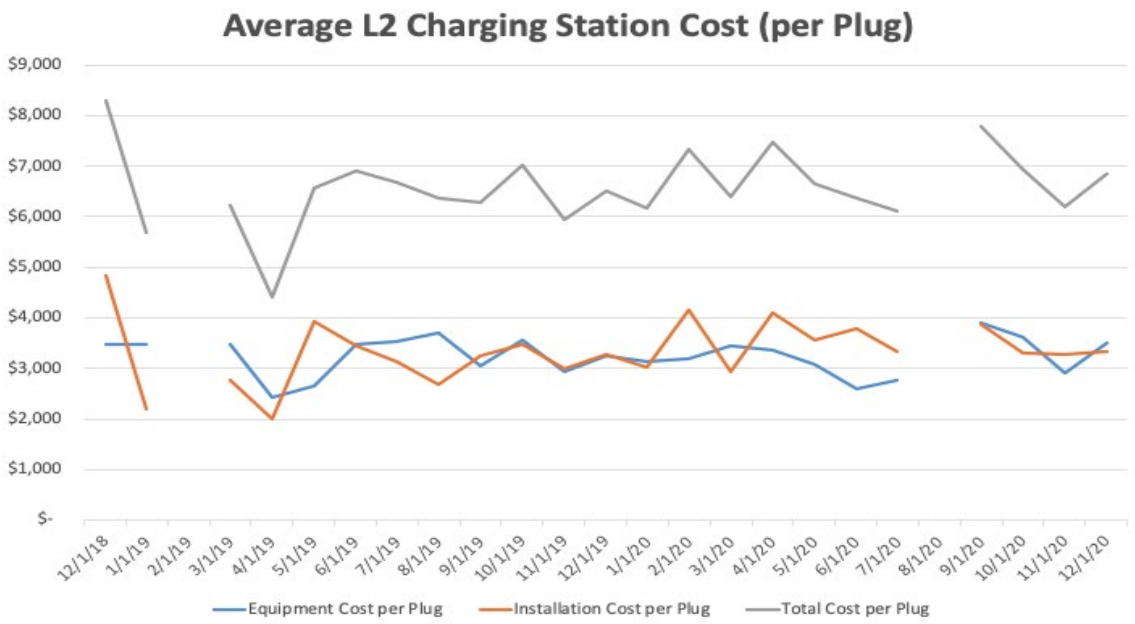

Figure 1. Average L2 charging station costs over time.

ChargePoint

ChargePoint, a large-scale EVSE installer company, interviewed with the Market Evaluation Team. The interviewee reported that there has been a slight downward trend in installation costs, in part due to competition and more hardware options. Note that while this may be true for ChargePoint, Charge Ready NY invoice data suggests that the installation cost for Level 2 chargers has actually experienced a slight increase over time. While EVSE equipment is still considered expensive, the ChargePoint interviewee reported that in the future, the company expects to realize economies of scale for EVSE equipment production and use the savings to lower prices of its hardware for customers.[10] In contrast, ChargePoint's software prices have increased slightly, but the company believes more customers will be willing to pay higher prices as they get a better understanding of the technology.

Overall installation costs remain high as construction needs can be costly and time intensive, especially where interconnection between ChargePoint and utilities is delayed. The interviewee indicated that the

[9] Note: A significant limitation to generalizing from the EV station cost data is that the data-years are mostly restricted to 2019 and 2020, which prevents annual comparison back to the 2017 baseline. It is reasonable to assume that the installation cost increases seen in 2020 may be attributable in part to logistical disruptions resulting from the COVID-19 pandemic or may reflect differences in the complexity or type of sites where installation is occurring.

[10] Timing for customer savings realization was not shared with the Market Evaluation Team.

profitability of EV chargers hinges upon port turnover (how many cars can be parked and charged per day), and a lack of significant subsidies challenges this as a business model. The interviewee suggested that in general, rebates or other subsidies are usually critical to supporting entities buying chargers (e.g., Charge Ready NY's $8,000 dual port rebate). In addition, some retailers such as Target can use free EV charging to attract customers to shop, while some municipalities are reportedly using a different approach: providing charging for visitors/tourists, or setting local pollution reduction and clean transportation goals to increase usage. To address the profitability barrier, ChargePoint has developed a "ChargePoint as a service" subscription-based model, where customers subscribe to terms from one to five years. ChargePoint installs, operates, and manages the stations, while the customer collects revenues and pays ChargePoint for their services. This program can be linked with the Charge Ready NY rebates.

3.1.3 How many business models have monetized the second lives of batteries or enabled charging station finance?

NYSERDA's Investment Plan underscores the importance of business models that make EVs easier to use and more grid-compatible as a key driver of deployment, but does not define the metric explicitly. Conversations with NYSERDA program staff noted that in the case of batteries, declining cost in stationary storage and other changes in the market had rendered this area of focus a lower priority. The value for this metric is therefore zero, reflecting changes in program that (as with charging station aggregation products/programs), shifted the focus toward other areas of focus on grid integration.

3.1.4 How many bench-scale prototypes of economically viable technologies that enable smart charging have been demonstrated in NYS? What is the scale (e.g., number of participants, charging stations enabled) and maturity level of smart charging demonstration projects?

The Investment Plan has as an overarching goal to promote the development and demonstration of new technologies and strategies to reduce greenhouse gas emissions from the transportation sector and to gain market traction for these products. The Investment Plan further notes that product development and demonstration efforts will target technology and business model innovators. The EV Innovations Program funded a cumulative total of 19 product development and demonstration companies through 2020, an increase from 17 companies in 2019 (cumulative total).[11]

[11] EV Innovation Contract Commitments Spreadsheet provided by Adam Ruder, March 2, 2021

The Siemens EVSE prototype, an "integrated charger," was one of 19 smart charging technologies. NYSERDA Program Staff identified this as a particularly viable product, so the Market Evaluation Team explored the project further in an interview with the developer.

Siemens

In 2018, Siemens looked at metering built into chargers (submetering) and recognized that issues with integration, accuracy, and communication would prevent their adoption and practical use because they would not meet utilities' needs. To address these issues, Siemens developed a product that integrates standard utility smart meters into chargers. The product combines a charger, meter socket, and meter into a single unit.

The Siemens interviewee identified benefits that their integrated product provides over a standard charger. Primarily, it enables a flat rate (special tariff) for a customer's EV. This could be a solution for charging at commercial sites and multi-family dwellings as it would allow utilities to directly bill those with EVs, bypassing the need for landlords to get involved in billing. The charger also offers customers more granular information about their energy use. Further, it gives customers the possibility of using a subscription approach for charging. In addition, the interviewee noted that this product would support a tariff structure that enables customers to sell surplus energy back to the grid (V2G), although this is not part of the current pilot project. Details about the pilot project are described in the findings for Question 3.1.4.

3.1.5 How many in-service demonstrations of EV-enabling technologies have been demonstrated in NYS?

Of the 20 total product development and demonstration projects identified in the list of NYSERDA EV Innovation Contract Commitments (an increase from 19 projects in 2019),[12,13] the Market Evaluation Team interviewed the New York City Department of Sanitation, EV Connect, and Simple Energy (now Uplight), all of whom were identified by NYSERDA Program Staff as having EV-enabling technology demonstration projects in NYS. The Siemens pilot product is also discussed in this context.

New York City Department of Sanitation (DSNY)

[12] EV Innovation Contract Commitments Spreadsheet, March 2, 2021

[13] The list of projects includes 11 "approved" projects, seven "pending approval," and two with an unknown status. The record types include: nine demonstration projects, five product development, two information dissemination, one research study, one technology feasibility assessment, and two unknown record type.

The Market Evaluation Team's interview with DSNY focused on the department's battery electric-powered street sweeper – the world's first all-electric street sweeper. DSNY partnered with CALSTART to initiate the development of this product through a NYSERDA grant. Global Environmental Products and US Hybrid developed the street sweeper for this project. The sweeper has been operating in an environmental justice community in Brooklyn but, at this point, DSNY is unsure if they will add additional sweepers mainly because they like to take an incremental approach toward fleet transition; the department needs to assess the sweeper's performance before deciding. Their partnership with CALSTART will generate data that will enable them to assess performance on an ongoing basis, tracking metrics such as start time, end time, kilowatt-hours overnight, and charging status at the beginning and end of each day. The street sweeper lifecycle is approximately five years due to the heavy usage in NYC; therefore, the fleet could be converted relatively quickly if DSNY decides to procure additional all-electric street sweepers.

Aside from the sweeper, departments across New York City are starting to phase EVs into their fleets. New York City's Executive Order No. 53 calls for the city fleet to go completely electric by 2040, which has prompted various departments to start electrifying the "low-hanging fruit" of their fleet of 6,000 vehicles across the city. The interviewee stated that different types of EVs will start to roll out across the city, but the transportation and EVSE infrastructure changes need to happen in parallel.

As the city starts to add new EVs to its fleet, it will also need to continue to develop its charging infrastructure to accommodate different types of vehicles and chargers (e.g., AC for light-duty vehicles and DC for heavy-duty vehicles) and identify strategic locations for optimal use. It will take environmental justice concerns into account when making these decisions. As of now, NYC lacks the capacity to install DC fast chargers across the city and has few garages that can transition to all-electric, whether the chargers are level 2 or 3. DSNY is currently conducting feasibility studies to determine what will be required to transform the garages. Regardless, the city will need to make a substantial investment in its charging infrastructure.

Siemens

A 2019 NYSERDA grant funded Siemens' pilot of an integrated charger, which combines a charger, meter socket, and meter. In partnership with ConEdison, Siemens identified 20 customers/sites and has completed agreements with most of them. At the time of the interview, Siemens was in the process of installing the integrated charger prototypes and aimed to have this completed in six to eight weeks. The technology is open architecture, so other companies could mass produce their own version of it. According to Siemens, their goal is to grow the EVSE market.

The interviewee characterized the product design as "inelegant" in terms of how it integrates metering and charging for a wall socket application (i.e., the prototype fits together three existing pieces of hardware), but improvements could be made in future iterations of the product to further streamline its design. Customer adoption may require electrical panel upgrades, but Siemens is further exploring this possible barrier as well.

Simple Energy (now Uplight)

Uplight offers smart charging software and customer engagement solutions, playing a role that "fills the gap between the utility operator and the customer." Uplight has had three projects with NYSERDA. One project was a collaboration with Central Hudson and Orange & Rockland to address personal EV adoption and promote grid integration through managed charging, which responds to changes in electricity load (e.g., charging during off-peak periods) and may make EV chargers less expensive as a result. Another project was a hybrid effort to a) sell EV chargers and b) address demand response.

Uplight identified a third project, an online efficient products marketplace, as one of their most successful innovations. This e-marketplace "aligns rebates with smart products" by providing any Orange & Rockland customer in New York with rebates to subsidize the purchase of a charger. NYSERDA's role in this work is to bring a rebate budget to the project (added to Orange & Rockland's rebate for increased customer benefits). While installations were challenging during the COVID-19 pandemic, Uplight interviewees noted that 119 chargers have been sold since July of 2020.

3.1.6 How widely available are EV charging stations (ports) in NYS? What is the geographic availability of the charging stations?

A key area of focus in NYSERDA's Investment Plan is a need for reduced cost and improved development models (innovative financing or leasing) for public EV charging stations to support charging station owners in meeting increased demand. Number of charging stations (ports, or the number of plugs) is a critical indicator of the success of efforts to expand the availability of financing. The value listed in **Table 2** (7,208) refers to the count of public EV charging ports installed in New York and represents the upper bound of AFDC charge ports (6,208, **Table 4**) plus an additional combined 1,000 ports not

captured in the AFDC (identified in e-mail correspondence with NYSERDA program staff by EV Connect and ChargePoint).[14,15]

Table 4. Count of EV charging stations and plugs installed in New York.

Annual Construction 2020	**Stations**	**Charge Ports**
Level 1	2	3
Level 2	152	565
Level 3	23	134
Total	**177**	**702**
Cumulative 2020	**Stations**	**Charge Ports**
Level 1	12	23
Level 2	1,903	5,533
Level 3	147	652
Total	**2,062**	6,208

The analysis includes all charging ports in the AFDC dataset that had a NY state code, whether or not there was an opening date listed. The additional 1,000 ports identified by ChargePoint and EVConnect as missing from the AFDC data are located at a mix of public and private charging stations. The AFDC does not offer a complete report of private stations. The cumulative count is the upper limit of plugs, based on the AFDC data with additional ChargePoint and EVConnect-reported ports. Though the AFDC only recently started archiving their electric charging stations database, we assume that past data are accurate, and that both ChargePoint and EVConnect have been thorough in their count of missing stations. Our assumptions for geographic availability are consistent with the previous reporting period.

[14] U.S. Department of Energy's Alternative Fuels Data Center (AFDC). 2020. Electric Vehicle Charging Station Database. Accessed 2/11/2021: https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=all&access=public&access=private&region=US-NY&show_map=true.

[15] NYSERDA Program Staff. 2020. Personal Communication with EV Connect and ChargePoint Staff. July, 2020.

Figure 2 and **Figure 3** provide an update to those data using the US Department of Energy's Alternative Fuels Data Center dataset, which suggests charging station coverage in New York is predominantly from three network types: ChargePoint (38 percent of charging stations), Tesla (31 percent), and EV Connect (15 percent).[16] Charger types are mostly Level 2 open standard (80 percent).

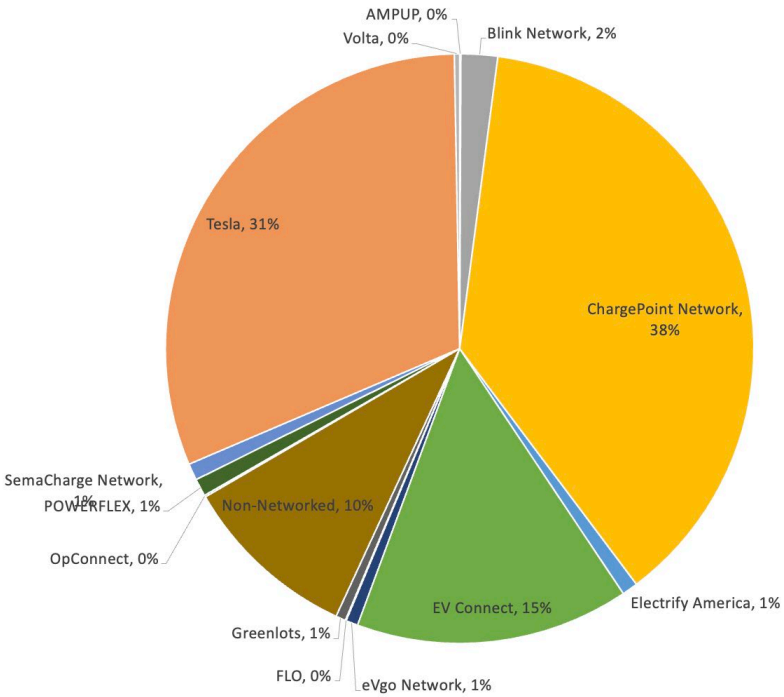

Figure 2. Proportion of EV charging stations in New York State by Network

[16] U.S. Department of Energy's Alternative Fuels Data Center (AFDC). 2020. Electric Vehicle Charging Station Database. Accessed 2/11/2021: https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=all&access=public&access=private&region=US-NY&show_map=true.

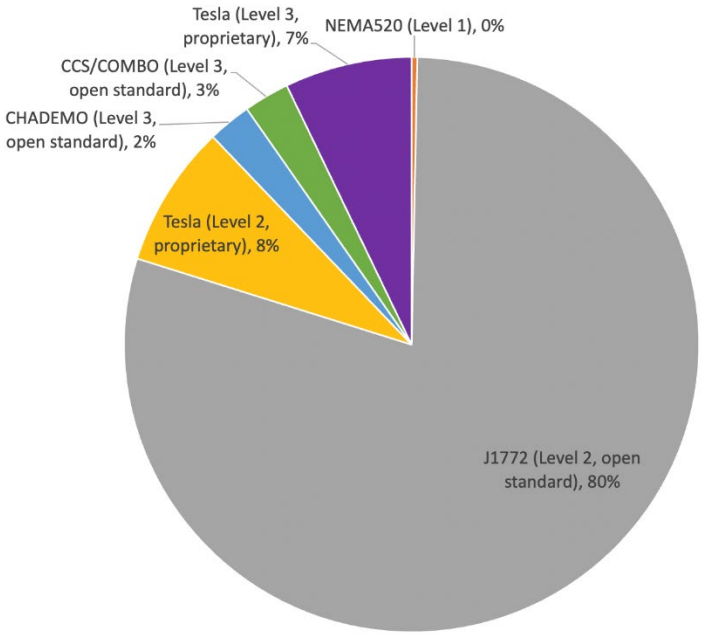

Figure 3. Proportion of EV charging station in New York State by Plug Type.

EV Connect

EV Connect has installed about 2,000 charging stations for around 300 customers, mostly outside the NYC area.[17] Despite the 2,000 installed chargers, the interviewee noted that there is still a small number of level two charging stations in New York's affluent communities, especially compared to California. In general, New York State has not bought into EV adoption as much as California, which is likely a key reason that charging infrastructure is not as prevalent. Charging stations in California are more profitable too. It takes about twice that amount of charging in New York State to get the same revenue as in California. EV Connect has also experienced some challenges in the New York market due to a lack of consumer knowledge on level two charging stations. A lack of cell service in New York's rural areas has been a barrier to installing stations upstate as well (e.g., if phone service is limited, users may have trouble connecting to smart charging apps and charger locating functionality). Looking forward, the interviewee thinks New York should shift its focus from highly populated areas to achieving charger coverage for the state as a whole. Outside of metropolitan areas, the interviewee notes that there are not many plans for or visions of what the future should look like, which NYSERDA could help change.

[17] The U.S. Department of Transportation's Alternative Fuels Data Center (AFDC) puts the total number of chargers in NYS closer to 1,000, meaning that approximately half of the EV Connect chargers are either a) located on private properties or b) not yet registered in the AFDC database, though given the size of the discrepancy it is more likely that they are installed on private sites.

ChargePoint

ChargePoint was a subcontractor for CALSTART's "Charge to Work New York" program, which NYSERDA funded. The initial goal of the program was to promote EVs and EVSEs, but it eventually evolved into a charger installation program. Over the course of the three project years, ChargePoint installed 150 ports in NYC and Long Island.

Geographic Availability

Geographic availability of NY EV public charging stations is expressed here as another simple count metric. The Market Evaluation Team identified that a vehicle owner can find direct current (DC) fast charging stations in a total of 59 cities,[18] and non-Tesla fast-charging stations in 44 cities within the state.

For the purpose of benchmarking geographic availability, the Market Evaluation Team also considered the availability of charging stations in all "urban areas" in the US census, defined as densely settled territory that contains a minimum of 2,500 people. These areas are shown in red in **Figure 4**, with charging station locations indicated by grey dots.

[18] "City" here may actually refer to municipality, because the city attribute is referenced in address format (e.g., street number, city, zip code); however, "city" is the terminology used in the AFDC dataset, and without additional information regarding data collection, it is the terminology we will use here. The data source appears consistent with previous NYSERDA reports, and the "city" terminology is the same.

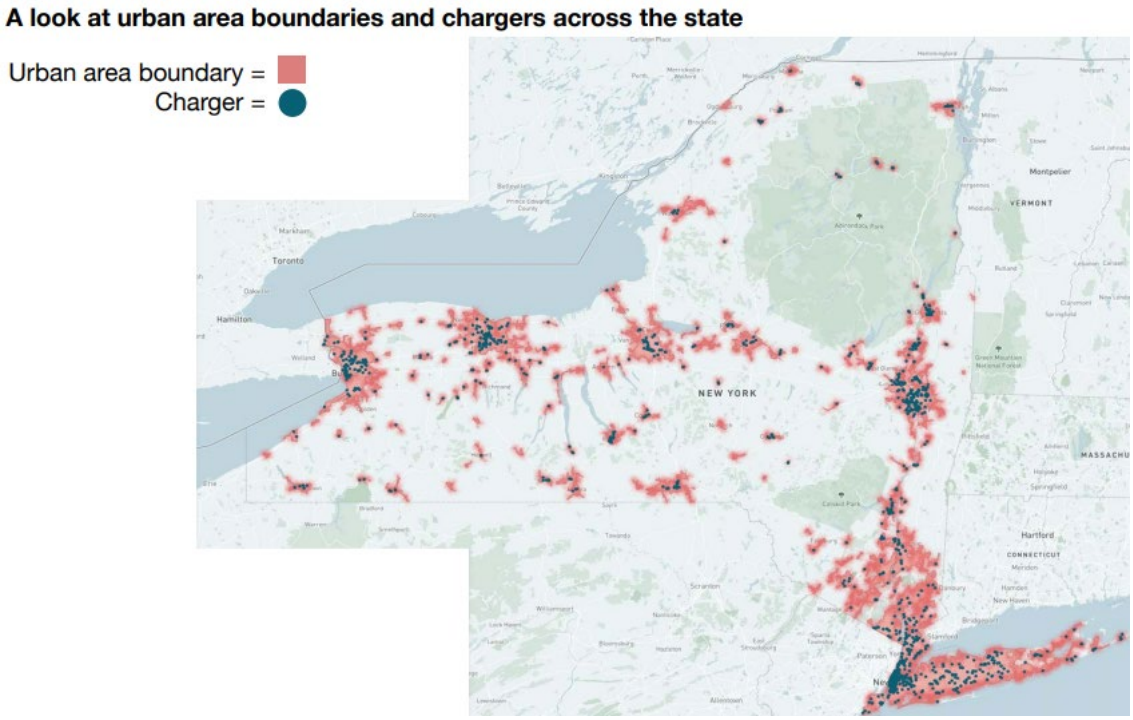

Figure 4. Urban area boundaries and charging station locations in New York State

Around each charging station, the Market Evaluation Team defines a walkshed that identifies the population of residents who live within a ¼ mile (5 minute) walk of a charging station, taking the topology of the local road network and other walkable routes into account. An example of these walksheds for the Albany-Schenectady urban area is shown in **Figure 5**.

