Massachusetts EV Charging Station Program Evaluation Report – Program Year 1

prepared for

National Grid

ILLUME

dunsky

ERS Corporate Headquarters
120 Water St., Suite 350
North Andover, MA 01845
978-521-2550
Fax: 978-521-4588

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1 EXECUTIVE SUMMARY

This report presents the ERS Team's evaluation results and findings for Program Year 1 (PY1) for National Grid Massachusetts's Electric Vehicle (EV) Charging Station program (Charging Program), a program designed to facilitate development of Level 2 charging stations and Direct Current Fast Charging (DCFC) stations throughout National Grid's service territory in Massachusetts.

The PY1 evaluation in this report covers program activity from January 1, 2019, through December 31, 2019. National Grid and the ERS Team – including ERS, Illume, and Dunsky – collectively selected the December 31, 2019, cutoff date to include a full calendar year of reporting for this evaluation report. ERS Team evaluation activities for PY1 included the following:

- Review and analysis of all program data and materials, including general program information, marketing reports, and program tracking spreadsheets that monitor charging station progress and costs.
- In-depth interviews conducted with 8 members of National Grid program and sales staff.
- DCFC expert interviews – three with electric vehicle supply equipment (EVSE) providers and one with a program manager of a successful utility-run DCFC program.
- Analysis of charging station utilization data provided by two EVSE suppliers and covering 87 individual program-supported charging stations.
- Surveys with general population, EV owners, and site host community members to gather data on attitudes and behaviors regarding EV charging.

From these initial evaluation activities, the ERS Team developed the following PY1 program findings, recommendations, and considerations, grouped into program achievements, challenges and barriers, process improvement opportunities, and EV owner insights. These are summarized below:

1.1 Program Achievements

Finding #1: The Charging Program has activated 108 stations through December 31, 2019. This represents 16% of the overall program goal of 680 stations. Broken out by station type, the program activated 107 Level 2 stations and 1 DCFC station during PY1. The program also has a strong pipeline of committed projects, discussed in greater detail in Section 4.4.2.

- **Consideration #1-A: Enhance outward-facing program materials to inform prospective site hosts on EV-related topics.** Many site hosts have little knowledge about EVs or EV charging (including charging fees from site hosts, promotions like discounted charging for

using the site host business, and non-use