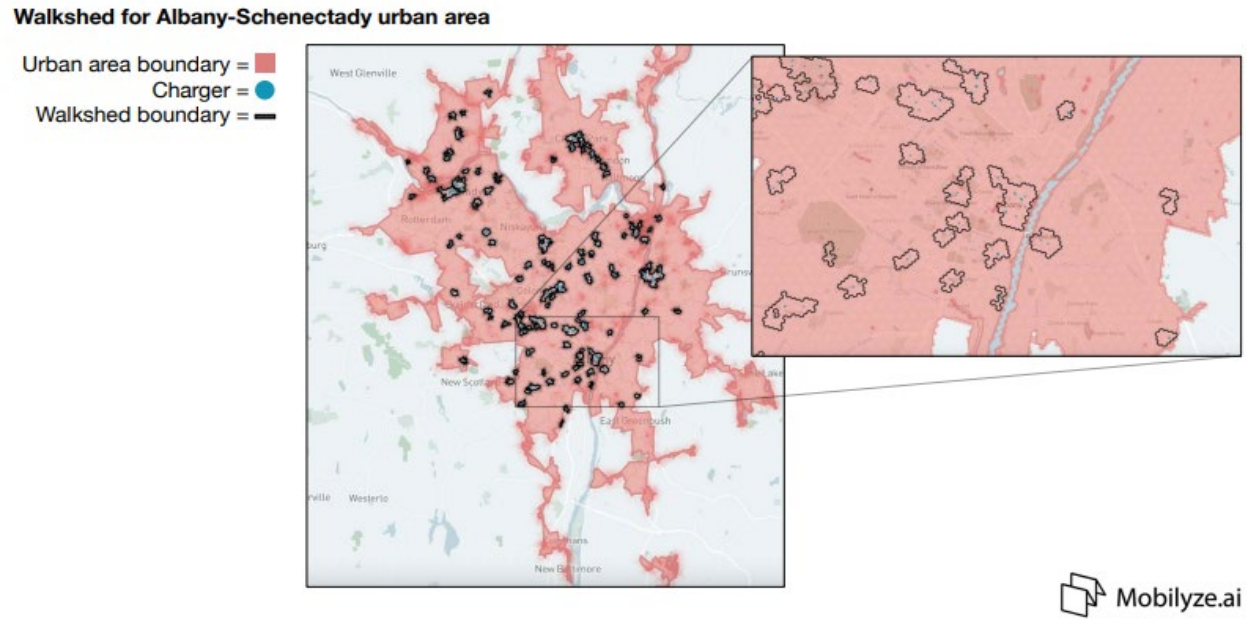

Figure 5. Example urban area walkshed.

This analysis finds that 11.0 percent of New York State residents have convenient access to a public EV charging station (**Figure 6**). However, this statistic is strongly influenced by New York City, which has a very large population in Manhattan proximate to a relatively small number of chargers, many of which are in paid parking garages. On an unweighted basis, the average urban area in New York State provides convenient access to charging for only 4.6 percent of that area's population.

New York City appears to have high charger coverage overall, but chargers are concentrated in downtown Manhattan (higher income, majority white residents), with fewer chargers nearby in population-dense Brooklyn, Bronx, and Queens. In New York City, 13.4 percent of the population has access to public EV charging stations. Ithaca has the highest public charger coverage in the state – a total of 22.5 percent of the population has access to a public charging station. Ithaca has high charger concentration near Cornell University, downtown hotels, and downtown parking garages, but lower charger concentration in the population dense areas of the city. In general, lower income residents, and Black and Hispanic communities have a higher proportion of population with access to public chargers than the statewide average. In Syracuse and Rochester, chargers are likewise concentrated in campus and downtown or commercial areas, and not in population-dense areas within those same cities. In Syracuse and Rochester, a lower proportion of the population has access to public charging (3.4 percent and 4.3 percent, respectively), when compared with the statewide average of 4.6 percent. Unlike in New York City, Syracuse and Rochester both see comparatively better access for renters, lower income residents, Black and Hispanic communities than the state-wide average.

Examining where these public EV charging stations are located within the wider set of New York's urban areas, the Market Evaluation Team finds that public chargers are frequently clustered in downtown areas, and around commercial centers, schools, hotels, hospitals, and airports. These locations have an important bearing on the demographic makeup of the population with convenient access to public charging, with traditionally underserved communities relatively well-served (recognizing that the overall number of people with convenient access is still low). Across New York State, and in comparison with populations who do not live near public charging stations currently, people who live nearby to charging stations more frequently have lower household incomes (**Figure 7**), have a higher proportion of renters (**Figure 8**), and have relatively more Black and Hispanic/Latino residents (**Figure 9**).

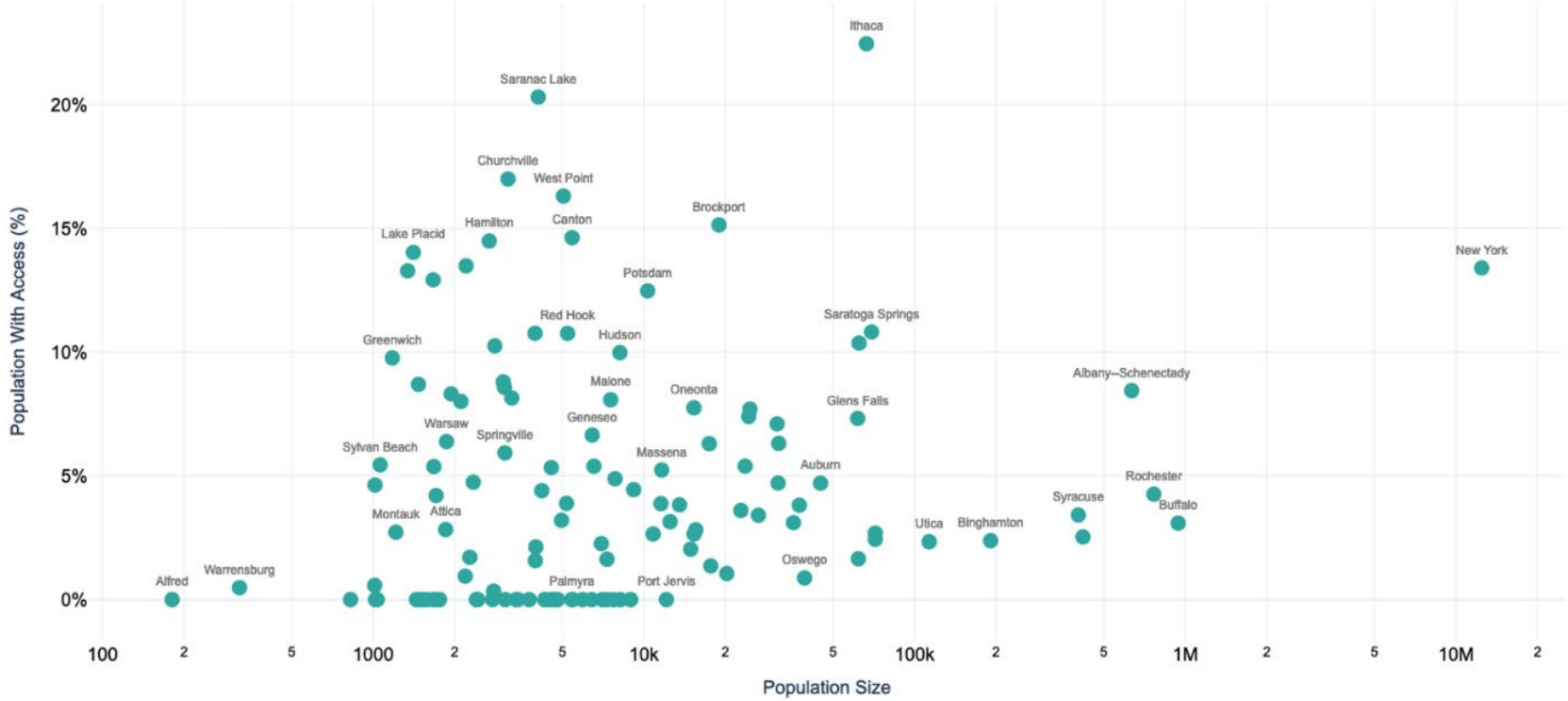

Figure 6. Population with convenient access to charging vs population size by city

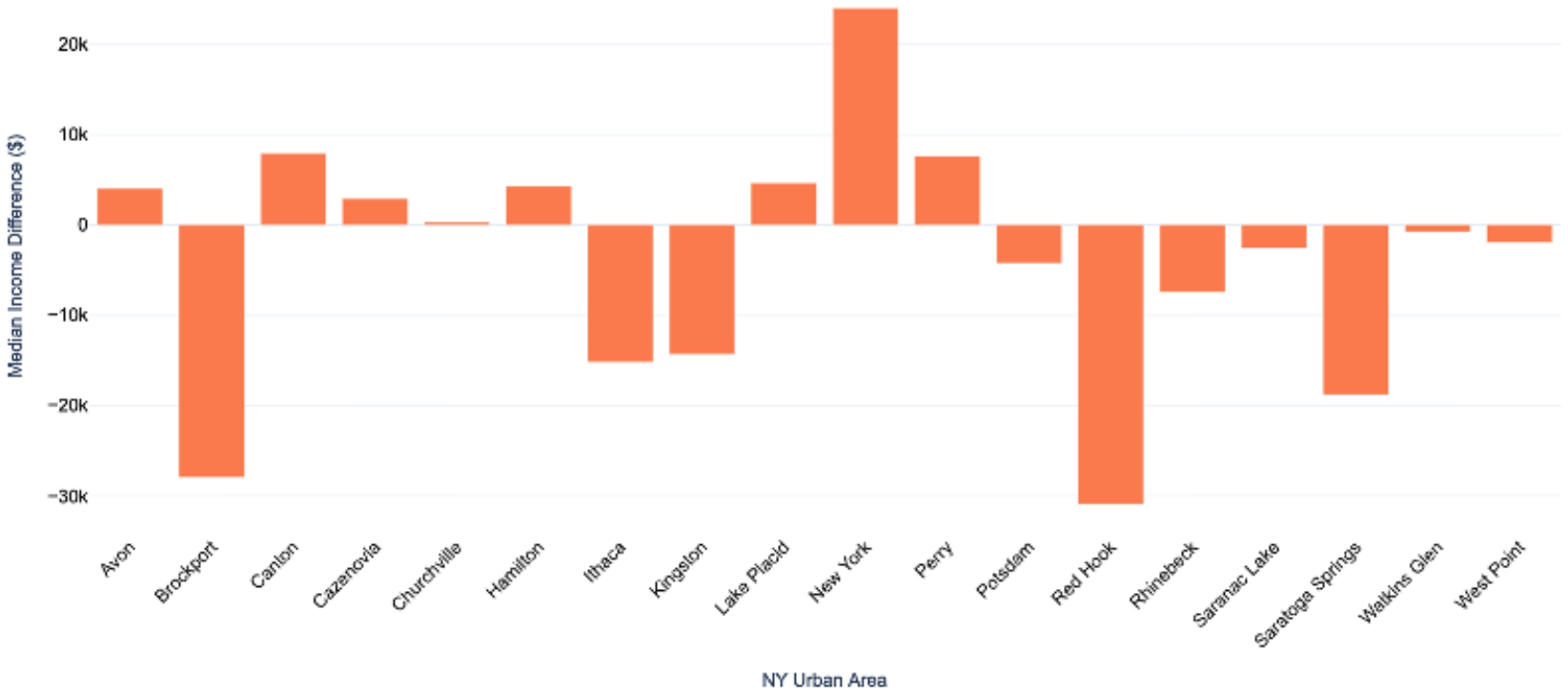

Figure 7. Household income differential for within-walkshed households for urban areas with >10% of population with access to charging

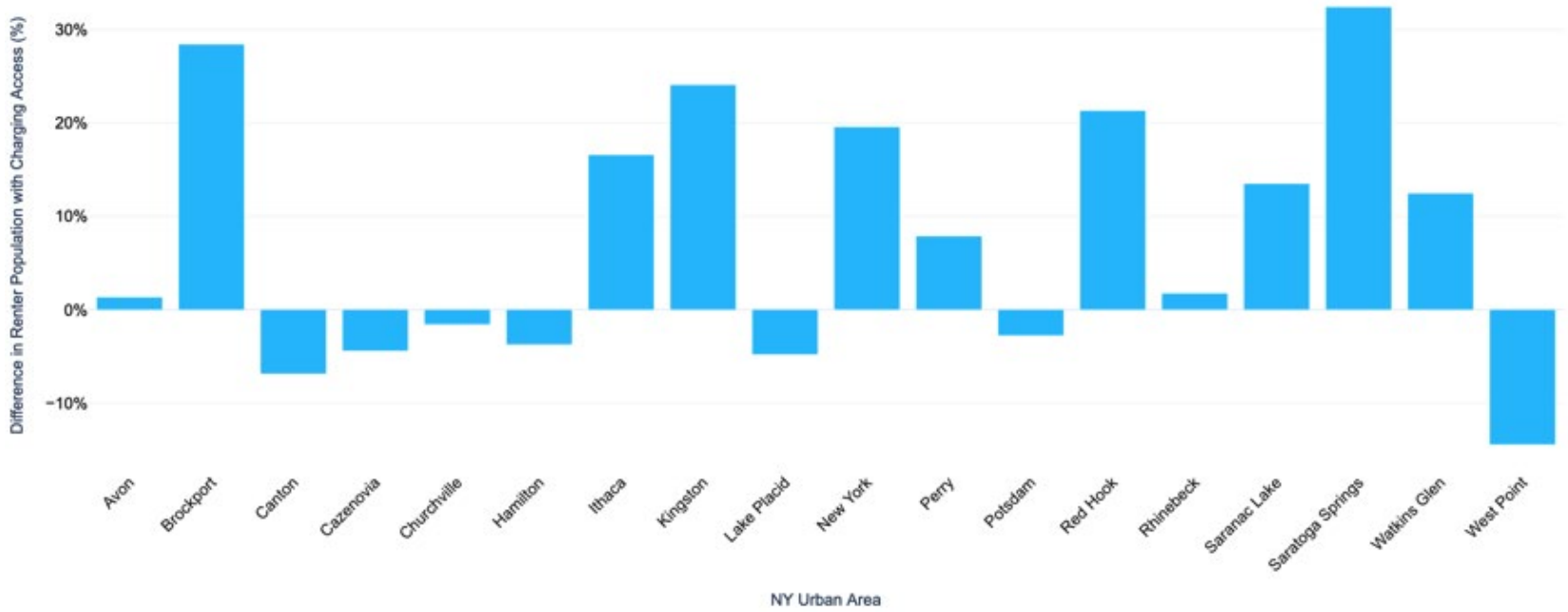

Figure 8. Renter differential for within-walkshed households for urban areas with >10% of population with access to charging

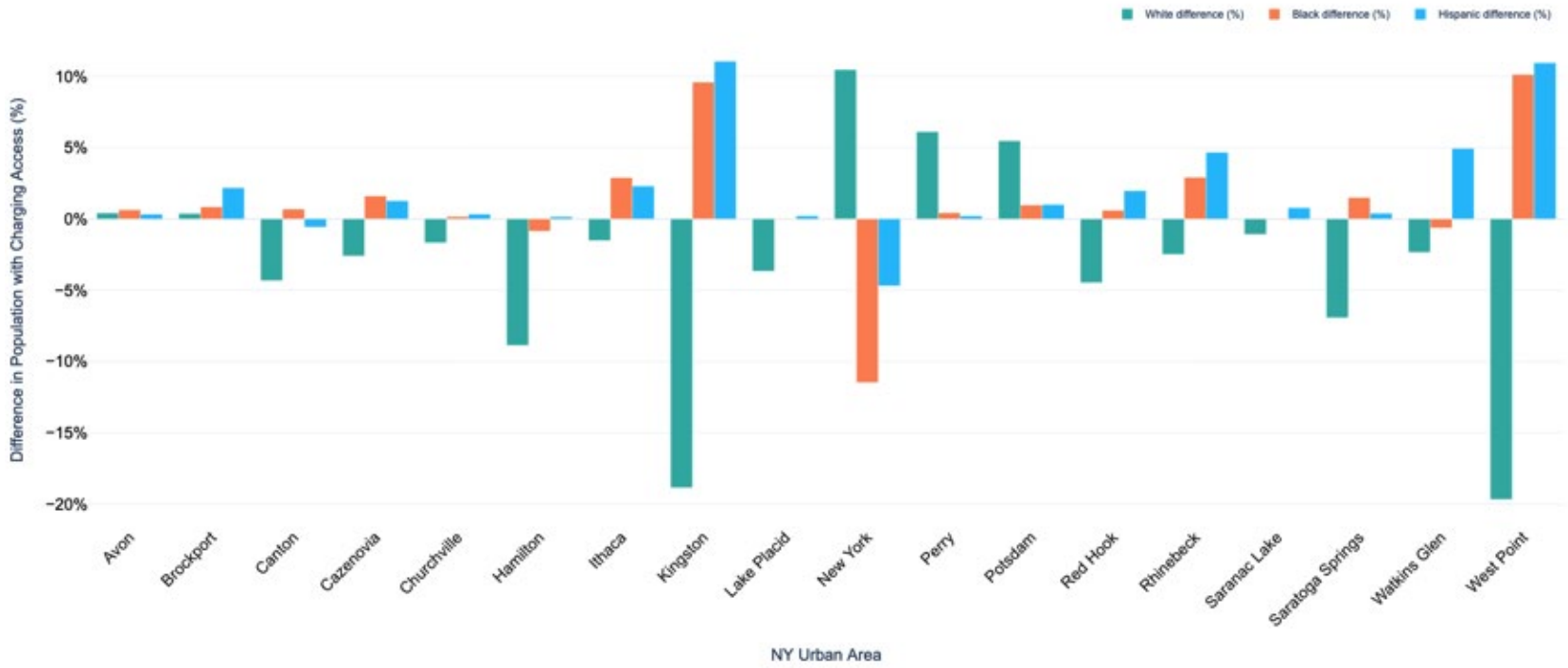

Figure 9. Race/ethnicity differential for within-walkshed households for urban areas with >10% of population with access to charging

3.1.7 What new programs and products have utilities introduced that enable smart charging?

The Investment Plan does not define smart charging explicitly, but the concept can be defined as optimization of EV charging through two-way communication with the utility or grid operator, with the goal of shifting peak electricity usage and reducing cost to the driver. The "smart" piece refers to a shared data connection between the EV and the charging device that allows the owner, utility, or the charging port operator to manage the vehicle's charge remotely and adapt to ensure that charging requirements are met for the driver with minimal cost.[19] According to EV Innovations Contracts Commitments data,[20] five projects total, by Siemens, Smarter Grid Solutions, Avangrid, and Simple Energy (now Uplight) have produced a product enabling smart charging (5 projects total). While it appears that not all companies developed or demonstrated the product using NYSERDA funds, the product may still have contributed to enabling smart charging in NYS and is therefore included in the count. For example, Avangrid has a new EV charging station data-sharing agreement with EV Connect,[21] and both Central Hudson Gas & Electric and Orange & Rockland utilities have both partnered with Simple Energy in their service territories to provide customer-facing energy insights through a new software platform.[22]

There are seven utility programs enabling smart charging.[23] Con Edison has a smart charging-based incentive program (SmartCharge New York).[24] Central Hudson, Rochester Gas & Electric, New York State Electric & Gas, and Orange & Rockland all have time-of-use pricing and/or lower overnight charge costs.[25] Long Island Power Authority has an incentive program similar to Con Edison, and Public Service Electric & Gas offers smart charger rebates for purchasers. Also, Con Edison, National Grid, New York

[19] Smart charging of electric vehicles (guide): https://www.virta.global/smart-charging .
[20] EV Innovation Contract Commitments Spreadsheet provided by Adam Ruder, March 2, 2021
[21] Avangrid published a press release in December of 2020: https://www.avangrid.com/wps/portal/avangrid/pressroom/pressrelease/2020/20-12-02%20ev%20connect/!ut/p/z1/pVFRT8IwEP4r8MBjc9dubuOxISMIToyKbH0hXelgytoxFtR_b0d8MCFgjG1yuWvvvnz3fSAgBWHksdzItrRG7lydiWDl0SSe-CO8Rx77yB_nye1oQdl8EsILCBDKtHW7hUxumlXd6MOhsbYa4Fmqd1oe9ACZu10klBFkPX3sKWuMVm0HVqty7aAK5VO5zkmki5z4iq1JHnQZYyEbDnOqkMHyN3bCfeOFw9HNi1MLnUcxnUUsiWZsjHwaPPMxTikGN98NVzAyxyG8yGFIYXks9TssjG0qJ-jTH1ecIExPFK5s6UxiTTJKNg5ZtltSmsJC-lNySDvJu3guuZsuX_d7wZ2P1rT6wz3938i6qiLvk7wVSez5Inu44_3-F5bJ3MQ!/dz/d5/L2dBISEvZ0FBIS9nQSEh/.
[22] Uplight is partnering with two New York utilities to provide energy insights to customers with smart charging and other energy use in mind: https://uplight.com/blog/central-hudson-and-simple-energy-promote-energy-efficiency-with-new-online-store-and-engagement-platform-2/
[23] AFDC. 2021. Electricity Laws and Incentives in New York. Accessed 2/11/21: https://afdc.energy.gov/fuels/laws/ELEC?state=ny.
[24] Con Edison's SmartCharge New York: https://www.fleetcarma.com/smartchargenewyork/
[25] NYSERDA. Charge NY: Charging Station Info for Drivers. 2020. Accessed: https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Charge-Electric/Charging-Station-Info-for-EV-Drivers.

State Electric & Gas, and Rochester Gas & Electric all have programs where owners of DC fast chargers may qualify for an EVSE connector-based incentive.

For more context on these projects, the Market Evaluation Team interviewed Avangrid about their OptimizEV program, and Nuvve about their partnership with ConEdison for vehicle-to-grid (V2G).

Avangrid

The Market Evaluation Team's interview with Avangrid about the Smart Home Rate (which Avangrid branded "OptimizEV") focused on the utility's experience with OptimizEV and their plans to expand it. The Smart Home Rate uses a scheduling algorithm developed by researchers at Cornell University, which optimizes EV charging based on how long it takes EVs to charge and the time by which EV owners need their vehicles charged. The algorithm aims to flatten peak base load and reduce stress on the power grid. See additional information on this pilot project in **Sections 3.1.8** and **3.1.12**.

Nuvve

Nuvve partnered with ConEdison for a school bus project in White Plains. The project involved upgrading five electric school buses to be V2G and retrofitting the charging stations for bidirectional use. The project has been going on for two years and ConEdison indicated that they would like to expand the project in the future. V2G adds value to EV charging installations because it can provide energy management and cost savings (i.e., enables creative opportunities for project financing).

During the project, Nuvve ran into some challenges with AC-V2G interconnection but noted that the interconnection process is usually easier with DC chargers. In general, the smoothness of the interconnection process depends on utilities; barriers are regulatory rather than technical. Nuvve suggested that having a regulatory identity for V2G would help given that V2G is currently in a regulatory grey area. The Nuvve interviewees suggested that having agreements in place with utilities would be a major step forward.

3.1.8 What stage of development are these programs and which customer market segments do they target?

Avangrid

The Avangrid OptimizEV pilot project with Cornell University tested whether EV owners are willing to delay time to charge if they get a discount on their electricity bill, and whether the utility can increase

efficiency through direct control (impact load around the chargers). The pilot enrolled 35 customers in Tompkins County and collected three months of baseline data (normal charging); after three months, it allowed customers to interact with the program to optimize their charging. The interviewee reported that Avangrid considers the program a success, because they were able to optimize at 64 percent usage, 14 percent higher than their original goal of 50 percent. Customer enrollees approved of the program, too. The pilot ended on May 1, 2021. The next step for Avangrid is to scale up a version of the program for increased customer participation. Avangrid has submitted a program proposal to the NY Public Service Commission for approval, where the goal is to target overloaded grids and expand beyond Tompkins County. See additional information on Avangrid's commercialization plans in **Section 3.1.12**.

3.1.9 How many industry stakeholders have engaged in consumer awareness programs?

NYSERDA has directly engaged with 53 partners through Drive Clean Drive Electric, including 22 local companies, 13 OEMs, 5 state agencies engaged through NESCAUM (in addition to NYSERDA), one trade association (Alliance for Automotive Innovation), and 12 Additional Partners (including Sustainable Hudson Valley, Akimeka, Sustainable Westchester, and Essense). Through these partners, the EV-Innovation program was able to engage with a wide range of stakeholders throughout the state and the region. Several interviewees noted the types of outreach activities undertaken, including presentations to municipalities, general awareness campaigns on EVs, engagement in ride and drive events, and targeted social media campaigns.

In general, the NYSERDA-funded projects have tended to focus on expanding charging, improving awareness in primary markets, and primary market incentives. Significant evidence exists for efforts to expand charging markets throughout NYS, including locating charging in LMI communities and multi-unit dwellings. There seems to be wide receptivity to educational initiatives in some target groups (Gen X and baby boomer men, as well as "Grown-Up Millennials", or Millennials who have purchased a home or had a child). Nevertheless, interviewees indicated that there is some evidence that consumers still find EV charging networks to be lacking,[26] regardless of whether or not this is actually the case (see **Section 3.1.6** on geographic availability of charging stations for empirical evidence on charging networks).[27] One interviewee reported that people's perceptions of public charging availability are linked with individual willingness to make the transition to EVs (based on the interviewee's consumer survey findings).

[26] NESCAUM Interview
[27] The Market Evaluation Team discusses similar evidence about consumer perceptions regarding public EV charging networks in the *EV Rebate Program Market Evaluation*.

In interviews, grant recipients indicated that outreach and market development to LMI communities was still nascent, reflecting efforts to bolster the primary market. Other areas identified for further work included electrifying medium and heavy-duty fleets, as well as re-engaging with dealerships, especially with regard to strengthening the secondary market. Specific interview findings are detailed below.

Akimeka (formerly Energetics)

Akimeka was part of two projects funded by NYSERDA. One project was a needs assessment, an effort to understand how the transportation electrification market is being influenced by all demographics. Akimeka reached out to communities, dealers, and Cornell Cooperative Extension offices in the region to conduct an informal needs assessment. Ultimately, community perceptions about EVs are still a barrier, and there is resistance to EV adoption where EV programs are seen as prescriptive, rather than suggestions to address local needs. Also, some municipalities that had adoption plans and purchased EVs prior to the pandemic have since sold the vehicles back due to budget constraints. The needs assessment process was followed up by presentations: to municipal planning boards, multi-unit dwelling and mixed-use building owners and developers, and potential EV customers.

The second project was a collaboration between Akimeka, Cornell Cooperative Extension of Tompkins County, Center for Community Transportation (dba Ithaca Carshare), Clean Communities of Central New York, and Ridge Road Imports to develop a business model for expanding the secondary EV market (used EVs) and facilitate EV usage among LMI communities. Initially, Tompkins County received a grant for a geographic analysis of EV charging coverage in the area, but additional funding through Cleaner, Greener Communities built on the geographic analysis and expanded to planning studies for I-90 corridor regions to understand how transportation electrification is being adopted in LMI communities. For this project, Akimeka used a multi-pronged approach, reaching out to communities, dealers, Cornell Cooperative Extension, and others to gather multiple perspectives. Akimeka identified that EV needs for LMI customers may differ based on the available technology, and that a range of charging options will be necessary to support LMI customer adoption of EVs, such as publicly available or multi-unit dwelling charging and wall outlet chargers.

NESCAUM

NESCAUM has collaborated with NYSERDA on several EV-related efforts, including Drive Change, Drive Electric and "Destination Electric," both of which aimed to improve consumer awareness of charging infrastructure and understanding of light-duty EVs. The Drive Change, Drive Electric initiative

was a collaboration with NYSERDA, the Connecticut Department of Energy and Environmental Protection, the Massachusetts Department of Environmental Protection, the New Hampshire Department of Environmental Service, New Jersey Department of Environmental Protection, Rhode Island Department of Environmental Management, and automotive manufacturers. The initiative was aimed at closing the gap in customer EV knowledge using a brand-neutral campaign strategy. OEM logos were displayed on initiative outreach materials, but the information about EVs was not brand-specific; rather, the materials focused on raising general consumer awareness and understanding about EVs using multiple communication channels.

"Destination Electric" is specific to light duty vehicles in the Northeast, where there is concern from prospective customers about lack of public charging stations. Other sources of customer hesitation over EV adoption include concerns about EV range, battery material sourcing, and end-of-life disposal.

Vermont Energy Investment Corporation (VEIC)

NYSERDA funded a VEIC pilot program to expand adoption of EVs within LMI communities. The project focused on the North Country Economic Development Region (New York's Adirondack Region). In Phase I of the project, VEIC developed a research paper about LMI energy issues relating to electric transportation and engaged stakeholders in various ways (including interviews). The intention is to use community-based organizations to expand a network for outreach, to ask about general awareness of EVs and their benefits. In Phase II, VEIC is implementing a pilot program that could potentially involve work to support charging infrastructure or developing an incentive for used plug-in hybrids (understanding that drivers may not plug hybrids in, an issue they observed in a Vermont program, which just means that the PHEV functions as a standard HEV).

VEIC's general approach is to address cold-climate issues with EV adoption and build EV awareness in LMI communities, but the COVID-19 pandemic has hindered progress somewhat by preventing in-person meetings for capacity-building conversations with local community-based organizations. Specific observations to date include the following:

- There is limited used EV stock in North Country, and dealers are not motivated to develop the market further.
- Availability and affordability of EVs for LMI customers (a used EV in the North Country is approximately ~$10,000, which is a stretch for those on the lower end of the LMI spectrum).
- Car share programs may not be feasible in the area.

LMI Initiatives

Most interviewees stated their intention to address equity; but even where they have tried to do so, the market is underdeveloped. Across the board, interviewees indicated that reaching LMI communities was not an explicitly tracked metric of their projects, although many grant recipients indicated the need to service these communities and an interest in doing so. Because LMI outreach was not an explicitly tracked metric of the projects, findings were anecdotal. The potential focus of future LMI outreach included:

- Identifying EV needs, which may differ for LMI customers based on what technology is available to them (especially charging station proximity and chargers for wall outlets)
- Research into appropriate infrastructure for Uber and Lyft drivers
- Equity implications of Medium- and Heavy- duty ZEV programs
- Developing and supporting car share programs
- Developing the secondary market for used EVs

Car share programs

One significant area for LMI outreach initiatives is through car share programs, such as those in Rochester and Buffalo. Car share programs serve those who cannot afford or do not wish to own a vehicle, especially an electric vehicle – especially older populations. These programs can serve pre-employment activities such as interviews and background checks, as well as means to access grocery stores and other essentials.

Although these programs did not track directly the populations served, grantees indicated that in general the vast majority of the population served by these programs would fall under the LMI designation for NYSERDA. The programs further served LMI communities by providing subsidized prices for low-income residents. For example, the City of Rochester's electric car share program in coordination with Mobility Development, a model similar to Zipcar (and currently contracted through Zipcar), provided LMI customers with an allotment of free car share hours (where typically there is an hourly fee). The program reached users who did not necessarily have access to public transportation, including older customers.

Another challenge of these programs is establishing the long-term sustainability of operating projects, and the need to transfer the programs to a third party, especially a profit-driven private sector entity. High

prices for insurance and other financial barriers can create a "valley of death" similar to other valleys of death in the adoption of new technology. The challenge however is that technology and programs serving LMI communities may not have as much potential for profitability, regardless of need. In the case of the City of Rochester electric car share program, the sustainability of the program reportedly hinges upon the installation of two on-street charging stations, the growth of the fleet (i.e., purchase of 5-10 new car share vehicles in addition to the operating base of 10), and continuation of the contract, either through Zipcar or through another partner if the non-profit model is maintained.

Used Car Market/Dealerships

In working with dealerships, interviewees indicated some challenges to measuring the success of dealership programs. In particular, multiple grantees indicated that dealerships themselves do not effectively track where their consumers are coming from. Broader, longer-term tracking of metrics involves investment by these dealerships that many are hesitant to undertake. Automotive manufacturers and dealerships have both been enlisted in closing the knowledge gap on EVs but maintaining OEM interest in brand-neutral outreach has been identified as a challenge. Qualitative data suggest that direct incentives to dealerships could provide an opportunity for expansion.

The secondary car market is also key to developing adoption of electric vehicles and is an area for potential growth in outreach going forward. The used car market is 2-3 times the size of the new car market in the United States. Many grantees indicated interest in building out the used EV market but noted that it does not really exist currently. Interviewees indicate interest from their stakeholders regarding incentives for used vehicles; many grant holders, especially those working closely with LMI communities and dealerships, have thoughts on barriers to used car supply within NYS and the region, including competing incentives drawing used car stock to California.

Follow-up/Tracking Data

With few exceptions, none of the grantees thought it was in their purview to track outcomes, especially outreach. Multiple interviewees mentioned that there was no clear follow-up required from the NYSERDA grant delivery. There is not a clear and consistent record of the types and numbers of participants in various programs supported by NYSERDA. Several grantees indicated that they independently tracked where they went and what they did, but there was no requirement to track interactions with individual municipalities or other constituents, and there is no centralized source for outreach from NYSERDA to grant holder to outreach partner to end recipient.

- One interviewee noted there was no formal follow-up process for their project, though they executed data tracking and review as part of their own organizational practice.
- No tracking of interactions with participants/types of participants could result in redundancy or loss of lessons learned when trying to replicate and expand projects.
- Equity and access issues were not measured or tracked in most projects but will need to be tracked moving forward under the CLCPA.

While not in the purview of this evaluation, an extremely valuable tool for NYSERDA would be the tracking of the specific outreach targets of each initiative, including the number of times each target was engaged. A centralized reporting requirement would make evaluation of success and continuation of successful projects much more precise (see **Section 3.1.11** and **3.1.15** for further information).

3.1.10 What percent of NYS municipalities have adopted standard policies relating to: EV-friendly zoning, building codes, planning procedures, or permitting?

Using interviews with NYSERDA program staff and a 2020 report by Energetics and WXY Architecture + Urban Design, the Market Evaluation Team identified 16 instances of EV/EVSE building codes adopted by municipalities in NYS (examples in **Table 5**).[28] This was not a comprehensive overview of building codes adopted by municipalities, but rather highlights of best practices adopted as part of policy guidance documents for dissemination to other municipalities.

Table 5. Examples of municipalities with EV/EVSE building codes to streamline EV adoption.

Municipality	County
Cohoes	Albany
Otto	Cattaraugus
Brutus	Cayuga
Redhook	Dutchess
Brockport	Monroe
Port Washington North	Nassau
New York City	New York
Oneida	Oneida
Ithaca	Tompkins
New Paltz	Ulster

[28] Energetics and WXY Architecture + Urban Design. 2020. Promoting EV Charging Stations for Commercial and Residential Developments: Information, Incentives, and Installation Guidelines for New York Property Owners and Developers. Accessed online, 2/10/2021: https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Charge-Electric/Best-Practices. (referred to as Energetics report)

Though there is little documentation of building codes adopted by NY municipalities, the NY Clean Energy Communities (CEC) program records instances of municipalities participating in "clean fleets" activities (i.e., installing charging stations and/or purchasing heavy-duty electric vehicles and light/medium duty electric vehicles). Municipal purchase of EVs and public EV charging stations may encourage local EV-friendly policies in the future. Information on the communities participating in the CEC program shows that while 234 communities participated in some version of a clean fleets program under the CEC program, only 24 of those communities are participating in a current version of clean fleets activities – possibly indicating that the focus of the program has shifted away from EVs and towards other types of clean energy initiatives.[29] Of the 24 communities participating in clean fleets, nine local governments are participating in clean fleets charging stations activities.

In response to inquiries as to EV policy and code, interviews with NYSERDA and other program staff indicated that they have not been making a big push on streamlining and code review within the state's municipalities. The general sentiment in interviews is that these efforts provide a low return on effort towards the goal of electrification of transportation as opposed to other efforts undertaken by state agencies. If this is the case, there may be other more relevant indicators to track in the codification of EV laws and code for municipalities.

As mentioned in **Section 3.1.9**, interviewees indicated that project leads were not required to track outreach to municipalities with the goal of streamlining EV policies and codes. Requiring tracking information for all forms of engagement and outreach could build out the chain of proof and provide more effective evidence as to whether outreach efforts affect municipalities and in turn result in greater pro-EV rule promulgation; building an effective monitoring, reporting, and verification system would also allow further correlation with policy implementation and household EV adoption.

The EV Connect interviewee reported that their chargers are fairly easy to install for any electrician and that, in most cities, there have not been serious permitting barriers that hinder installations. However, the interviewee thinks that the NYS Public Service Commission could do more to encourage charging development and that existing regulations have been restrictive. Similarly, Uplight's interviewees noted that some New York municipalities have strict regulations about what chargers can be installed in homes. This is an immediate barrier to charger purchases.

[29] NYSERDA. 2020. Clean Energy Communities Program Map. Accessed online August 2021: https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Communities/Tracking-Progress/CEC-Map

Some efforts have been undertaken to create policy documents for municipalities hoping to implement pro-EV rules and initiatives. Unfortunately, many of these documents, while prevalent, need to be updated and are not very accessible. For example, "Creating EV-Ready Towns and Cities: A Guide to Planning and Policy Tools," available on the Charge NY website, is dated November 2012. Even cursory updates to these materials might be worthwhile in supporting a comprehensive push toward EVs.

3.1.11 How widespread are coordination activities for encouraging adoption of standardized policies and programs?

This metric, widespread coordination activities for standardized policy adoption, was designed to capture coordinated engagement, outreach, or policy analysis activities geared toward streamlining policy benefitting EVs and EVSE.

Gladstein, Neandross, & Associates (GNA)

In a project aiming to reduce barriers to EV charger permitting, GNA assessed existing direct current fast charger (DCFC) permitting processes in NYS and developed a list of 10 best practices, published in a guidebook.[30] The best practices were developed based on pain points experienced by EV service providers in completing installations, code officials, and municipalities in other parts of the country. Best practices focus on 1) structuring the application process in a consistent way, including hiring dedicated staff and setting requirements for pre-application meetings; 2) generating support documents for applicants, including checklists, timelines, and recommendations; and 3) formalizing requirements, such as zoning and user accessibility.

GNA stated that the project team did not disseminate findings to jurisdictions and was unable to follow-up with them, as that was outside their scope. GNA handed off the Guidebook to NYSERA and recommended a multi-phase Part 2 of the work, including outreach and education and an ombudsman hotline, but both elements have not moved forward at this date. GNA stated that NYSERDA disseminated findings and hosts the Guidebook.

Stakeholder Outreach

[30] NYSERDA. 2020. *DC Fast Charger Streamlined Permitting Guidebook.* Accessed online August 2021: https://www.nyserda.ny.gov/-/media/Files/Programs/clean-energy-siting/DC-Fast-Charger-Guidebook.pdf

The "hub and spoke model" of stakeholder outreach was raised several times throughout interviews. In this model, grantees serve as the convener to bring together various players and to realize what one grantee called "force multipliers," or in other words, organizers benefitting from the progress of one another. One grantee explained it as follows:

> *"This is an organizing project-- the idea is to pull together all the nodes that exist in the transportation system, and [to] galvanize them to create a series of what could be individual actions or programs, but the value of the program/design is that the programs all amplify off one another."*

The intention of these projects is arguably highly effective, engaging multiple sets of stakeholders in order to grow the EV ecosystem in NYS. However, there is low evidence of cross-stakeholder coordination of EV outreach activities for encouraging adoption of standardized policies and programs between the various projects. While some stakeholders did mention that there was "intentional cross-pollination," several interviewees mentioned that they were not aware of or involved with other related programs. Other interviewees mentioned that while they were aware of other programs, they were not directly involved or specifically encouraged or requested to coordinate with related programs. For example, EVSE building codes policy documents are prevalent, but need to be updated. Currently, they are either not very accessible, or outdated.

Programs could be intentionally diverse to cover a wide array of projects and innovation models. However, overlap and coordination among projects could help to strengthen the overall EV ecosystem and rapid uptake and adoption of electric vehicles. Coordination would be improved with more granular reporting from partners, allowing NYSERDA to identify areas that are well covered vs. areas that need improvement/more attention, as well as areas where partners should work together to amplify and strengthen efforts. As a way of tracing impact, NYSERDA could track municipality use of educational and outreach materials and templates developed by grantees, in addition to a "report card" approach for evaluating streamlined EVSE permitting policies.

3.1.12 How many products have been commercialized with NYSERDA's support?

The Investment Plan has as an overarching goal the development, demonstration, and market traction of products that reduce greenhouse gas emissions from the transportation sector. The Investment Plan also notes that for any new technology development launched under the program, on a yearly basis,

NYSERDA staff and contractors will reassess the Technology and Commercialization Readiness Levels for each project in the portfolio. The EV Innovation Contracts Commitments Spreadsheet and the Products Development Salesforce data indicated that no products have been commercialized with support from the EV Innovation program.[31] However, one project – Avangrid Smart Home Rate EV Charger Demo – had a product ("Smart Home Rate") in the proof-of-concept stage. The Salesforce data identified five other organizations in the EV Innovation Contract Commitments Spreadsheet – Clean Power Research, HEVO, Unique Electric Solutions of NYS LLC, Alliance for Sustainable Energy, and New York Power Authority – with products in various stages of commercialization, but none were linked to EV Innovation projects (rather, they were linked to other NYSERDA projects). NYSERDA Clean Transportation program staff recommended we interview two of these companies – HEVO and Unique Electric Solutions (UES) – in addition to Avangrid.[32] HEVO and UES have made progress toward commercializing their products with support from multiple NYSERDA awards, including but not limited to EV Innovation program awards.

Avangrid

The Avangrid interviewee stated that the OptimizEV pilot (first described in **Section 3.1.7)** was "overwhelmingly successful." The pilot achieved 64 percent optimization usage against a target of 50 percent, helped reduce peak load, and 95 percent of enrollees approved of the program.

Avangrid is scaling up the pilot and plans to eventually offer a version of the program to its customers. Avangrid recently submitted the "Mass Market Managed Charging Program" to the Public Service Commission. The program has three phases: demand response communication; time of use rate; and optimized charging, which is based on OptimizEV. The program will be targeted to areas with high potential EV adoption and overloaded grid; it will not be limited to Tompkins County, the area covered in the initial pilot.

According to the Avangrid interviewee, the utility is undecided about whether they will use Cornell's scheduling algorithm going forward; if not, they would use a similar algorithm. Avangrid is interested in potentially accounting for other factors in the algorithm, including capital costs that differ across the grid, carbon reduction, and other factors.

[31] None had a "Tech/Product Commercially Available?" = Yes status.
[32] NYSERDA program staff confirmed that the products from the other three organizations, Clean Power Research, Alliance for Sustainable Energy, and New York Power Authority, were not on track for commercialization.

When asked how EV adoption more generally will affect Avangrid's operations, and what other questions the utility is looking to answer, the interviewee stated they are developing make-ready infrastructure. This is motivated in part by NYS's ambitious goals for EV adoption and charging targets set by the Public Service Commission. However, there is uncertainty in how this will play out. The Avangrid interviewee stated that market actors including dealerships seem to be lagging in their efforts to help reach the state's goals for EV adoption. Moreover, Avangrid is uncertain which parts of the grid will become large charging areas, and therefore, which parts of the grid to invest in.

HEVO

HEVO is a technology company that provides wireless EV charging. The company received its first project funding from NYSERDA in the 2007-08 timeframe. NYSERDA has supported a variety of technology advancement at HEVO, including R&D for advanced transportation in 2013, additional work on EV charging in 2018, and recently integrating plug-in charging with HEVO's wireless power station (the CEF-funded project).

HEVO's system offers both plug-in and wireless charging in the same product. Their core markets are infrastructure (local Level 2 charging) and automotive (DC fast charging for fleet vehicles and passenger medium and heavy-duty vehicles). Their software is independent of their hardware, allowing EV drivers to plan their actual drive range. HEVO distributes the ground equipment and retrofits to channel partners (energy developers or electrical contractors).

HEVO reached major commercialization milestones in 2020. As far as HEVO is aware, they are the only company that has met both the UL 2750 wireless charging standard and SAE J2954 automotive operability and performance safety standard. Under the NYSERDA project, HEVO is currently developing the prototype and planning for UL testing. HEVO's production units will be UL-certified once the certifiers visit their facility. HEVO is currently waiting for the power electronics components to arrive; a post-COVID challenge has been delayed supply chains for semiconductors and chips.

The interviewee from HEVO stated that NYSERDA plays a key role in helping companies like HEVO raise capital, as private capital for early-stage hardware companies has been limited. He believes the HEVO/NYSERDA partnership will be "a major success story." HEVO's vision is that wireless charging will become the new normal of charging, including dynamic charging ("charge as you drive"), plus wireless charging at every bus stop. In HEVO's vision, parking lots and garages would be strategically located away from pedestrian and bike centers and would be energy assets (wirelessly charged and bidirectional). Public transportation and delivery routes would be optimized with EVs and drop-off

locations would be wirelessly charged. And underserved communities would have access to these services.

With respect to access for underserved communities, HEVO hopes that channel partners will be small businesses and entrepreneurs from underserved communities who will help deploy chargers to these communities. HEVO's interviewee emphasized the need to ensure that people have access to charging, especially for those who cannot charge at home, while supporting public transit and affordable housing. HEVO's interviewee noted that NYSERDA could potentially connect HEVO with channel partners and/or help match HEVO with installation-approved vendors that are targeting underserved communities.

Unique Electric Solutions (UES)

UES has a longstanding relationship with NYSERDA. The current work focuses on refurbishing existing vehicles to make them electric vehicles. This involves integrating commodities available on the open market with UES's own hardware and software technology.

UES first began offering this service after a UPS contractor approached them to electrify a delivery vehicle. This was a signal that the EV market was growing, which prompted the company to meet with NYSERDA to discuss commercializing the vehicles at scale. UES has continued to grow and scale since. As of now, they have supplied UPS with 31 vehicles and have entered the school bus fleet market as well. Their customer base is centered around NYC's five boroughs, where UES gets "the best bang for their buck."

UES's interviewee attributed their growth to several factors. First, he noted that their services have seen great reception given that customers can simply replace their vehicle's engine, rather than wait and buy a new car. He also noted that these vehicles have been easy to drive for customers. Additionally, increasing consumer knowledge of EVs has been another contributing factor because UES no longer must explain to consumers what EVs are and how they work. Nonetheless, UES still sees a few limitations to the development of its market. The company's biggest challenge is financing its products. Since UES offers a unique service and occupies a small market, banks are not as willing to loan money as they would be otherwise. The interviewee suggested that it would be beneficial for the state to use its power to finance UES's projects. In addition, he noted that repowering as an alternative to buying a new EV is not an option that many consumers are aware of and that NYSERDA could play a role in communicating this.

Looking forward, UES is open to opportunities in any market where they can use and scale their technology. For example, they recently entered the rail car mover market; it is a small market, but these vehicles are compatible with their technology. They have also considered moving into the paratransit

space. Ultimately, UES needs to increase the volume of its customer base to decrease its costs. Limited financing for their technology remains the biggest hurdle for UES.

3.1.13 Revenue from sales of commercialized products

This metric captures revenues from sales of the commercialized products tracked in the previous metric. Because the 2020 cumulative value for commercialized products is "0," the revenue from sales of commercialized products is also "0."

Three of the five organizations identified under the previous metric – Clean Power Research, HEVO, and Unique Electric Solutions – all reported revenues in the Salesforce data, but the revenues all started accruing before 2019, and none were counted in the previous reporting year. The timing of revenues and the fact they were not included in the 2019 reporting suggest the revenues may be linked to other NYSERDA-funded projects (outside of the EV-Innovations area). A fourth company – Smarter Grid Solutions – also reported revenues in the Salesforce data, but again, the revenues began accruing before 2019 and have not been previously counted in reporting for CEF EV projects. To be consistent with last year, The Market Evaluation Team has not counted Smarter Grid Solutions' revenues in 2020, assuming these revenues are associated with different projects."

3.1.14 How many demonstration projects were replicated?

The EV Innovations Contract Commitments Spreadsheet and Salesforce data indicated that there were no replications from product demonstrations. NYSERDA Program Staff confirmed this count. However, during the primary data collection process, interviews with EV Innovation partners identified two NYSERDA-funded demonstrations that showed promise for replication: Electrification Coalition's Rochester Electric Vehicle Accelerator and Electric Power Research Institute's pre-packaged DC as a service.

Electrification Coalition

While not a physical product, the Rochester Electric Vehicle Accelerator (a joint effort between Akimeka and the Electrification Coalition, in partnership with the City of Rochester and the Greater Rochester Clean Cities, funded by NYSERDA) was based on the Electrification Coalition's Drive Electric Northern Colorado program, but scaled to the NY context and with a more aggressive timeline. The interviewee reported that the goals of the program were to:

- Improve consumer education through outreach, dealership engagement, and ride and drive events with EV enthusiasts.

- Partner with cities and advocate for EV adoption.
- Leverage existing infrastructure.
- Engage the private sector in thinking about fleet transition.
- Improve on the Northern Colorado program and evaluate new lessons learned to improve in the future (identify replicable best practices).

The interviewee mentioned that one key lesson learned from the Northern CO implementation is that the program is more successful over a longer time period, and that project partners need more ownership over the program's deployment. In the past, Electrification Coalition had too much ownership, or responsibility over too many aspects of the program, and their eventual withdrawal from the program limited ongoing success. For the Rochester EV Accelerator initiative, Electrification Coalition collaborated with OEMs, dealerships, and utilities to provide product support for the Rochester market (e.g., some OEMs donated vehicles). The interviewee reported that they consider the Rochester version of the model to be replicable, and cited replication in other locales (e.g., SMART Columbus, Drive Electric Orlando, City of Ithaca, Fleets for the Future).[33,34] Electrification Coalition anticipates the next phase of this type of work will be an extension of EV Accelerator programs at a broader scale to reach multiple cities at one time, develop economies of scale, and cultivate institutional knowledge to limit starting over.

Electric Power Research Institute (EPRI)

EPRI is involved in a NYSERDA-funded effort to explore pre-packaged DC as a service, which was focused on packaging DC charger equipment into six standardized components. While the idea "looks promising" (cost-effective, quick, reliable) the project is not yet complete (and therefore not yet replicated, though the pathway is clear). EPRI is currently testing whether standard or custom technologies are more cost effective. EPRI has done a similar project in Washington State with DOE funding, where the utility offered DC as a service. EPRI's role is as a convener, bringing together utilities, charging companies, and bus companies. Their assessment of the NY project is that scaling up will require coordination between utilities (especially where existing policies and procedures need to be

[33] Smart Columbus. 2021. We Are Smart, Columbus. Accessed online August, 2021: https://smart.columbus.gov/about./
[34] Fleets for the Future (F4F). 2021. F4F: About Us. Accessed online, August, 2021: http://www.fleetsforthefuture.org/about.

updated) and big electronics companies (e.g., Siemens), with an anticipated time frame of three to five years after project completion. Possible barriers identified in this work are:

- Municipal permitting.
- Multi-unit housing codes and standards.

3.1.15 Other results

This section includes results identified during the Market Characterization that did not fall under any one evaluation question. These results are cross-cutting at a higher level, and address themes that arose from interviews with EV Innovation Partners: the role of utilities, future directions of the EV market, and possible roles for NYSERDA.

3.1.15.1 Particulate Matter (PM) Emissions Benefits from EVs in DACs

NYSERDA's interim definition of DACs describes communities located within U.S. Census block groups that meet the HUD 50 percent below area median income threshold or communities located within NYS Opportunity Zones (map available from Open Data NY).[35,36] Using EV registration data from EvaluateNY, the Market Evaluation Team analyzed the distribution of 13,850 personal battery electric vehicles (BEVs) and 15.976 plug-in hybrid electric vehicles (PHEVs) to assess the benefits of reduced local air pollutants (in this case, particulate matter (PM) reductions) in disadvantaged communities (DACs) and non-DACs.

PHEV and BEV Distribution

The fraction of BEVs is noticeably higher than PHEVs in urban areas like New York City, while there are relatively more PHEVs in rural areas (**Figure 10**– **Figure 15**). In regional cities, patterns are more pronounced: most EV adopters live outside DACs. DACs tend to be in the inner city, whereas EV adopters frequently live in more affluent suburbs.

[35] NYSERDA. 2021. Disadvantaged Communities Interactive Map. Accessed online December 2021: https://www.nyserda.ny.gov/ny/disadvantaged-communities
[36] NYSERDA. 2021. Interim Disadvantaged Communities (DAC): 2020. *Published on Open Data NY.* Accessed online December 2021: https://data.ny.gov/Energy-Environment/Interim-Disadvantaged-Communities-DAC-2020/t6wd-tdrv

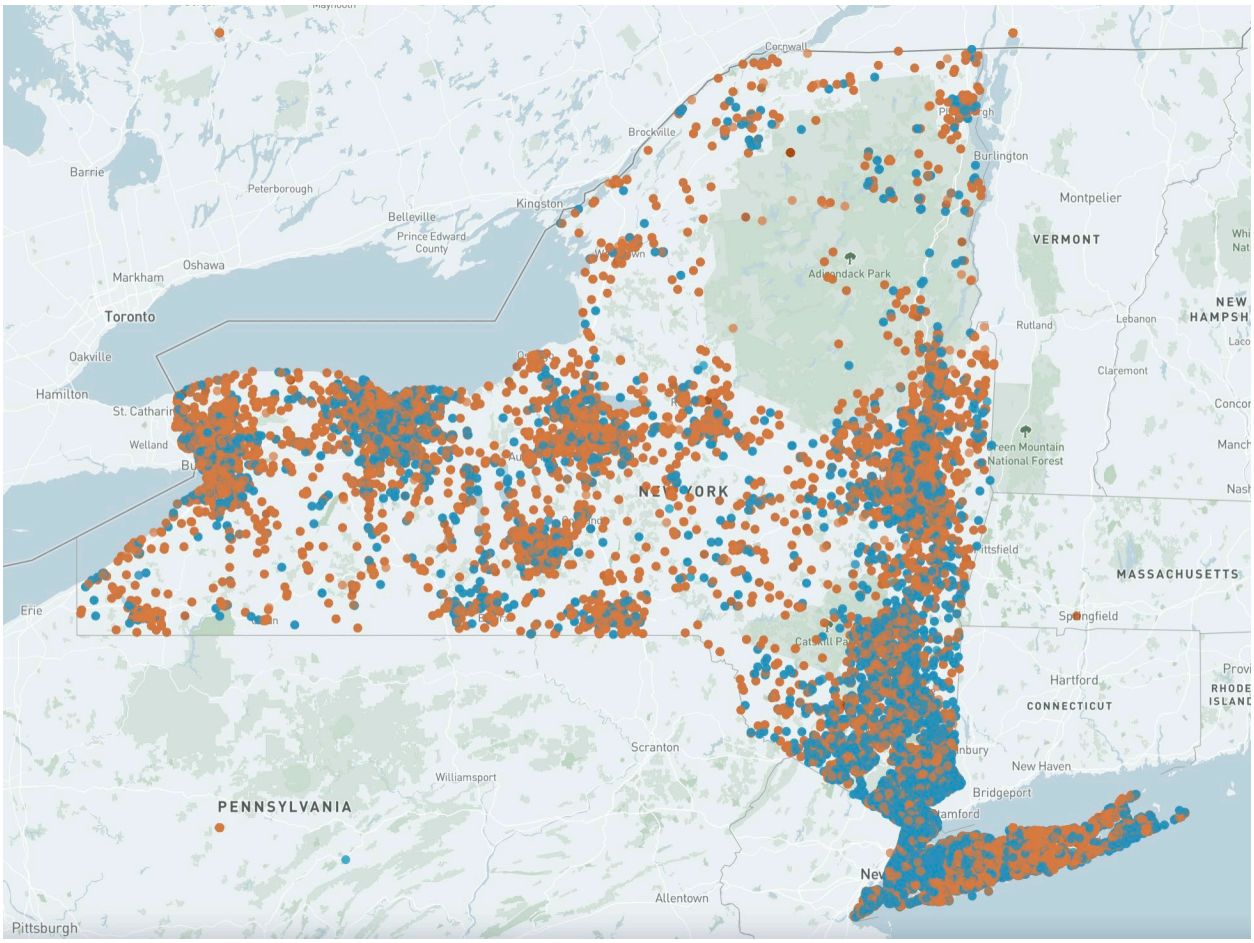

Figure 10. PHEV (orange) and BEV (blue) adoption patterns across New York State: adoption tends to cluster near urban areas.

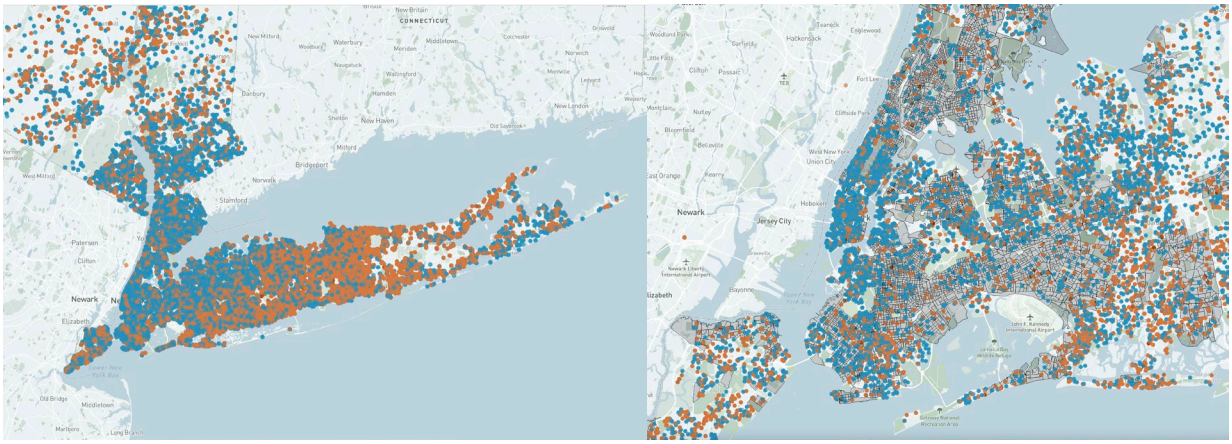

Figure 11. Comparatively more BEVs are adopted in or near NYC DACs.

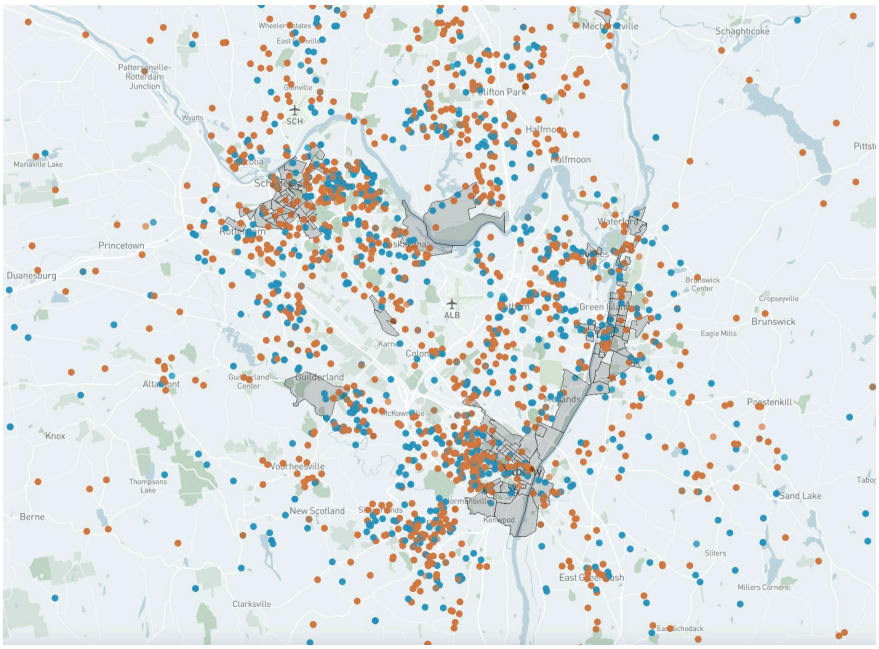

Figure 12. PHEV and BEVs in Schenectady DACs.

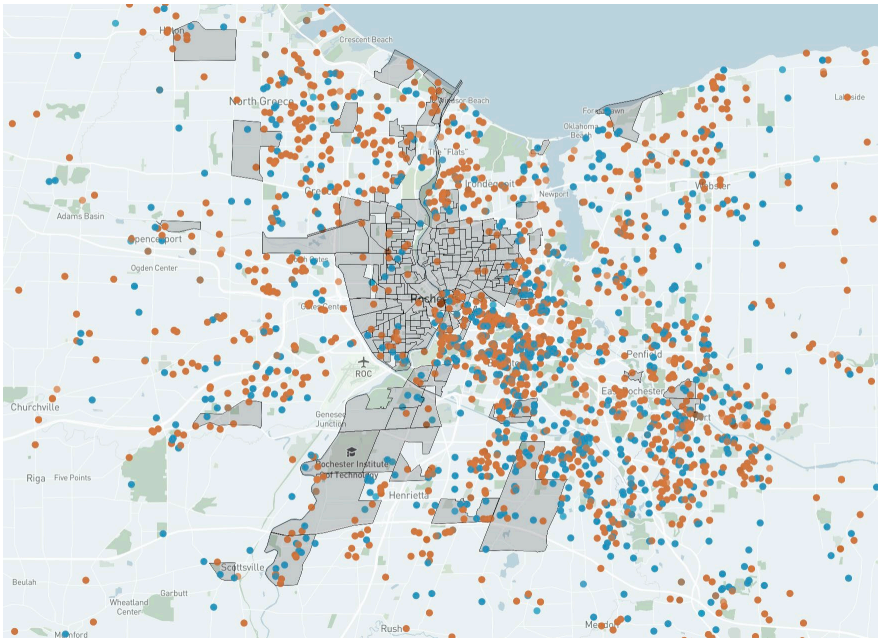

Figure 13. PHEV and BEVs in Rochester DACs.

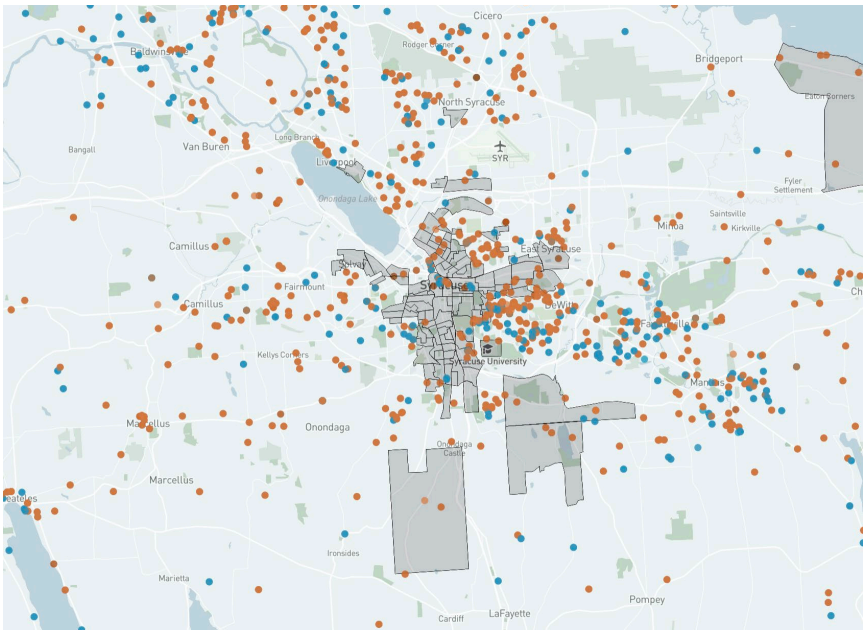

Figure 14. PHEVs and BEVs in Syracuse DACs.

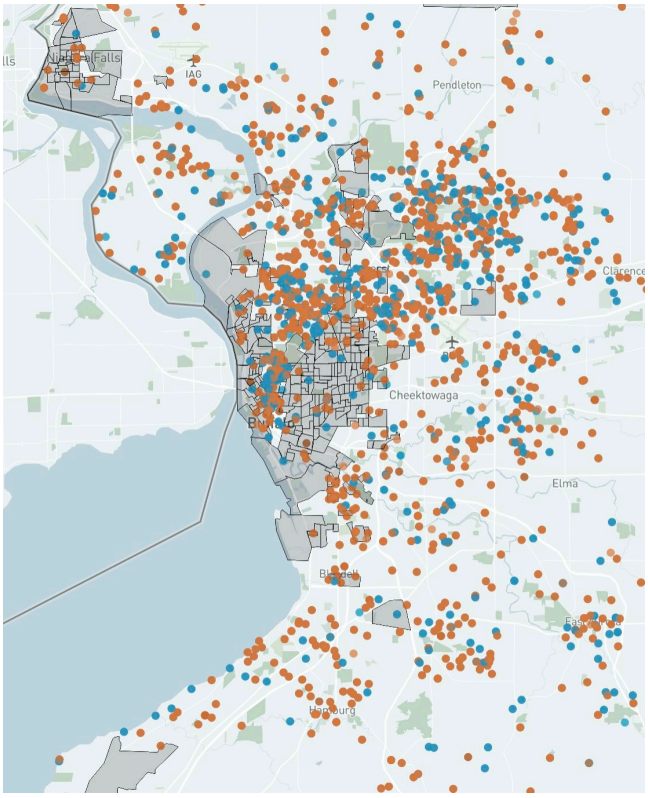

Figure 15. PHEVs and BEVs in Buffalo DACs.

The relationship between public EVSE availability and DAC benefits is more difficult to establish. EVSE is often located near or within DACs because it gets deployed in dense urban areas; however, public

chargers are not always accessible for people within DACs (Section **3.1.6**). Rarely is public EVSE built in suburban areas.

Benefits Attribution

For the benefits analysis, the Market Evaluation Team used registration data from EvaluateNY and assumed a 20-mile travel radius around each registered BEV and PHEV owner address, where 65 percent of "normal" EV driving trips occur. Within the 20-mile radius, all trips are assumed to be 100 percent electric for both BEVs and PHEVs. The 20-mile trip radius sits within a larger 150-mile trip radius (where the remaining 35 percent of trips occur). Within the larger 150-mile radius, trips were assumed to be exclusive of the 20-mile benefit from PHEVs.[37] The nested 20 and 150-mile radiuses were used to calculate the PM reduction for to DACs and non-DACs.

In general, PM reductions were higher in non-DACs than in DACs (**Table 6**). The effect for DACs was comparable for BEVs and PHEV trips within the 20-mile radius, while a larger effect can be seen for PHEV trips within the 20-mile radius for non-DACs (recall, PHEVs are more prevalent in non-urban areas).

Table 6. PM reductions within 20 and 150-mile radiuses for BEVs and PHEVs.

	Effect	PM Reduction	PM Reduction / Total Area of DAC or Non-DAC geometry	% Total PM Reduction for this Effect Level
BEVs	20-mile Effect: DACs	464.5	1.864	5.2%
	20-mile Effect: Non-DACs	8,521.10	1.857	94.8%
	150-mile Effect: DACs	74.1	0.018	1.5%
	150-mile Effect: Non-DACs	4,764.30	0.018	98.5%
	150-mile Effect, Exclusive of 20-mile Ring: DACs	70.9	0.018	1.5%
	150-mile Effect, Exclusive of 20-mile Ring: Non-DACs	4,767.50	0.018	98.5%
PHEVs	20-mile Effect: DACs	465.2	1.853	4.5%
	20-mile Effect: Non-DACs	9,892.60	1.846	95.5%

A small portion (4.1 percent) of total PM benefits is attributable to EVs (both PHEVs and BEVs) driving in DACs in New York State (**Table 7**). The remaining portion (95.9 percent) of benefits is attributable to EV driving in non-DACs. If adjusted for geography (i.e., land coverage of each type of community: DAC

[37] This provision eliminates double counting of benefits.

and non-DAC), PM reduction benefits are equally present in both community types (50.1 percent for DACs and 49.9 percent for non-DACs).

Table 7. Proportion of total PM reduction occurring within and outside of DACs.

	% Total PM Reduction	% Total PM Reduction (area adjusted)
DACs	4.1	50.1
Non-DACs	95.9	49.9

This analysis is limited in assessing local impacts in two ways. First, it does not reflect specific driving patterns and the impact of congestion; vehicle travel in DACs may vary in both total VMT and total emissions from the general percentages attributed. Second, the health impacts related to reduction in particulate matter reflect baseline health conditions and may be concentrated in certain populations and/or geographic areas. Overall, however, the general estimates in this analysis suggest that the geographic purchase patterns of EVs to date do not suggest that air quality-related benefits are concentrated in DACs.

3.1.15.2 The Role of Utilities

Interviewees observed the necessity of utility engagement and coordination in EV and EVSE-related programs. Utilities are critical to the grid interconnection process and commonly offer customer-facing educational materials for energy efficiency, so the connection with EVs and EVSE is a natural one.

Grid Interconnection

In terms of grid interconnection, coordination with utilities is important for ensuring that projects stay on track, as delays can be costly. EVSE installer ChargePoint reported having an entire team devoted to utilities. EV Connect, the largest independent open standard software provider in the US, found that some utilities in NYS have been easy to work with, while another has become increasingly easier to work with over time. EPRI also identified utilities as key partners in updating procedures and policies for scaling up EV infrastructure, and Nuvve underscored that working with utilities smooths the interconnection process.

Customer Outreach

In terms of customer outreach, one interviewee pointed out that utilities could champion EVs with some prepared marketing materials like blogs or videos or ride-and-drive events with customer follow-up

interviews. The interviewee with Electrification Coalition pointed out the importance of utility involvement in product and program success. Rochester Gas & Electric was identified as a critical stakeholder in both branding and promoting the Rochester EV Accelerator program, in particular. Utilities provide leadership and become champions of the project. For example, Rochester Gas & Electric hosted advertising for a rebated Nissan LEAF "group buy" on their website and in their newsletter.

3.1.15.3 Future Directions for the EV Innovation Market

Interviewees shared a range of insights about future directions for the EV market.

EV Connect

The interviewee from EV Connect opined that the EV industry will not survive as an independent industry. Instead, he thinks the industry will be integrated into other energy industries—for example, gas stations will start to replace pumps with EV chargers. Additionally, he thinks the need for smart technologies will eventually decrease as EV technologies continue to become more sophisticated.

ChargePoint

The ChargePoint interviewee underscored the critical role of incentives in expanding EV charging infrastructure. Profitability is a big problem for owners, so understanding non-economic incentives including alternative owner motivations is also important. ChargePoint does not own and operate chargers, for the most part; rather, much of their EVSE equipment is independently owned or under contract for a certain period of time (e.g., government parking lots). ChargePoint has found success in new construction markets, where adding charging stations does not present a high marginal cost. Multi-unit apartment buildings are an obvious target for a first wave of EV infrastructure expansion, because providing chargers where people park their cars is efficient. The multi-unit building value proposition is somewhat diminished for owners if the buildings are not newly constructed.

Uplight

One individual on the call noted that EVSE and EV OEMs are not making standardized products, which has been a challenge for developing the market. Moreover, some municipalities limit the types of chargers that can be installed in private homes. To address this, Uplight is trying to create a level of standardization for partner companies and areas that they are serving.

More projects are on the horizon for this company. Uplight is partnering with Motor on E-mobility as a service. Similar to the City of Rochester project, Motor is offering a service similar to Zipcar, where users can sign in a car and pay by the hour. They are also in talks with a Massachusetts utility to develop a car share program using existing EV charging infrastructure. Uplight's business model is to create and manage the platform for connection with EV consumers, so they are also thinking about insights into customer adoption and aggregate charger load profiles for future load forecasting.

NESCAUM

NESCAUM is thinking about how to work with states on equity considerations for light, medium, and heavy-duty vehicle electrification; how to create effective and equitable incentive programs; and considering if there are other ways they can support states in determining program impact in various communities (EJ communities, disadvantaged communities). Equitable EV market expansion is something they are thinking about as a future direction.

3.1.15.4 Possible Roles for NYSERDA

In addition to outreach data tracking, interviewees saw some other useful possible roles for NYSERDA and their investment efforts going forward.

DSNY

The NYSERDA funding allowed DSNY to test an all-electric street sweeper. DSNY underscored the importance of NYSERDA's continuing role in supporting municipal vehicle fleet transition to electric, especially where there are many medium and heavy-duty vehicles that have not yet matured to a plug-in platform. The Market Evaluation Team reflects that this may be especially important in the wake of the pandemic, as many municipal department budgets were cut significantly during that time, impacting how they make purchases into the future. DSNY also emphasized the importance of developing the necessary charging infrastructure. The interviewees also perceived that NYSERDA could play a valuable role in collecting data and tracking markets for heavier EVs.

EPRI

The EPRI interviewee suggested that NYSERDA encourage grantees to focus on efforts around policy, regulation review, and qualitative work to complement their technical work in the future. For example, there are many gaps in codes, standards, and incentives for multi-unit housing that create barriers to installing EV chargers in tenant parking lots that could potentially reach many customers.

VEIC

The VEIC interviewee identified a possible role for NYSERDA in broader consumer and dealer education and outreach. NYSERDA has, in the past, relied on regional partners for this work; however, a more top-down approach may be beneficial. NYSERDA could encourage dealers to start carrying EVs through incentives or other subsidies, and continue making investments in charging infrastructure (especially in LMI communities).

Uplight

Uplight interviewees perceived a need for NYSERDA to play an educational/promotional role for customers, similar to the role of utilities identified by other interviewees. They identified key talking points that NYSERDA could address using various modes of communication:

- For personal EV drivers:
    - What does the EV lifestyle entail?
    - What are the economic benefits to driving an EV?
    - What are the environmental benefits?
    - How does charger access/availability impact day-to-day life and/or travel?
- For EV dealers:
    - What incentives could support them in pushing EV sales?
    - What information do they need to explain EV costs and benefits to customers?
- Legal issues around chargers:
    - What regulations need to be addressed to standardize home charger installation?
- Sales of consumer charging data:
    - What is NYSERDA's position on charger OEMs selling consumer data?

Across all interviews, the Market Evaluation Team found project disruption to be a major barrier for success. Project disruption may happen in multiple ways, but the overarching themes were:

- There is currently a lack of data and evidence from projects to verify or validate interviewee-reported project success or failure. Additional evidence is required to gain a more granular view of success or failure.
- COVID-19 pandemic impacts were varied and far reaching, leading to funding challenges, new hurdles to overcome in public outreach, and ultimately project disruption. Conversations with

NYSERDA staff indicate that the pandemic was a major reason why some projects did not go forward.

- The "funding cliff" or "valley of death" for projects also presented a source of disruption. If projects are unsupported by the market, or where equity/access-focused products or programs have to be absorbed by the private sector to maintain cash flows (e.g., public transit projects, LMI transportation access-focused projects), they may experience this "funding cliff" problem and ultimately become disrupted.

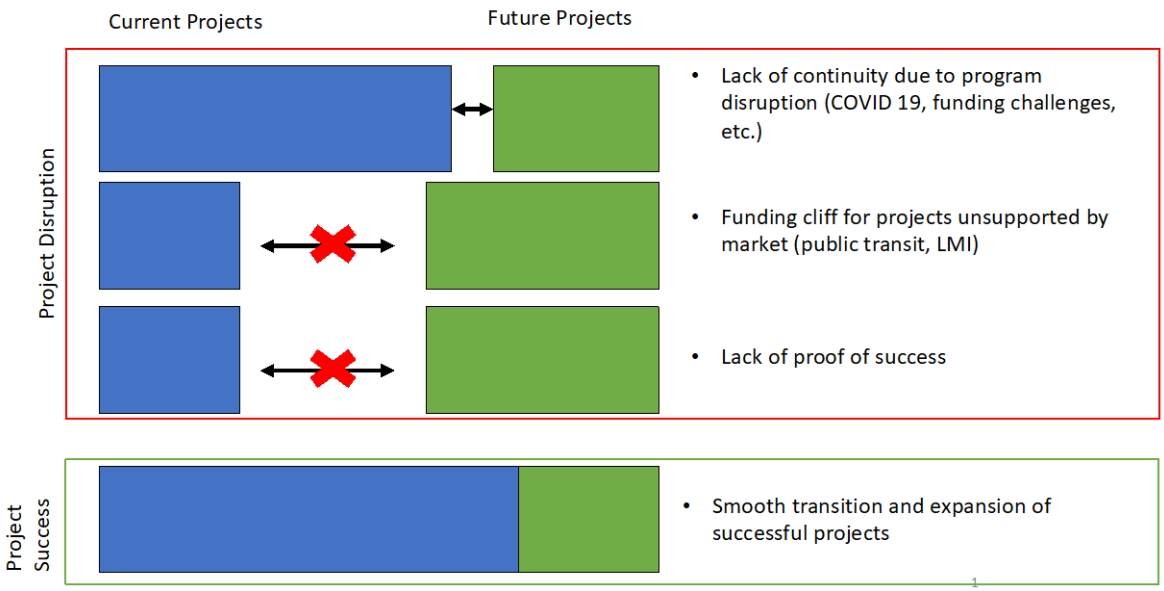

Figure 16. Project disruption vs. project success: project disruption happened due to lack of funding, COVID-19 pandemic impacts, and lack of proof of success.

3.2 Public Transportation and Electrified Rail Program

This section of the report relies on external federal data sets, NYSERDA data, and primary data collection (interviews, surveys) to address evaluation questions and NYSERDA's testable hypotheses (**Table 1**) to the extent possible. Primary data collection included a web survey of transit operators in NYS and follow-up interviews with select transit operators.

Surveys were designed to gather service and operation information about transit agencies around the state of New York that is not necessarily captured by the U.S. Department of Transportation Federal Transit Administration (FTA) National Transit Database (NTD) dataset. While initially the survey was conceived to provide measurement information about NYSERDA's program implementation, the onset of the COVID-19 pandemic severely disrupted the overall market for public transportation as ridership plummeted and financial planning shifted to response. NYSERDA Program Staff agreed that a new baseline approach was necessary for understanding this sector moving forward. As a result, the focus of the survey shifted to examine the current "baseline" operations in the context of Covid. Surveys asked about fleet size, vehicles, and fueling, recent changes in service due to the COVID-19 pandemic, the impacts of on-demand transportation (e.g., Uber, Lyft), and plans for fleet electrification.

The Market Evaluation Team issued the survey to 91 transit operators across the state, receiving 22 responses.[38] The team conducted in-depth interviews with a five of the 22 transit operators that participated in the web survey. Of the 22 agencies that responded, 14 indicated willingness to participate in a one-hour interview for follow-up questions and more detailed perspectives from operators. Five were chosen from the 14 agencies to represent a geographic cross-section of transit operators in NYS and a mix of rural, smaller, and larger systems. Interviewed agencies had the option to be identified or have their responses anonymized. The five interviewees are characterized below:

- Broome County Transit in central NY is a small to mid-size urban transit agency serving a transit-dependent population in the City of Binghamton and the surrounding area, and SUNY Binghamton.
- City of Gloversville in the Hudson Valley is a small rural transit operator serving a transit dependent population, community college students, and K-12 public-school students and their parents.

[38] The sample frame was built from a list of transit operators provided by NYSERDA and augmented with the directory of the New York Transit Public Transit Operators.

- St. Lawrence County Public Transit in northeast NY is a transit operator covering the largest rural county in the state serving a transit-dependent population and students at SUNY Potsdam, SUNY Canton, and Clarkson University.
- A large suburban system in a densely populated county with diverse fleet, support vehicle and complexity of routes serving a transit-dependent and essential workers population was interviewed.
- City of Olean Area Transit Service is a rural service in western NY serving an array of commuters, students and residents going to social services with connections to neighboring counties and the Seneca Nation.

Interview questions focused on goals for NYSERDA funding, current operations, and transit agency plans for new technology and future operations.

This section addresses the evaluation questions and baseline market characterization issues as follows:

- **Section 3.2.1** summarizes brief updates to the Public Transportation and Electrified Rail Initiative evaluation questions and metrics that were summarized above in **Table 2**.
- **Section 3.2.2** provides updated benchmarks for NYS for key Federal Transportation Administration metrics, including: average passengers per hour, number of unlinked trips, and total fuel use (in gallons), as noted in **Table 2**.
- **Sections 3.2.3** and **3.2.4** include the results from the transit operator web survey and interviews, respectively, characterizing the current (baseline) conditions and priorities for respondents.

3.2.1 Public Transportation Evaluation Metrics

This section provides a brief summary of each of the Public Transportation and Electrified Rail metrics, and documents key data sources, assumptions and limitations, and, where relevant, alternative approaches to estimation.

3.2.1.1. Private Investment/Leveraged Funds

For the purposes of calculating this metric, the Market Evaluation Team used the CEF Transit Projects data for cost share information and the Innovation Markets Evaluation dataset for investment information; the latter includes investment data for Transportation and other programs.

This metric includes project cost share (50% cost share is typically required) as well as follow-on investment raised by companies. According to NYSERDA program and evaluation staff, the $14.4 million cumulative total reported for this metric in 2019 was entered mistakenly and should be $1 million (this consisted entirely of cost share).[39] Through the end of 2020, the total billed cost share for CEF Transit projects was $2.3 million; in addition, companies reported $2.8 million of follow-on investment, resulting in a cumulative value of $5.1 million for this metric for 2020.[40,41]

3.2.1.2. Number of Companies Supported

To count the number of companies, the Market Evaluation Team identified records in the updated CEF Transit Projects data that indicated awarded, approved, and closed projects (excluding projects "pending approval" assuming work has not started on those projects). The Market Evaluation Team then filtered out two Research Studies and one Technology Feasibility/Assessment as unlikely to be supporting technology (both appear to have been conducted by consultants) and counted the number of unique "accounts" for the remaining projects. All 16 companies supported have demonstration or product development projects.[42]

3.2.1.3. Number of Projects Initiated with NYSERDA Support

The number of projects initiated is a measure of the level of activity in the Public Transportation and Electrified Rail program, and is represented by a count of awarded, approved, and closed projects in the updated CEF Transit projects dataset. Nineteen projects were initiated with NYSERDA support excluding projects pending approval.[43]

3.2.1.4. Number of Products Commercialized with NYSERDA Support

The Market Evaluation Team's review of program data identified one project identified as having produced a commercialized technology and several that appear to be pre-commercial products.[44,45]

---

[39] Phone call with Megan Bulman, Adam Ruder, and Kartik Pilar, March 26, 2021

[40] Salesforce data provided by Megan Bulman for the Innovation Markets Evaluation project, January 18, 2021

[41] In NYSERDA's Salesforce data, two companies – Unique Electric Solutions and Dollaride – together reported $6.12 million in investment. According to NYSERDA, the $6.12 million should not be counted for this metric because it was raised prior to the start of the Transit projects and could have been leveraged by a different project.

[42] CEF Transit Projects data provided by Megan Bulman, March 8, 2021

[43] CEF Transit Projects data provided by Megan Bulman, March 8, 2021

[44] CEF Transit Projects data provided by Megan Bulman, March 8, 2021

[45] Two other companies in the CEF Transit projects dataset – Unique Electric Solutions and Dollaride – reported commercialized products in the Salesforce data, but these products are not directly linked to specific projects in the

Unique Technical Services has an initial prototype; Helix Power Corp has a commercial prototype; and Dayton T. Brown Inc has a proof of concept. The Market Evaluation Team assumes these are all pre-commercial products. Sentient Science Corporation has a "defunct" product. Except for Autronic, none of the project numbers associated with the products are linked to the specific projects in the CEF Transit dataset.

3.2.1.5. Revenue Earned from Commercialized Products

This metric captures revenues from sales of the commercialized products tracked in the previous metric. The Market Evaluation Team confirmed and carried forward the $0.24 million cumulative revenue estimate reported by NYSERDA in 2019. The $0.24 million in revenue appears to correspond to sales from Autronic Plastics. Autronic does not have any revenues reported for 2020 in NYSERDA's Salesforce dataset; however, this could be a reporting/data completeness issue rather than an actual lack of sales. Note that Autronic Plastics had additional, pre-2020 revenues that were not included in the $0.24 million that was first counted in the 2019 reporting; available data do not indicate whether those revenues were related to this project, and the Market Evaluation Team therefore continues to exclude them for consistency; the $0.24 million carries over to 2020.

3.2.1.6. Replications of NYSERDA-Demonstrated Projects

Autronic Plastics deployed 29,663 units in 2020 ($2.19 million revenue).[46] It is not clear, however, whether these relate to the Transit project identified in the CEF data set provided separately; NYSERDA has funded multiple projects with Autronic Plastics. Replications reported for the company in 2018 by the Clean Transportation staff were not included in the cumulative total by NYSERDA in 2019, which could imply that the replications are not related to the Transit project. On the other hand, Autronic commercialized a new product in 2019, which appears to have been reported to the Department of Public Service in 2019 as part of the Clean Transportation reporting. If the 2020 replications in the broader Salesforce data are due to the newly commercialized product, then they should be counted. However, the Market Evaluation Team cannot tell from the Salesforce data because replications are not broken out at the project level. The 2020 cumulative value is therefore reported as "0 (updated)."

CEF Transit projects dataset. The former is associated with a different NYSERDA project, and the latter is not associated with any specific NYSERDA project. The New York Power Authority reported a commercialized product in the Salesforce data, but it is affiliated with a different project number and was reported in 2009.

[46] Salesforce data provided by Megan Bulman for the Innovation Markets Evaluation project, January 18, 2021

The Autronic Plastics project is classified as product development, not demonstration. Even though the Investment Plan metric technically calls for replications from "demonstration" projects, this seems like an insignificant distinction. The main question is whether the replications are from the project identified in the CEF Transit data set.[47]

Other public transit-relevant NYSERDA-demonstrated projects within the EV Innovations portfolio (i.e., with possible transit-related extensions) include Nuvve's V2G school bus project in White Plains (**Section 3.1.7**), UES' refurbishment of traditional vehicles with electric (**Section3.1.12**), and the City of Rochester's carshare program (**Section 3.1.9**).

3.2.1.7. Number of In-Service Demonstrations and Purchases of Electric Transit Buses

While there are has been wide use of hybrid, LNG, and CNG transit vehicles in NYS, the deployment of fully electric zero-emission buses is more recent. For example, the MTA has 800 CNG buses that are being switched to RNG biogas fuel. Currently, at least 72 electric transit or buses are in demonstration, deployment, on-order and/or leased status in New York State.[48] These buses are in operation in transit fleets with the MTA in the NYC metro area as well as in the Albany area with the Capital District Transit Authority, the Rochester Regional Transit Service (RTS) and in the Ithaca area with the Tompkins Consolidated Area Transit (TCAT). Electric buses are also being operated by the Port Authority of NY and New Jersey as shuttles at LaGuardia and John F. Kennedy airports. Columbia University has also employed electric buses as a student shuttle service.

Table 8. Zero emissions transit bus purchases and demonstrations represent a fraction of total estimated transit agency fleets.

Agency / Entity	Number ZEBs*	Estimated Total Fleet
MTA[a]	25	5,800
CDTA[b]	4	300
Rochester RTS[c,d]	10	214
City of White Plains[b,e]	1	Unknown
Port Authority NY NJ[g]	24	24
Columbia University[h]	6	6

[47] Also, according to the Salesforce data, NYPA reported that replications occurred in 2018, 2019, and 2020 ("Did Replication Occur?" = Yes). No other information is provided about the replication(s); and this was not included in the cumulative total reported to the Department of Public Service in 2019, which seems to suggest that the replications are not related to the Transit project. NYSERDA Transportation program staff confirmed that the replications do not seem to be related to any of their projects.

[48] Sustainable-Bus.com. Mar 2020. "New York State, 24 million dollars funding to replace old ICE buses with electric ones." Accessed 2/11/21: https://www.sustainable-bus.com/electric-bus/new-york-state-24-million-dollars-funding-to-replace-old-ice-buses-with-electric-ones/.

Tomkins Consolidated Area Transit (TCAT)[i]	3	50

***Note:** Number of buses is number reference from sources which are reports of agency press. This may be buses rolled out/ deployed, as well as ordered and/or leased.

[a]MassTransitMag.com. Jan 2020. "MTA deploys newest all-electric articulated bus fleet to Harlem." Accessed 2/11/21: https://www.masstransitmag.com/bus/vehicles/hybrid-hydrogen-electric-vehicles/press-release/21123533/mta-new-york-city-transit-mta-deploys-newest-allelectric-articulated-bus-fleet-to-harlem.
[b]Electrive.com. Jan 2021. "New York launches bus electrification initiative." Accessed 2/11/21: https://www.electrive.com/2021/01/05/new-york-launches-bus-electrification-initiative/.
[c]MassTransitMag.com. Oct 2020. "Rochester RTS celebrates first of 10 electric buses." Accessed 2/11/21: https://www.masstransitmag.com/bus/vehicles/hybrid-hydrogen-electric-vehicles/press-release/21157638/regional-transit-service-rts-rochester-rts-celebrates-first-of-10-electric-buses.
[d]Electrive.com. Jan 2021. "New York launches bus electrification initiative." Accessed 2/11/21: https://www.electrive.com/2021/01/05/new-york-launches-bus-electrification-initiative/.
[e]WestchesterGov.com. Jun 2020. "Westchester County to expand its Electric Vehicle Fleet with $1.5M Grant from the U.S. Department of Transportation." Accessed 2/11/21: https://www.westchestergov.com/home/all-press-releases/8502-westchester-county-to-expand-its-electric-vehicle-fleet-with-1-5m-grant-from-the-us-department-of-transportation
[f]Port Authority NY NJ. Oct 2020. "Port Authority Doubles Electric Shuttle Bus Fleet at Airports, Becoming the Largest All-Electric Fleet on the East Coast." Accessed 2/11/21: https://www.panynj.gov/port-authority/en/press-room/press-release-archives/2020-press-releases/port-authority-doubles-electric-shuttle-bus-fleet-at-airports--b.html.
[g]Columbia University. July 2018. "Our Electric Buses." Accessed 2/11/21: https://transportation.columbia.edu/content/our-electric-buses
[h]IthacaVoice.com. August 2018. "TCAT receives $2.3 million grant for electric buses." Accessed 2/11/21: https://ithacavoice.com/2018/08/tcat-receives-2-2-million-grant-for-electric-buses/

The number of buses is referenced from agency press reports and may be incomplete or include vehicles that are not directly related to the CEF-funded Public Transportation and Electrified Rail program. The number may also include both rolled out and/or deployed, as well as ordered and/or leased but not on the road yet.

3.2.1.8. Number of Transit Procurements Assisted

Procurements is defined here as purchase of electric transit vehicles (in this case, electric buses), and NYSERDA's involvement is determined by specific mentions of NYSERDA in reports. Using these definitions, NYSERDA has assisted with four (4) electric bus procurement efforts for CDTA, RTS, Logan Bus Company, and Columbia University. These 4 procurements represent a total of 20 electric buses. This estimate likely does not include the New York New Jersey Port Authority, which recently purchased a number of buses under the NYTVIP) but may also reflect funding not directly associated with the CEF.[49]

[49] Sources listed under **Section 3.2.1.6**.

3.2.1.9. Percent of Penetration of In-Service Demonstrations and Purchases Across NYS Transit Agencies

Penetration is defined as the percent of electric buses of the total transit statewide bus fleet, excluding fleets from state agencies in NY. With electric transit buses just beginning to be deployed, penetration is currently low (1 percent). Including the total fleet of all agencies in the state will further lower that percentage of penetration. As fleet size by transit agency is not a metric that is collected by the FTA and not available from the New York Public Transit Association, this metric is updated as part of the transit survey data collection effort described in **Section 3.2.3**.

As with the above metrics, the number of buses is referenced from agency press reports and may be incomplete or require updated. It may also include vehicles that are not directly related to the CEF-funded Public Transportation and Electrified Rail program. The number may also include both rolled out and/or deployed, as well as ordered and/or leased but not on the road yet.

3.2.1.10. Number of Third-Party Partnerships Facilitated

Third-party partnerships are defined here as solution-providing relationships (novel financing, ownership of energy efficiency assets, or otherwise) between NYSERDA, a transit agency, and a third party. To identify partnerships for this metric, the Market Evaluation Team reviewed Transit Contract Commitments data for product development and demonstration projects with transit agencies. Most transit agencies are directly funded for such projects, so the sample is limited to a single third-party partnership, the WESS for Energy and Demand Savings on the New York City Transit system (a Wayside Energy Storage New York, LLC project).[50,51] The proof-of-concept energy storage demonstration project uses flywheel mechanical storage for the NYCT subway, which operates on the Con Edison grid, and represents a partnership between Wayside Energy Storage, NYSERDA, and NYCT.

3.2.1.11. Examples of Uptake of Electric Transit Buses Attributed to Novel Financing or Partnership Models

The web survey and interviews with transit operators did not reveal any existing novel financing or partnership models influencing uptake of electric transit buses and bus or rail efficiency; however, interviewees did have ideas about possible third-party relationships that would support planning and procurement. For example, transit operator interviewees suggested that it would be helpful to have technical assistance or advisement about transitioning the fleet to fully electrified vehicles. NYSERDA or

[50] CEF Transit Projects data provided by Megan Bulman, March 8, 2021
[51] Salesforce data provided by Megan Bulman for the Innovation Markets Evaluation project, January 18, 2021

some third-party operator could serve as a repository for expertise and provide technical assistance to others. Absent a third-party technical expert, templates for a turn-key EV transit system and/or procurement blueprints (i.e., ready-to-go planning and proposal documents) were also mentioned as a possible means of support for facilitating EV adoption.

3.2.2 What are the NYS benchmarks for key Federal Transportation Administration metrics?

The Market Evaluation Team benchmarked FTA public bus transit metrics for NYS using two major metropolitan areas: one on the East Coast (Boston), and one on the West Coast (Los Angeles), as well as the rest of the United States. Reported values in **Table 9** are the combined statistic for buses: motor buses, commuter buses, rapid transit, and trolley. For the electrified rail benchmarking exercise, the Market Evaluation Team compared NYS to the rest of the country (**Figure 17).**

Total fuel use and total unlinked trips (i.e., separate trips) statistics in Boston and Los Angeles are vastly different from NYS statistics; NYS has three times the total number of unlinked trips that Boston and Los Angeles report combined, because the NY Metropolitan Transit Authority (MTA) is the largest transit authority in the country.[52] At 9.5 mpg, NYS buses have a greater gasoline fuel economy than all other areas, but the average diesel fuel economy is lower (Boston's statistics are reversed, in this respect). Though year-over-year passenger miles for NYS rail is comparable to passenger miles for rail in all other US states, NYS rail emissions range from 16 – 18 percent of total US passenger rail emissions.

[52] MTA is the largest transit authority in the U.S., according to the Federal Transit Administration's National Transit Database, accessed online August 2021: https://www.transit.dot.gov/ntd/ntd-data

Table 9. NYS benchmarks for public transportation (2019). *Source:* derived from the National Transit Database. Buses include "motor buses", "commuter buses", "rapid transit buses", and "trolley buses".

	NYS	Non-NYS US	Boston	Los Angeles*
Average number of passengers per hour	44.8	24.0	37.4	38.26
Total number of unlinked trips	998,770,085	3,724,733,168	114,775,270	292,777,938
Total fuel use by buses (gal)	68,808,153	526,676,890	7,916,201	42,868,531
Average diesel fuel economy of buses (mpg)	3.3	4.6	9.4	NA
Average gasoline fuel economy of buses (mpg)	9.5	4.7	3.0	NA
Average compressed natural gas fuel economy of buses (mpg)	2.6	3.1	2.5	2.2
Average bus speed in revenue service	9.9	12.8	9.0	12.1

* *Los Angeles abandoned diesel and gasoline-fueled buses for compressed natural gas in 2019.*
Note: For consistency, bio-diesel fuel is folded in with diesel. The table excludes buses run on electric power. Passengers per hour are calculated as unlinked trips divided by vehicle revenue service hour. Fuel economy is calculated as miles in revenue service divided by fuel consumption. Average speed is miles in revenue service divided by vehicle revenue service hours.

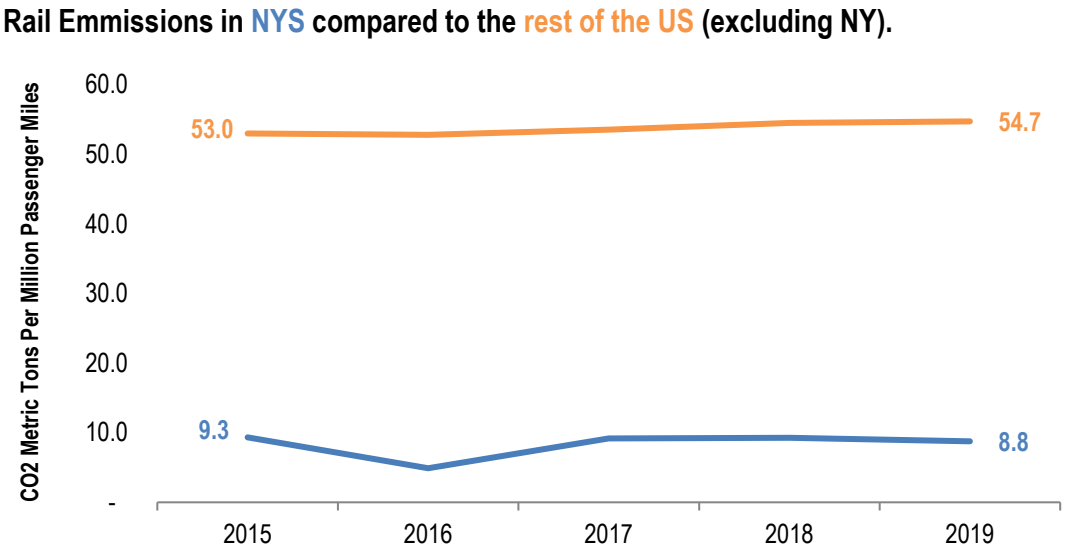

Figure 17. Rail emissions in NYS compared to all other US states. Source: Fuel and passenger miles data are from the NTD and emissions data are from the EPA.

3.2.3 Current NYS public transit market characteristics

The web survey that the Market Characterization Team implemented provides insights into current New York State transit market characteristics as well as insights into operator perceptions of opportunities and challenges for transit electrification implementation.

The web survey received a total of 22 responses in July 2021 for a 24 percent response rate. Nearly every individual responding to the survey is involved in oversight of planning and/or operations, as indicated by

their job title. The results are comprehensive, with every participant answering most, if not all, applicable questions. Additionally, 14 agencies indicated a willingness to participate in an in-depth follow-up phone interview. The responses do not include a response or data from the MTA.

Key Survey Findings

- Survey responses reflect a cross-section of New York State transit agencies representing a variety of geographic locations and service types.
- Operators serving urban areas are more likely than rural operators to offer a combination of both fixed route/scheduled and variable route/on-demand service.
- Standard buses dominate the surveyed inventory, representing 70 percent of the total transit fleet. Minibuses are the most ubiquitous, with three-quarters of transit agencies having at least one.
- Diesel, followed by CNG/LNG, is the most common fuel source for standard buses. All smaller vehicles, including minibuses, standard vans, and minivans, are powered by gasoline.
- Only 17 percent of fleet inventory is electric vehicles. Three agencies use electric standard buses, and one agency utilizes electric articulated buses.
- Gasoline-powered automobiles make up almost three-quarters of the reported support vehicles not included in the agencies' transit fleet counts.
- Ridership fell by an average of 46 percent in 2020 amid the Covid-19 pandemic. Roughly one-third of respondents expect a short-term impact, while the remainder foresee longer-term repercussions.
- Most agencies plan to purchase new standard buses and/or minibuses within the next five years. Approximately one-quarter plan to buy or lease an electric vehicle.
- Respondents voiced significant concern regarding fleet electrification, including physical and electrical capacity constraints, lack of dedicated maintenance staff, and vehicle/charger costs.
- Potential NYSERDA measures considered most beneficial to agencies include technical support, fleet and facility management strategies, strategies to increase rural access and strategies to improve equity/affordability.

General Respondent Agency and Ridership Information

The geographical representation of the 22 survey respondents is diverse. About 60 percent of the agencies serve a rural area with a population of less than 50,000. Of the remaining nine responding agencies, five

service large, urbanized areas with a population over 200,000, while the other four are in small, urbanized areas with a population under 200,000. The total number of employees at the agencies ranges from a high of 1,000 to a low of two. The average number of employees was 154, while the median number was 20. The number of employees within the agencies deemed responsible for managing the physical fleet, including passenger transportation and support vehicles, ranged from zero to 200 people. The average number was 20, while the median was two employees.

The transit agencies responding to the survey represent a variety of service types. Over three-quarters offer fixed route and schedule. Ten of the 22 agencies provide on-demand service with variable routing, and ten agencies provide paratransit (six provide both on-demand/variable service and paratransit). Five of the transit agencies indicated another type of transit offering including some form of deviated route service (only one of five transit agencies offering route deviated service also provides on-demand service with variable routing). None of the respondents identified as having micro-transit with a private partner.

Table 10. Number of Transit Agencies Offering Service Types, by Service Area Size (as defined by the FTA).

	Fixed Route & Schedule	On Demand / Variable Route	Paratransit	Route Deviated Service	Cohort TOTAL
Large Urban Area *(population > 200,000)*	5	3	4	0	12
Small Urban Area *(population 50,000 - 200,000)*	4	2	2	1	9
Rural *(population < 50,000)*	7	5	4	4	20
Total	16	10	10	5	41

Fleet Composition and Fueling

Transit agencies provided information regarding fleet composition, either directly operated and/or contracted, as well as fuel type. Half of all transit agencies report having standard buses, defined as approximately 40 feet in length. The total number of standard buses across all agencies is 1,107, representing 70 percent of the overall fleet inventory for the responding agencies. Over half the standard buses are diesel-powered and the remainder are either compressed or liquified natural gas (CNG/LNG) or gasoline driven. Three agencies report electric buses, yielding a combined inventory of 162 vehicles.[53]

[53] Discussions with NYSERDA Program Staff suggest that electric buses are actually non-plug-in hybrid vehicles (i.e., gasoline-electric hybrid). Survey questions did not differentiate between different types of electric vehicle (e.g., battery electric, plug-in hybrid electric, and non-plug-in hybrid electric).

Less than 6 percent of the total bus inventory is gasoline-fueled, and no standard buses powered by biodiesel fuel were reported.

The second most common vehicle among the fleet inventory is minibuses, defined as holding 16 to 24 passengers. Minibuses comprise less than 15 percent of the total vehicle count, but more than three-quarters of the agencies surveyed have at least one. Over 90 percent of these minibuses are powered by gasoline, with the remainder powered by diesel.

Table 11. Number of Transit Fleet Vehicles, by Fuel Type.

	Gasoline	Diesel	CNG/LNG	Biodiesel	Electric	Total
Articulated Bus	0	44	5	0	78	127
Standard Bus	60	0	275	0	162	1,017
Minibus	188	17	0	0	0	205
Standard Van	50	0	0	0	0	50
Minivan	39	0	0	0	0	39
Total	337	581	280	0	240	1,438

Only four of the 22 agencies reported having articulated buses, defined by a length of 54 to 60 feet and connected with an accordion-like joint mechanism. Unlike standard buses, where some agencies report multiple types of vehicles in terms of fuel usage, agencies with articulated buses only use one type of fuel. Two of the agencies oversee a combined total of 44 diesel articulated buses, while one has 78 electric buses and the other has five CNG/LNG vehicles [54]

Standard vans, defined as holding 12 to 15 passengers, as well as minivans, are part of the fleet at three agencies. All 50 standard vans and 39 minivans are powered by gasoline. Two agencies also noted buses of other sizes. One operator has 38 diesel-fueled passenger ferries, each with a capacity of either 150 or 350 riders.

[54] This came from Westchester County Beeline system and should be confirmed for accuracy. They responded that they had 78 electric articulated buses.

Table 12. Number of Support Vehicles, by Fuel Type.

	Gasoline	Diesel	Biodiesel	Electric	Total
Trucks	7	12	0	0	19
Utility Vans	16	12	0	0	28
Automobiles	130	0	0	0	130
Total	153	24	0	0	177

In terms of support vehicles not counted in the transit fleet, eight agencies reported having support automobiles for staff non-transit use. These combined 130 automobiles are all powered by gasoline. Five agencies cited support trucks, including pick-up trucks, tow trucks, etc. Twelve are diesel-driven and seven are powered by gas. Three agencies noted utility vans, such as Sprinter. Of these, 16 are gasoline and 12 are diesel. Thirteen agencies reported having no support vehicles.

Future Inventory

An overwhelming majority of transit agencies (86 percent) plan to purchase or replace buses or other fleet vehicles within the next five years. The total number of new or replacement vehicles projected across all 22 agencies is 579. The individual estimates vary widely across agencies, from a low of just one, to a high of 230 vehicles. The median number is seven. Eleven agencies plan to buy or replace standard buses and 12 agencies are looking to do the same for minibuses. Only one agency plans to buy or replace any articulated buses. The same is true for minivans and standard vans. In every instance, the responding agency plans to purchase new vehicles, as opposed to used or refurbished.

In terms of support vehicles, seven agencies plan to purchase or replace a total of 60 vehicles. Six agencies are looking to purchase or replace automobiles, four are planning to do the same for support trucks, and one agency expects to purchase or replace utility van(s). In all but one instance, the responding agency plans to purchase new vehicles, as opposed to used or refurbished.

3.2.4 Operator perceptions of opportunities and challenges for transit electrification

In 2020, ridership among the 22 transit agencies that responded to the survey registered a combined total of 52.5 million trips, down from 93.9 million in 2019 – a decline of 44 percent. Every reporting agency experienced a decrease in passenger trips, but the percentage varied widely, from as much as a 75 percent drop to a more modest seven percent decline. The median decline was 47 percent. The small, urban areas generally fared best with an average decline of 39 percent, compared to 46 percent for the large urban areas and 48 percent for the rural areas. Every agency representative confirmed that the Covid-19 pandemic affected ridership. Of the 20 responses regarding the likely longevity of the impact, 65 percent expect it to last over two years before returning to pre-pandemic levels. The remaining 35 percent of

respondents foresee a shorter time horizon of 12 to 24 months. No respondents projected the changes to ridership will be permanent.[55]

In terms of future planning related to the pandemic, several agencies are looking to increase marketing and outreach efforts, particularly regarding new safety measures. Others mentioned re-evaluating routes and service frequency based on changing passenger needs. A few also cited technological improvements, such as electronic fare payments and QR codes for schedules. Only 18 percent of respondents felt that on-demand transportation apps like Uber and Lyft have impacted ridership.

Vehicle Electrification Plans and Transportation Support

A total of six agencies surveyed (27 percent) expect to purchase or lease an electric vehicle in the next five years. To better understand the challenges facing greater electrification, respondents were asked to indicate their level of concern regarding a variety of factors. According to the response data, the most significant area of concern is physical and electrical capacity constraints at the depot. On a scale of one to ten, this topic received an average response of 7.9 and a median of 10. The median is the center of the data set and therefore less impacted by outliers. Indeed, 13 of the 22 agencies gave capacity constraints a 10, the highest possible ranking. Three other areas of significant concern are cost of vehicles and cost of vehicle chargers, both of which received an average score of 7.0, and lack of maintenance staff dedicated to electric vehicles, with an average score of 7.2. The median for all three factors was 8, indicting a large grouping of responses in the 7 - 8 range. Of less concern for agencies is a lack of sufficient technical support for procurement process, which received an average score of 6.0. Available financing for vehicles and difficulty of training for staff are considered less of a constraint, receiving an average score of 5.1 and 5.4, respectively. Nonetheless, nine of the 22 responding agencies gave lack of technical support a ranking of eight or higher, and the same is true for availability of financing, indicating these issues are also considered major challenges for many transit agencies.

[55] The Market Evaluation Team notes that this is an optimistic perspective, possibly tied to funding needs for maintaining/continuing operations.

Table 13. Areas of Concern Regarding Fleet Electrification (Scale of 1-10).

	Average Rating	Median Rating	Number Ratings ≥ 8
Physical and Electrical Capacity Constraints	7.9	10	16
Lack of Dedicated Maintenance Staff	7.2	8.0	14
Cost of Electric Vehicles	7.0	8.0	14
Cost of Electric Chargers	7.0	8.0	12
Lack of Technical Support of Procurement	6.0	6.0	9
Difficulty Training Staff	5.4	5.5	7
Availability of Financing	5.1	5.0	9

Of the 22 responding transit agencies, five participated in NYSERDA's assistance for electric vehicles and three have participated in a pilot or demonstration project with an electric vehicle vendor. To better understand the type of outside assistance viewed as most (or least) helpful to agencies in adopting greater fleet electrification, respondents were asked to indicate their level of support regarding a variety of options. Unlike the rankings regarding areas of concern, no single response stands out in terms of types of assistance programs. Nonetheless, technical support for operators, such as developing a technology strategy, conducting a feasibility study, fleet modernization/electrification planning and/or review of technology proposals, is most popular, receiving an average rating of 7.0. The median ranking is even higher at 8.5, as 13 agencies of the 22 responding agencies gave this option a ranking of at least 8. Assistance with transit fleet and facility energy management strategies, such as energy efficiency, anti-idling, driver-assistance, and fleet management technologies, as well as strategies for improving transit access and connectivity in rural and underserved areas both garnered an average rating of 6.9. However, the number of agencies ranking access to rural/underserved areas at or above an 8 out of 10 was notably higher, indicating that more agencies find this option valuable. Also cited as a helpful form of assistance was technical support for innovative business models that make transit service more equitable and affordable. This received an average score of 6.7 and a median score of 8. Integrated tools and technologies that improve the accessibility and convenience of transit for riders, such as real-time schedule, booking and payment applications, is considered slightly less helpful, with an average rating of 6.1. Transit partnerships with mobility providers to demonstrate first and last-mile trip connectivity, transit operator management tools, such as software and hardware to measure on-time performance, ridership and other operational insights, and transit partnership with local stakeholders to improve community outreach were considered least useful, although each received an average score greater than 5.0. Of these three options, partnerships for community outreach is viewed as most valuable, with 10 of the 22 agencies rating it at or above an 8 out of 10.

Table 14. Perceived Value of Measures to Facilitate Fleet Electrification (Scale of 1-10).

	Average Rating	Median Ranking	Number Ratings ≥ 8
Technical Support for Operators	7.0	8.5	12
Fleet and Facility Management Strategies	6.9	7.0	10
Strategies to Increase Access in Rural Areas	6.9	8.0	13
Strategies to Improve Equity/Affordability	6.7	8.0	13
Technologies to Improve Rider Convenience	6.1	6.5	10
Partnerships for Community Outreach	5.7	5.0	10
Partnerships with Mobility Providers	5.6	5.5	7
Operator Management Tools	5.3	5.0	7

In terms of other types of initiatives or assistance NYSERDA could provide that might facilitate the adoption of cleaner transit, many respondents pointed to some form of funding. These included grants for zero emission passenger vessels and charging/refueling infrastructure, as well as assistance in building facilities and even purchasing staff support vehicles. Assistance coordinating and streamlining the grant/funding process was also cited, as well as providing further details about the range/needs of cleaner transit options to determine their feasibility in rural systems. Two respondents noted adverse winter weather conditions in rural areas as one of the biggest barriers to pursuing an electrified bus fleet. One suggested hydrogen fuel cell and hydrogen infrastructure development as an alternative given the limitations of battery electric vehicles in cold-weather environments and rural areas.

The five organizations interviewed (Broome County Transit, City of Gloversville, St. Lawrence County Public Transit, City of Olean Area Transit Service, and a large suburban system in a densely populated county with a diverse fleet) have near-term plans to replace over 150 vehicles.[56] Below are the key findings:

- *Performance*. Operators reported hearing from industry colleagues and operators of EV buses that the actual mileage capacity of the vehicles is significantly less than what is advertised by manufacturers. This is particularly problematic for rural transit fleet operators that have longer routes and less opportunity for recharging. This factor becomes a cost issue as more e-buses would be needed to run the same route as conventional buses. It was also mentioned that manufacturers acknowledged that cold weather would impact mileage capacity but would not commit to an in-service operating range under cold conditions. Nevertheless, two of the five interviewed organizations are in the process of purchasing e-buses and are planning the

[56] The large suburban system declined to be identified in this report.

construction of the needed ancillary charging infrastructure, but noted that the e-buses would require route planning specific to the equipment to account for the limits on mileage per charge.

- *Cost*. The price of fully electric buses was also cited as a major constraint given limited transit funds available. A rural operator mentioned that the cost could be five times the replacement cost of its current vehicle type and that they would not be able to present a viable return-on-investment to their county budget officers.
- *Staffing.* Operators reported limited staffing resources to research EV technology, prepare grant applications, write procurement RFPs, and manage a procurement process. This was a uniform comment expressed from a large suburban transit operator to a small rural transit operator.
- *Equipment.* Given the performance and the cost, one potential opportunity may be increased electrification of the support fleet, which includes automobiles and light-duty trucks. This was mentioned by the large suburban operator who also noted that governmental partners are more focused on the transit fleet but that support vehicles have less demanding charging requirements and may be more amenable to electrification. The City of Gloversville mobility manager mentioned that he has not seen the buses with sufficient ground clearance desired for operation on bumpy rural roads.
- *Alternative fuels.* Two of the operators have a portion of their fleets on alternative fuels. The large suburban operator has a large CNG fleet that has worked well for them. Broome County has some hybrid gas minibuses that have been reliable and has been powering about a third of its operating miles in electric mode. The remainder of the entities use gas and diesel fuel vehicles which provides their drivers with flexibility to refuel at locations other than the central depot or a government facility. It was also noted that the gas costs are discounted as the organization fuels at a county facility which buys its fuel with bulk pricing without a gas tax. The actual cost of recharging was also discussed as an unknown if electricity rates change with more nighttime users. However, non-electric vehicles will likely be phased out as NY pushes to adopt all-electric fleets.

In the context of some of the above barriers and limitations, interviewees were asked to recommend programs and pilots to increase EV fleet adoption in the transit community. Key suggestions from transit operators are listed below:

- *Technical Assistance*. Multiple agencies requested technical assistance for templates on a turn-key EV transit system. Limited staff resources to research, plan and implement an EV fleet was

uniformly mentioned. Operators suggested that it would be helpful to have specifications or templates for what a fleet conversion would look like for both revenue vehicles and support vehicles by type of vehicle, and for the needed charging infrastructure, operations, maintenance, and training. It was mentioned that there could be more near-term opportunity for the conversion of support vehicles in the transit fleet as the battery technology continues to improve for transit buses. One interviewee mentioned that NYSERDA or a third-party operator could be a repository of technical expertise to provide this technical assistance to others.

- *Procurement Blueprint.* One interviewee also recommended that having ready-to-go procurement and proposal planning documents would be of great assistance to enable conversion, increase grant applications and help speed adoption.
- *NYSERDA Coordination with NYSDOT.* Also related to procurement, First Transit, the transit contractor for the City of Olean, highlighted that as transit agencies are subrecipients of FTA funding through NYSDOT, they are limited by the state's transit vehicle procurement contract that has been specified for compliance with FTA regulation and pre-negotiated with vendors by NYSDOT. This contract is administered by the NYS Office of General Services. Currently, according to First Transit, there are no options for midsize electric transit vehicles available through the OGS procurement process for smaller transit agencies. For smaller transit agencies to access electric vehicles, it was recommended that NYSDOT research and provide specifications by fleet type, and get bids by manufacturers, for the OGS contracts similar to how the conventional fleet is procured.
- *Transportation Energy Analysis*. St. Lawrence Transit recommended a program to help agencies with route optimization and operations analysis to reduce vehicle-miles traveled (VMT) and reduce energy consumption cost-effectively. They noted that this can also apply to the maintenance of buses as some buses cannot be serviced locally, which also creates VMT and excess carbon footprint. Rural and smaller transit agencies do not typically have the technical expertise for this type of analysis, and optimization software is costly. A pilot project to examine potential savings from these programs was also suggested.
- *Reduced contribution requirements and rigidity of program requirements*. Though it does not relate specifically to NYSERDA's programs, one interviewee suggested lowering the current 50/50 state cost sharing requirement for the New York State DOT program to match the federal 80/20 participation model to further reduce the cost of an EV fleet conversion.

4 EV Innovation Program and Public Transportation and Electrified Rail Market Overall Findings and Recommendations

Looking across the data collected for this evaluation, including primary data collection and previous analysis of existing data, the Market Evaluation Team notes the following findings and poses recommendations below.[57]

4.1 NYSERDA has a role to play in addressing non-financial challenges to wider market adoption

Ultimately, NYSERDA funding was helpful for all or most interviewees, and in most cases, grantees reported successful outcomes. However, several non-financial challenges to wider market adoption need to be addressed to improve funding outcomes. Policy, regulation, and outreach for information dissemination were highlighted as priorities for interviewees, areas where financial support cannot bridge the barriers to replication and broader commercialization. According to interviewees, NYSERDA has an opportunity to provide significant value beyond funding to address these challenges.

Based on findings from interviews, the Market Evaluation team identified several potential roles for NYSERDA, including:

- Providing follow-on funding for successful technology development and/or early-stage demonstration projects to scale up.
- Encouraging widespread deployment and equitable access.
- Coordinating with other actors to address key regulatory policy barriers.
- Engaging with utilities.
- Publicizing the results of successful technology demonstrations or otherwise conducting outreach to improve consumer awareness.
- Publicizing best practices to disseminate knowledge acquired through NYSERDA-funded projects.

[57] . These findings and recommendations should be considered an update to the *Clean Transportation Market and Impact Evaluation: Early Findings Report* submitted in early 2021. *To request a copy of the Early Findings Report, please contact* evaluation.questions@nyserda.ny.gov.

- Develop off-the-shelf procurement and proposal planning blueprints, as well as templates for technical assistance.

Recommendation 1: NYSERDA should determine what role they can play to further support EV Innovation partners. For example, coordination with other actors to address non-financial barriers and disseminate project findings and best practices would support grantees in continuing their important innovation and outreach work after NYSERDA project funding runs out. NYSERDA already provides some of this support, so if NYSERDA can take on even one additional role (e.g., developing procurement and proposal blueprints for transit agencies) the agency could provide significant additional value to the Clean Transportation EV Innovation Program and Public Transportation and Electrified Rail initiative.

NYSERDA Response to Recommendation: Pending. This recommendation is being considered on a number of different collaborations.

4.2 Project continuity is critical issue for innovations in the early stages of research and development

Project continuity remains a critical issue for early-stage research and development of technological innovations. In particular, projects that are designed for private sector uptake, or a reliance on market forces after project conclusion, require different handling if the desired impacts are improvements to customer access and equity (i.e., longer timelines and thoughtful planning for longevity).

Recommendation 2: NYSERDA should streamline the pipeline of project growth and development by providing support for grantees to help them to move past the "funding cliff," where grantees may find it unclear how or with which funding source a successful project could be continued. This support is particularly needed for business models designed to benefit low-income customers, where the value comes from price subsidization (e.g., car sharing).

NYSERDA Response to Recommendation: Pending. The Tech to Market Team is working on this.

4.3 EV Innovation contractors exhibited low levels of monitoring/tracking

The Market Evaluation Team observed a low level of monitoring/results tracking for consolidation of next steps, which points to a need to improve documentation and measurement of project metrics to support further learning and improvement. This type of project tracking information would benefit not only the grantee, who may be able to adjust their future plans in response to their monitoring information, but also NYSERDA's own reporting and future investment decisions.

Recommendation 3: In future requests for proposals, NYSERDA should require applicants to submit a plan for data collection and monitoring efforts from stakeholder engagement (who did they engage with the project?) to project outcomes (how many customers were reached by educational outreach or ride-and-drive events?). Improved coordination and data tracking will improve resources for evaluation efforts such as this one, as well as NYSERDA's ability to learn from and evaluate funded project outcomes. For example, understanding how many and what type of customers were reached by engagement and outreach can inform NYSERDA's requirements for future requests for proposals.

NYSERDA Response to Recommendation: Pending. This will be implemented when the Clean Transportation Team releases a new PON.

4.4 Public charging station access is limited in New York State

Public charging station access is only available to ~ 4.6 percent of the average New York urban area's population (unweighted). While many people have access to home charging, expanding charging infrastructure to improve charging access remains a critical goal for NYSERDA's Clean Transportation Program. NYSERDA should ensure that technology research and development for EVSE focuses on solving logistical problems with residential charging accessibility (e.g., street charging, multi-unit dwelling parking lots).

Recommendation 4: NYSERDA should consider a structured approach to fostering coordination between EV Innovation partners and utilities. A structured approach to coordination is especially needed around streamlining interconnection applications, which is important to planning and managing charging station infrastructure expansion.

NYSERDA Response to Recommendation: Implemented. The Clean Transportation Team has done this more frequently through their Clean Transportation Prizes than they have in the past.

4.5 Transit operators require support in transitioning public transit systems away from fossil fueled fleets

Transit operator interviewees identified third party planning support as a key need for transit systems of all sizes in the transition away from fossil fueled fleets. Providing this support would help address lack of dedicated budget and staff resources for research, the need for specialized technical expertise, vehicle specifications (high clearance for rural transit and the necessity of cold starts upstate), route optimization (to reduce vehicle miles traveled and energy consumption), and fueling infrastructure logistics (i.e., a

requirement for additional buses on routes and centralized fueling at the depot) are barriers to electrified vehicle adoption by transit agencies.

Recommendation 5: NYSERDA should make available third-party planning or technical assistance to provide transit agencies with the help they need to make fleet replacement decisions or optimize routes to meet changing fuel needs. If NYSERDA is able to provide vehicle procurement and technical assistance for transition services for electric fleet operations, it would support transit operators in their planning and enable a faster rate of electric vehicle adoption among resource-limited transit agencies.

NYSERDA Response to Recommendation: Implemented. The Clean Transportation Team has provided this kind of assistance to transit operators often.

5 Methods

5.1 EV Innovation data sources and methodology overview

The Market Evaluation Team analyzed program data extracted from NYSERDA's Salesforce project tracking system, where counts for most metrics emphasize activities that are directly funded by NYSERDA under the CEF EV Innovation program.

To build on these findings and provide context, the Market Evaluation Team conducted 20 primary data collection interviews: four NYSERDA Program Staff, two EVSE installers, and 14 Clean Transportation funding recipients, including technology developers, non-profits, one municipality, and one utility. Interviews with NYSERDA Program Staff were open-ended, aimed at filling data gaps and providing context for understanding Clean Transportation projects to support interviews with funding recipients (EV Innovation Partners). Interviews with EV Innovation Partners and EVSE installers lasted approximately 60 minutes and covered four main topic areas in a semi-structured way:

- Activities and outcomes.
- Recent market changes.
- Forward-looking strategic focus/activities.
- Outreach strategies and equity considerations.

The Market Evaluation Team also performed a desk review of secondary data, including web and electronic documents about Clean Transportation-funded projects, as well as electronic documents and data shared by NYSERDA Program Staff, including the Energetics Report.[58]

For the geographic analysis of charging station access, the Market Evaluation Team constructed five-minute walking distance street network graphs ("walksheds") around every public EV charging station ("charger") in all of New York's Census-designated urban areas. Urban areas are defined by the U.S.

[58] Energetics and WXY Architecture + Urban Design. 2020. Promoting EV Charging Stations for Commercial and Residential Developments: Information, Incentives, and Installation Guidelines for New York Property Owners and Developers. Accessed online, 2/10/2021: https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Charge-Electric/Best-Practices (referred to as Energetics report)

Census as "densely settled territory that contains [a minimum of] 2,500 people."[59] All chargers identified for this analysis are listed as "public" in the U.S. DOE AFDC charging station dataset.[60]

The five-minute walksheds constructed for this analysis are equal to 400 meters, or one quarter mile, and follow the topology of the streets and other walkable routes. Walksheds identify the households that are within a convenient and realistic maximum walking distance a driver might be expected to travel to access EV charging while still managing for infrastructure cost and utilization.[61] Demographic variables from the U.S. Census were then overlaid on top of the walksheds to understand the differences between populations living inside ("with access") and outside ("without access") of charging walksheds. The Mobilyze.ai platform was used to map EV charger locations and analyze the differences between populations with and without access to public EV charging.

Finally, for the geographic analysis of air pollutant benefits in disadvantaged communities (DACs), the Market Evaluation Team identified PHEV and BEV owners and calculated the air pollutant benefits within an assumed driving range to understand the proportion of benefits experienced by DAC residents. NYSERDA defines interim DACs using either of the following definitions:[62]

- "Located within census block groups that meet the HUD 50% AMI threshold* (see below), that are also located within the DEC Potential Environmental Justice Areas."[63]
- "Located within New York State Opportunity Zones."[64]

The Market Evaluation Team identified PHEV and BEV rebate recipient addresses using the NYSERDA Drive Clean dataset and overlaid the addresses atop the NYSERDA interim DAC areas where, theoretically, some of the benefits of reduced local air pollutants due to electric-only operation accrue.[65]

[59] Census.gov. 2020. Accessed online July 2021: https://www2.census.gov/geo/pdfs/maps-data/data/tiger/tgrshp2020/TGRSHP2020_TechDoc.pdf
[60] U.S. DOE AFDC. 2021. Data Download. Accessed online July 2021: https://afdc.energy.gov/data_download
[61] Mashhoodi et al. 2019. The two and a half minute walk: Fast charging of electric vehicles and the economic value of walkability. *Environment and Planning B: Urban Analytics and City Science.* Accessed online: https://journals.sagepub.com/doi/full/10.1177/2399808319885383
[62] NYSERDA. 2021. Disadvantaged Communities Interactive Map. Accessed online: https://www.nyserda.ny.gov/ny/disadvantaged-communities
[63] New York Department of Environmental Conservation. 2020. Maps & Geospatial Information System (GIS) Tools for Environmental Justice. Accessed online: https://www.dec.ny.gov/public/911.html
[64] New York Empire State Development. 2017. The Opportunity Zone Program in New York State. Accessed online: https://esd.ny.gov/opportunity-zones
[65] NYSERDA. 2021. Interim Disadvantaged Communities (DAC): 2020. Accessed online: https://data.ny.gov/Energy-Environment/Interim-Disadvantaged-Communities-DAC-2020/t6wd-tdrv

Emissions benefits were calculating using Argonne National Laboratory's AFLEET model.[66] AFLEET uses scrapped and replacement vehicle parameters (e.g., vehicle type, model year, fuel efficiency in miles per gallon or equivalent for electric vehicles, and annual vehicle miles traveled), as well as well-to-wheels (lifecycle) calculations to estimate reduction in local emissions of particulate matter (PM 2.5) from switching from a petroleum vehicle to an electric vehicle.

The Market Evaluation Team used average PHEV and BEV parameters (annual miles traveled, miles per gallon, fuel efficiency) from the *EV Rebate Impact Evaluation*. With AFLEET's vehicle footprint module, the Market Evaluation Team calculated the benefits from replacing a 2014 gasoline passenger vehicle with 10,835 annual miles with an efficiency of 30 miles per gallon (for 361 total gallons of gasoline used) with a 2019 passenger BEV (with an efficiency of 81.2 miles per gallon equivalent, using 4,495 kWh electricity). In this case, benefits from PHEV and BEV are calculated in the same fashion, assuming the driver was using full electric power (not gasoline) in the miles traveled within a 20-mile radius of their home address (65 percent of total trips). The Market Evaluation Team used setting option 1 in the Petroleum Use, GHGs and Air Pollutant options, which assumes well-to-wheels petroleum use, and well-to-wheels GHGs, with direct vehicle operation air pollutants (i.e., air pollutants are not well-to-wheels). Finally, the Market Evaluation Team set the AFLEET model state to New York, county New York. Though county information has no bearing on this specific AFLEET calculation, it is a required model input.

Using EV registration data from EvaluateNY, the Market Evaluation Team analyzed the geographic distribution of trips for 13,850 passenger BEVs and 15.976 passenger PHEVs. The Market Evaluation Team assumed a 20-mile travel radius around each registered BEV and PHEV address to which 65 percent of trip emissions reductions from EV driving is attributed (assuming 100 percent electric operation within the 20-mile radius). The Market Evaluation Team assumed a larger 150-mile trip radius for the remaining 35 percent of trips, and calculated the fraction of each ring (e.g., 20-mile radius ring, 150-mile radius ring) intersecting with DAC geographies. Using the intersecting fraction and the effect size from the AFLEET calculation described above, the PM reduction was calculated for all DACs (and non-DACs) within the ring as some number between 0.0 and either 0.65 or 0.35).

The total PM reduction across all BEVs was calculated by adding the PM reductions for each EV attributable to the DAC and non-DAC geometries. The Market Evaluation Team applied the same process

[66] Argonne National Laboratory. 2021. Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool. Accessed online: https://greet.es.anl.gov/afleet

to calculate the PM reduction across PHEVs. For each EV ring geography, the Market Evaluation Team calculated the two areas (in square degrees) overlapping with DAC and non-DAC communities. To get the total area, the overlapping areas were added across all EVs. PHEVs To calculate the proportion of total PM reductions, the Market Evaluation Team used **Equations 1-3**.

Equation 1. $\frac{DAC}{Non-DAC\ PM\ Reduction} = (20\ mile\ effect\ for\ PHEV) + (20\ mile\ effect\ for\ BEV) + (150\ mile\ effect\ exclusive\ of\ 20\ mile\ effect\ for\ BEV)$

Equation 2. $\%\ Total\ PM\ Reduction\ Occuring\ in\ DACs = Total\ DAC\ PM\ Reduction / (Total\ DAC\ PM\ Reduction + Total\ Non - DAC\ PM\ Reduction)$

Equation 3. $\%\ Total\ PM\ Reduction\ Occuring\ in\ Non - DACs = Total\ Non - DAC / (Total\ DAC + Total\ Non - DAC)$

5.2 Public Transportation and Electrified Rail data sources and methodology overview

The Market Evaluation Team reviewed program data extracted from NYSERDA's Salesforce project tracking system. Counts for most metrics emphasize activities that are directly funded by NYSERDA under the Public Transportation and Electrified Rail program. However, NYSERDA's program operates in the context of several other initiatives that aim to improve public transit efficiency and use, such as the NYTVIP and efforts by NYS and New York City transportation departments. Survey, interviews, and secondary FTA NTD data provide additional context.

As part of the Clean Transportation Evaluation Plan, Cheng Solutions designed a web survey to assess current New York State transit market characteristics as well as to compile operator perceptions of opportunities and challenges for transit electrification implementation. Ninety-one (91) transit operators were contacted for participation in the web survey from a list of transit operators provided by NYSERDA which was augmented with the directory of the New York Transit Public Transit Operators.

The web survey of New York State transit agencies received a total of twenty-two (22) responses in early July of 2021 for a 24 percent rate response rate. Nearly every individual responding to the survey is involved in oversight of planning and/or operations, as indicated by their job title. The results were comprehensive, with every participant answering most, if not all, applicable questions. Additionally, 14 agencies indicated a willingness to participate in an in-depth follow-up phone interview. Five interview

candidates were selected from the sample of 14 willing transit operators. Interviews lasted approximately 60 minutes, and focused on goals for NYSERDA funding, current operations, and transit agency plans for new technology and future operations.

The Market Evaluation Team reviewed secondary FTA NTD data for the State of New York to address the metrics in **Section 3.2.2**.The NTD benchmarking analysis for NYS public bus transit compares metrics for two major metropolitan areas: one on the East Coast (Boston), and one on the West Coast (Los Angeles), as well as the rest of the United States. The Market Evaluation Team combined statistics for multiple bus types: motor buses, commuter buses, rapid transit, and trolley. For the electrified rail benchmarking exercise, the Market Evaluation Team compared NYS to the rest of the country, because there is no “nearest neighbor” comparison to NYS due to the robustness of the MTA.

A. Appendix: Primary Data Collection Materials

This Appendix contains data collection materials for both the EV Innovation Market Characterization and the Public Transportation and Electrified Rail Baseline, including contact letters, web survey questions, and interview guides.

1. EV Innovation in-depth interviews contact letter

Subject: Interview Request for NYSERDA Clean Transportation Program Study – EV Innovation

Dear [INSERT NAME]:

The New York State Energy Research and Development Authority (NYSERDA) is seeking your input for an ongoing evaluation of the Electric Vehicle (EV) Innovation Program. The EV Innovation Program, which is part of NYSERDA's Clean Transportation Program, supports a range of product development and demonstration projects to facilitate EV adoption. It also supports pilots of innovative business models and approaches to EV market participation, and research efforts that can provide market information and test outreach approaches.

We are requesting your participation in an interview to support the evaluation. NYSERDA initiated this evaluation in late 2020 to identify and measure market changes and impacts resulting from the Clean Transportation Program, including the EV Innovation Program. The evaluation aims to identify strategies that can transform transportation in New York State by working with organizations like yours. We are contacting you because you have received grant funding from the EV Innovation Program or have worked with NYSERDA on EV Innovation-related activities.

Please click here to schedule your interview: [Doodle poll link].

Please indicate up to **three (3)** days/times that work for you. Each interview will last for up to 60 minutes. We are aiming to conduct all interviews within the next few weeks. If none of the available time slots work for you, please email me so we can find a time that works.

The interview will ask about your work with NYSERDA's EV Innovation Program, including results achieved to date and next steps. Specific topics include the following:

- How you define your "market."
- How the market has changed since you began working with NYSERDA.
- How you see the market now, where the market is going, and how market changes have affected your plans moving forward.
- Your goals, outcomes, and role that NYSERDA played in helping achieve outcomes.
- Considerations about disadvantaged communities and the low and moderate income (LMI) segment, as they relate to your work and/or broader changes in the market.

An independent contractor that NYSERDA hired to conduct the evaluation, Industrial Economics (IEc), will conduct your interview. The information you provide will be kept confidential to the extent permitted by law including but not limited to the Freedom of Information Law (FOIL).

Thank you for your time and willingness to participate. We look forward to your input for this important study!

Regards,
The IEc Team

2. EV Innovation interview guide

Introduction: Thank you for making time to talk with us. Your input will help to inform an ongoing market characterization study for NYSERDA's Transportation Program.
As part of the market characterization study, we are interested in learning about your work with NYSERDA's Transportation Program, including results achieved to date and next steps. We also want to understand how the market has changed since you began working with NYSERDA, how you see the market now, where you see it going, and how that has affected your plans moving forward.

1. How would you define the market *(asked to companies, utilities, and EVSE installers)* or target audiences *(asked to municipalities or non-profit organizations)* for your products, services, or activities?
2. What were your organization's goals when you applied for NYSERDA Transportation funding?
    a. What were your specific goals as they relate to the NYSERDA grant?
3. What outcomes have you achieved to date? How did those outcomes come about? And, more specifically, how did NYSERDA support help achieve those outcomes? What comes next? Specifically: ***(Tailor the following list for each interviewee – <u>we will only ask the subset of outcome questions that are relevant to the specific person we are interviewing)</u>***

<u>For companies:</u>

a. Follow-on investment
b. Commercialization of a new technology (if yes, what stage of commercialization)
c. Revenues from sales of commercialized products
d. Replications of NYSERDA-funded demonstration projects (if yes, describe the number and type of replications, how replication occurred, and the replicators)
e. *(If their project involves customer engagement)* Number of industry stakeholders engaged in consumer awareness programs; and number of consumer awareness events held (ask interviewee how many industry stakeholders they have engaged, ask what *types* of industry stakeholders they have engaged)
f. What efforts has your company made to ensure engagement of underserved communities in customer awareness programs? How have you adjusted your programs to meet the needs of these stakeholders?

<u>For EVSE installers:</u>

Ask 3A-F to EVSE installers who are also NYSERDA-funded Innovation Partners (Siemens, Greenlots), followed by the questions below.
For all EVSE installers:

g. Number of charging stations installed in NYS (ask individual EV installers how many they have installed)

h. In-service demonstrations of EV-enabling technologies and the results of those demonstrations

i. What barriers, if any, have you encountered with respect to EVSE manufacturing or delays in orders for EVSEs? What barriers, if any, have you encountered with respect to finding workers with the right skills to work on a project? How do these barriers vary with geography? (both rural/urban and different municipal contexts)

j. What barriers, if any, have you encountered with respect to permitting of EVSE installations? How do these barriers vary with geography? (both rural/urban and different municipal contexts)

k. Have you encountered any permitting processes that were particularly streamlined?

l. Are you aware of any standard policies that municipalities use to help facilitate EVSE installation or EV adoption?

m. In your experience, how are utilities involved in the grid interconnection process? What role do the utilities play and how do they influence the process? Does your experience with utilities differ across NYS? Have you seen examples of utilities with faster/easier to navigate grid interconnection processes? If yes, please describe.

n. What efforts, if any, has your project undertaken to ensure equitable distribution/access of EVSE?

For utilities:

o. Have you developed any programs, technologies, products, or business models (or are you contemplating any) to encourage smart charging? If yes, what stage of development are these in and which customer or market segments do they target?

p. Have you developed any programs (or are you contemplating any) to encourage your customers to adopt EVs? If yes, please explain. How effective have these programs been?

q. What efforts have you made to ensure engagement of underserved communities in these programs? How have you adjusted your programs to meet the needs of these stakeholders?

For municipalities:

r. Can you describe your permitting process for EVSE installation?

s. Number of EV-friendly zoning policies, building codes, planning procedures, and permitting processes to streamline EV adoption (what policies have you passed in your municipality or are you aware of in other municipalities?)

4. How has the market changed between when you applied for NYSERDA Transportation Program funding and now? How has this reshaped your goals/focus?

Prompts:

- *Have technology advances/price changes been pronounced?*
- *Has the market moved toward any standardization of technologies/processes/permits?*
- *Have you changed the focus of your efforts in response to the CLCPA or other policy changes?*

Ask the following sub-questions only if/as relevant to the specific interviewee:

Smart charging:

a. What do you see as the current opportunities and challenges for introducing smart charging technologies into the consumer market? How has the pandemic changed the market landscape of challenges/opportunities?

b. Has the market evolved toward any dominant approaches/products/standards for smart charging?

c. What role can charging-as-a-service business models (or third parties providing charging services) play supporting the use of smart charging technologies in the consumer market?

d. What do you see as the current opportunities and challenges to obtain support from NYS utilities in encouraging customers to use smart charging technologies? How has the pandemic changed the market landscape of challenges/opportunities?

e. If these challenges/opportunities could be mitigated/realized, how do you think that would affect drivers' charging behavior?

Consumer outreach:

f. How has the COVID pandemic affected the ability to do consumer outreach for EVs? Given this, how have you adapted (or how are you thinking about adapting) your consumer outreach strategies?

g. Are you aware of any industry stakeholders with ongoing consumer awareness programs? If yes, which ones?

h. What needs to be done to engage key stakeholders, including auto manufacturers, in making a sustained investment in consumer outreach in NYS?

i. Can you share any good practices or lessons learned about effective consumer outreach strategies, particularly for a COVID/post-COVID world?

Utility support for EV adoption:

j. How do you anticipate that increased EV adoption will affect your service territory and operations in the next 3-5 years? Next 10 years?

Prompts:

- *How will home charging evolve?*
- *Public EVSE installation and use (and rate setting)?*
- *VGI/V2G?*

k. How will increased EV adoption be beneficial? What challenges will it pose?

l. How do these anticipated benefits and challenges affect your system planning?

m. How are you planning to deal with EV load shapes? Strains on residential circuits?

n. What, if anything, would encourage you to invest greater resources in supporting your customers to adopt EVs and/or smart charging?

o. What other transportation-related initiatives do you expect to be focusing on in the next 5-10 years? How do those compare to work related to EV adoption?

5. Given these market changes/challenges/opportunities, what should NYSERDA focus on to support the market moving forward?

6. One way that New York State's priorities are changing is to place increasing focus on equity. The Climate Leadership and Community Protection Act (CLCPA) has added an emphasis for NYSERDA to consider equity in its programs, including a focus on disadvantaged communities and the low and moderate income (LMI) segment. Although this is not a requirement under your current agreement(s) with NYSERDA, we are interested in

any thoughts you may have on these topics as they relate to your work and/or broader changes in the market. ***[If not already addressed above:]***

a. Have equity and/or LMI issues come up in your work with NYSERDA? If yes, please explain.

b. Specific to your business or mission, what do you see as the barriers to reaching the LMI segment and/or disadvantaged communities?

c. What role do you think NYSERDA should play in addressing these barriers?

d. Looking ahead, NYSERDA's Program Opportunity Notice (PON) solicitations will include increasing emphasis on equity issues. In the context of your work, how do you think NYSERDA can reach underserved populations through its solicitation process and programs?

Prompts:

- *How could NYSERDA's solicitation topics or solicitation process address the barriers that you identified above?*
- *Do you have other thoughts on this topic that were not covered above?*

7. Would you like to share any other thoughts on the topic that we have been discussing?

3. Transit operator web survey contact letter

Dear NY Transit Operator:

The New York State Energy Research and Development Authority (NYSERDA) is seeking input on the Clean Transportation Program as part of the State's goal to cut carbon emissions in all sectors, including transportation. There are several existing programs to advance this goal such as *Charge NY, Charge Ready NY*, and the *New York Truck Voucher Incentive Program*. More programs are currently getting underway, such as the *New York Clean Transportation Prizes Electric Truck and Bus Challenge.*

To help us identify the most effective strategies to help transit systems accelerate adoption of electrified transportation and expand access to public transportation, we are reaching out to public transit operators in the State for feedback through this web survey. This survey is expected to take 15-20 minutes and is solely for NYSERDA program planning purposes. The information you provide will be kept confidential to the extent permitted by law including but not limited to the Freedom of Information Law (FOIL).

[insert survey link]

Please help us identify the best strategies to help transit agencies like yours. We look forward to your input!

If you are not the correct contact for this transit system, or if your transit agency is regional with smaller local subsidiaries, please forward this invitation email with link to the appropriate parties. Thank you.

If you have any questions regarding the purpose of the survey, please contact Kartik Pilar, NYSERDA Project Manager (Kartik.Pilar@NYSERDA.ny.gov), or Emma Fox, Associate at Industrial Economics, Inc., a NYSERDA contractor (efox@indecon.com).

Regards,
RMS Analytics Team

4. Transit operator web survey questions

Clean Transportation Evaluation Plan Web Survey of NY Transit Agencies (TWO#161722)

This survey of New York State transit agencies is being undertaken as part of NYSERDA's Clean Transportation program, which is a suite of efforts to transform transportation and mobility in NYS as part of the state's goal to reduce greenhouse gas emissions and improve system efficiency in the transportation sector. There are several existing programs to advance this goal such as the *Charge NY*, *Charge Ready NY*, and the *NY Truck Voucher Incentive Program*. NYSERDA is evaluating the most effective strategies to help transit systems accelerate adoption of electrified transportation and expand access to public transportation. Your input in this survey is valuable! This survey is expected to take 20 minutes and solely for NYSERDA program planning purposes. The information you provide will be kept confidential to the extent permitted by law including but not limited to the Freedom of Information Law (FOIL).

A. Information of Survey Respondent

A1. What is the name of your agency or transit organization? Fill in blank

A2. What is the main address of your agency? Address cell (street, city, state, zip code)

A3. What is your name? Fill in blank

A4. What is your title? Fill in blank.

A5. What is your email? Fill in blank.

A6. What is the best number to reach you? Fill in blank.

B. General information about your Agency / Organization

B1. How would you characterize your service area? (check one)

- o Large urbanized area (population over 200,000)
- o Small urbanized area (population under 200,000)
- o Rural (population of less than 50,000)

B2. What are the types of transit service you offer? (check all that apply)

- o Fixed route and schedule
- o On-demand service with variable route
- o Microtransit with private partner
- o Paratransit
- o Other (please specify) [if checked, fill in blank for description]

B3 What was your approximate ridership for 2019? (fill in blank)

B4. What was your approximate ridership for 2020? (fill in blank)

B5. What is your **total** number of employees (Full-time and part-time) ? (fill in blank)

B6. Of the total, how many employees do you have that are responsible for managing your fleet (buses and support vehicles)? (fill in blank)

C. Recent Changes in Service

C1. Has the Covid-19 pandemic affected ridership? (Multiple choice)

- o Yes (go to C2)
- o No (go to C4)

C2. Do you expect these changes to be (select one): (multiple choice)

- o Short term (12 to 24 months) and then back to pre-pandemic levels
- o Longer term (last over 2 years or longer) and then back to pre-pandemic levels
- o Permanent
- o Other. If so, please elaborate. [provide text box]

C3. What changes are your agency exploring or implementing to adapt to changes in ridership? Explain. (Text box).

C4. Have on-demand transportation apps like Uber and Lyft reduced ridership? (multiple choice)

- o Yes
- o No

D. Questions regarding Size and Fueling of your Current Transit Fleet

D1. What types of transit vehicles does your agency have for transit service, directly operated and/or contracted? See categories below. Please respond for your total fleet of active service vehicles and those in the contingency stock. Check all that apply. [Once category is checked, show different fuel types]

- o Articulated bus (extra long 54-60' bus connected with an accordion-like joint mechanism).
- o Standard buses (approximately 40')
- o Minibus (16-24 passengers)
- o Standard vans (12-15 passengers)
- o Minivan
- o Others (please specify)

D2. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the articulated buses (extra long 54-60' bus connected with an accordion-like joint mechanism)? Check all that apply.

- o Diesel
- o Gasoline
- o Compressed or liquified natural gas (CNG/LNG)
- o Biodiesel
- o Electric

D3. [If fuel is checked in D2] How many diesel articulated buses " (fill in number)

D4. [If fuel is checked in D2] How many gasoline articulated buses?" (fill in number)

D5. [If fuel is checked in D2] How many CNG/LNG articulated buses?" (fill in number)

D6. [If fuel is checked in D2] How many biodiesel articulated buses?" (fill in number)

D7. [If fuel is checked in D2] How many electric articulated buses?" (fill in number)

D8. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the standard buses (approximately 40')? Check all that apply.

- o Diesel
- o Gasoline
- o Compressed or liquified natural gas (CNG/LNG)
- o Biodiesel
- o Electric

D9. [If fuel is checked in D8] How many diesel standard buses?" (fill in number)

D10. [If fuel is checked in D8] How many gasoline standard buses?" (fill in number)

D11. [If fuel is checked in D8] How many CNG/LNG standard buses?" (fill in number)

D12. [If fuel is checked in D8] How many biodiesel standard buses?" (fill in number)

D13. [If fuel is checked in D8] How many electric standard buses?" (fill in number)

D14. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the minibuses (16-24 passengers)? Check all that apply.

- o Diesel
- o Gasoline
- o Compressed or liquified natural gas (CNG/LNG)
- o Biodiesel
- o Electric

D15. [If fuel is checked in D14] How many diesel minibuses?" (fill n number)

D16. [If fuel is checked in D14] How many gasoline minibuses?" (fill in number)

D17. [If fuel is checked in D14] How many CNG/LNG minibuses?" (fill in number)

D18. [If fuel is checked in D14] How many biodiesel minibuses?" (fill in number)

D19. [If fuel is checked in D14] How many electric minibuses?" (fill in number)

D20. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the standard vans (12-15 passengers)? Check all that apply.

- o Diesel
- o Gasoline

- Compressed or liquified natural gas (CNG/LNG)
- Biodiesel
- Electric

D21. [If fuel is checked in D20] How many diesel standard vans? (fill in number)

D22. [If fuel is checked in D20] How many gasoline standard vans? (fill in number)

D23. [If fuel is checked in D20] How many CNG/LNG standard vans? (fill in number)

D24. [If fuel is checked in D20] How many biodiesel standard vans? (fill in number)

D25. [If fuel is checked in D20] How many electric standard vans? (fill in number)

D26. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the minivans? Check all that apply.

- Diesel
- Gasoline
- Compressed or liquified natural gas (CNG/LNG)
- Biodiesel
- Electric

D27. [If fuel is checked in D26] How many diesel minivans? (fill in number)

D28. [If fuel is checked in D26] How many gasoline minivans? (fill in number)

D29. [If fuel is checked in D26] How many CNG/LNG minivans ? (fill in number)

D30. [If fuel is checked in D26] How many biodiesel minivans? (fill in number)

D31. [If fuel is checked in D26] How many electric minivans? (fill in number)

D32. [If checked in D1 show the fuel types below] What type of fuel does your agency use for the OTHER vehicles? Check all that apply. If you identified more than one type of vehicle, please use the "other" option to write in your response for each type of vehicle.

- Diesel
- Gasoline
- Compressed or liquified natural gas (CNG/LNG)
- Biodiesel
- Electric
- Other (please specify)_____

D33. [If fuel is checked in D32] How many diesel OTHER vehicles? (fill in number)

D34. [If fuel is checked in D32] How many gasoline OTHER vehicles? (fill in number)

D35. [If fuel is checked in D32] How many CNG/LNG OTHER vehicles? (fill in number)

D36. [If fuel is checked in D32] How many biodiesel OTHER vehicles? (fill in number)

D37. [If fuel is checked in D32] How many electric OTHER vehicles? (fill in number)

D38. Does the agency also have any of the following support vehicles that are not counted in the transit fleet? Check all that apply.

- Automobiles (for staff non-transit use)
- Trucks (pick-up trucks, tow trucks, etc.)
- Utility vans (e.g. Sprinter)
- Others (if clicked, provide text box for description)
- No support vehicles (skip to D63)

D39. [If checked in D38 show the fuel types below] What type of fuel does your agency use for automobiles (for staff non-transit use)? Check all that apply.

- Diesel
- Gasoline
- Compressed or liquified natural gas (CNG/LNG)
- Biodiesel
- Electric

D40. [If fuel is checked in D39] How many diesel automobiles? (fill in number)

D41 [If fuel is checked in D39] How many gasoline automobiles? (fill in number)

D42 [If fuel is checked in D39] How many CNG/LNG automobiles? (fill in number)

D43 [If fuel is checked in D39] How many biodiesel automobiles? (fill in number)

D44 [If fuel is checked in D39] How many electric automobiles? (fill in number)

D45. [If checked in D38 show the fuel types below] What type of fuel does your agency use for trucks (pick-up trucks, tow trucks, etc)? Check all that apply.

- Diesel
- Gasoline
- Compressed or liquified natural gas (CNG/LNG)
- Biodiesel
- Electric

D46. [If fuel is checked in D45] How many diesel trucks? (fill in number)

D47. [If fuel is checked in D45] How many gasoline trucks? (fill in number)

D48. [If fuel is checked in D45] How many CNG/LNG trucks? (fill in number)

D49 [If fuel is checked in 45] How many biodiesel trucks? (fill in number)

D50. [If fuel is checked in D45] How many electric trucks? (fill in number)

D51. [If checked in D38 show the fuel types below] What type of fuel does your agency use for utility vans (e.g., Sprinter)? Check all that apply.

- o Diesel
- o Gasoline
- o Compressed or liquified natural gas (CNG/LNG)
- o Biodiesel
- o Electric

D52. [If fuel is checked in D51] How many diesel utility vans? (fill in number)

D53. [If fuel is checked in D51] How many gasoline utility vans? (fill in number)

D54. [If fuel is checked in D51] How many CNG/LNG utility vans? (fill in number)

D55. [If fuel is checked in D51] How many biodiesel utility vans? (fill in number)

D56 [If fuel is checked in D51] How many electric utility vans? (fill in number)

D57. [If checked in D38 show the fuel types below] What type of fuel does your agency use for OTHER support vehicles? Check all that apply.

- o Diesel
- o Gasoline
- o Compressed or liquified natural gas (CNG/LNG)
- o Biodiesel
- o Electric

D58. [If fuel is checked in D57] How many diesel OTHER support vehicles? (fill in number)

D59. [If fuel is checked in D57] How many gasoline OTHER support vehicles? (fill in number)

D60. [If fuel is checked in D57] How many CNG/LNG OTHER support vehicles? (fill in number)

D61. [If fuel is checked in D57] How many biodiesel OTHER support vehicles? (fill in number)

D62. [If fuel is checked in D57] How many electric OTHER support vehicles? (fill in number)

D63. Does the agency plan to purchase or replace buses or other fleet vehicles in the next 5 years or less? (Multiple choice)

- o Yes (go to D64)
- o No (If no, skip below options and go to D67).

D64. **How many** buses or other fleet vehicles do you plan to replace? (box to fill number)

D65. What **types** of vehicles do you plan to replace? (Select all that apply)

- Articulated bus
- Standard bus
- Minibus
- Standard van
- Minivan
- Other (please specify). [fill in]

D66. In what **condition** do you plan to purchase the fleet vehicles? (multiple choice)

- new
- used
- refurbished

D67. Does the agency plan to purchase or replace support vehicles in the next 5 years or less?

- Yes (go to D68)
- No (skip to E1)

D68. If yes, **how many** support vehicles do you plan to purchase or replace? (box to fill number)

D69. What **types** of support vehicles do you plan to purchase or replace? (check all that apply)

- Automobiles (for staff non-transit use)
- Trucks (pick-up trucks, tow trucks, etc.)
- Utility vans (e.g. Sprinter)
- Others (if clicked, provide text box for description)
- No support vehicles

D70. In what **condition** do you plan to purchase the support vehicles? (check one)

- new
- used
- refurbished

E. Vehicle Electrification Plans / Transit Support

E1. Has your agency participated in NYSERDA assistance for electric vehicles?

- Yes
- No

E2. Has your agency participated in a pilot or demonstration project with an electric vehicle vendor?

- Yes
- No

E3. Does your agency expect to purchase or lease an electric vehicle in the next 5 years?

- Yes
- No

[Introductory text] Below is a list of factors related to fleet electrification. Please fill in a numerical rating for each item from 1 to 10 to indicate the level of concern you have with each factor (1 being the least concerning for your agency to 10 being the most concerning and poses a constraint).

E4. Cost of vehicles (fill-in numerical response from 1-10)

E5. Cost of electric vehicle chargers (fill-in numerical response from 1-10)

E6. Available financing for vehicles (fill-in numerical response from 1-10)

E7. Lack of sufficient technical support for procurement process (fill-in numerical response from 1-10)

E8. Lack of maintenance staff dedicated to electric vehicles (fill-in numerical response from 1-10)

E9. Difficulty of training for staff (fill-in numerical response from 1-10)

E10. Physical and electrical capacity constraints at the depot (fill-in numerical response from 1-10)

[[Introductory text] Below is a list of assistance that could be provided to help agencies with fleet electrification. Which of the following efforts would be most helpful to your agency? Please fill in a numerical rating for each item from 1 to 10 to indicate the level of helpfulness for each type of assistance (1 being the least helpful for your agency to 10 being the most helpful).

E11. Technical support for operators. This assistance could be in the form of developing a technology strategy, conducting a feasibility study, fleet modernization/electrification planning and/or review of technology proposals. (fill-in numerical response from 1-10)

E12. Transit fleet and facility energy management strategies , such as energy efficiency, anti-idling, driver-assistance, and fleet management technologies. (fill-in numerical response from 1-10)

E13. Transit partnership with mobility providers to demonstrate first and last-mile trip connectivity. (fill-in numerical response from 1-10)

E14. Transit operator management tools, such as software and hardware to measure on-time performance, ridership and other operational insights. (fill-in numerical response from 1-10)

E15. Integrated tools and technologies that improve the accessibility and convenience of transit for riders, such as real-time schedule, booking and payment applications. (fill-in numerical response from 1-10)

E16. Strategies for improving transit access and connectivity in rural and underserved areas. (i fill-in numerical response from 1-10)

E17. Technical support for innovative business models that make transit service more equitable and affordable. (fill-in numerical response from 1-10)

E18. Transit partnership with local stakeholders to improve community outreach . (fill-in numerical response from 1-10)

E19. Are there other initiatives or assistance, not mentioned above, that you would like NYSERDA to consider to help your agency adopt cleaner transit? [Text box]

F. Follow-up

F1. We will be conducting a number of in-depth interviews with agency staff to better understand how NYSERDA can help assist NY transit operators. These interviews are expected to take one hour. May we contact you over the phone to further discuss your agency's clean transportation goals and / or implementation constraints? (multiple choice)

- o Yes
- o No

Thank you for your valuable input!

5. Transit operator in-depth interview questions

Interview Introduction: Thank you for making time to talk with us. Your input will help to inform an ongoing market characterization study for NYSERDA's Transportation Program. As you may recall from the transit operator survey, the New York State Energy Research and Development Authority (NYSERDA) is seeking input on our Clean Transportation Program as part of the State's goal to cut carbon emissions in all sectors, including transportation. There are several existing programs to advance this goal such as *Charge NY, Charge Ready NY*, and the *New York Truck Voucher Incentive Program*.

To help us identify the most effective strategies to help transit systems accelerate adoption of electrified transportation and expand access to public transportation, we are reaching out to public transit operators in the State for feedback. We are interested in learning about your current operations and exploring potential ways increase adoption of new technology, such electric battery buses.

The purpose of this interview is to enrich the survey responses with transit operator narratives and use this as an opportunity to confirm and clarify some of the survey findings.

Do you have any questions for me about the interview process or the larger project before we begin?

General Background

1. How would you describe your transit organization (size, budget, services, location, major service nodes, e.g., downtowns, schools, etc.)?

2. What is the general socioeconomic profile of your ridership (age, income, race, disability)? Do you have a profile you can share with us, perhaps something prepared for a grant application?

3. Have you worked with NYSERDA or applied for a NYSERDA grant or program in the past?
    a. Which program(s)?
    b. What were your goals with the NYSERDA funding?
    c. What outcomes were achieved, and how did they come about?
        i. More specifically, how did NYSERDA support help achieve those outcomes?

Current operations

4. Thank you for providing us with information on your fleet and support vehicles (to be confirmed via email as follow up to interview). Of the fleet, how many vehicles are active versus on standby or reserve?

5. What are the service hours and days of operation for the system?

6. How many routes do you operate?

7. What is the average length of your typical bus route (miles)?

8. Typically, how many miles will your operator drive per shift?

9. Where is the fleet domiciled at the end of a shift?

10. Is the depot(s) near any residential communities? What is the predominate zoning around the depot? (Industrial, residential, commercial)

11. Is your bus fueling at the depot? If not, how far away is the fueling location (miles)?

12. Does the depot have capacity constraints? If so, describe?

13. Are any capacity or operation improvements to the depot designed or planned in the foreseeable future?

New Technology and Operations

14. Is your organization using or exploring any new technology for your operations, such as routing software or fare payment platform or software, for example?
    a. What are some of the factors you will examine for deciding whether to adopt new technology?

15. Is your organization using or exploring greener fuels for your bus fleet (CNG, LNG, Biofuels)? If so, how many of each category?
    a. What do you see as the opportunities and challenges for these fuels for your organization?

16. Is your organization using or exploring the use of electric battery buses? Are there hybrid or battery powered electric buses?
    a. What do you see as the opportunity / challenges for electric battery buses for your organization?
    b. Have you seen e-buses being demonstrated? If so, where. And if yes, how have your views changed regarding e-buses?
    c. Have any e-bus vendors reached out to you directly to demonstrate e-bus performance for your transit organization? If yes, how have your views changed regarding e-buses? If no, would you be interested in a demonstration?
    d. Would alternative operating models, such as a third-party ownership of new buses or third-party maintenance of electric buses, help facilitate fleet electrification?

17. Are there any recent or planned changes in service?
    a. [if they already changed service] How are these changes working? How do these changes relate to your thinking about EVs?
    b. [if they are currently changing service]. How do you see EVs as part of your strategy?
    c. [if they haven't changed service] are you thinking of changes to service in the near future?
        i. [If yes] what do these changes look like? Is EV adoption part of the thinking?

18. Are you planning to apply for funding under NYSERDA programs (e.g., NYTVIP, or Transportation Prizes)?
    a. If so, can you tell us about your application?

Closing questions

19. Would you like to share any other thoughts on the topics that we have been discussing?

20. Is there any advice or recommendations you'd like to offer for NYSERDA on programs or pilot projects you'd like to see?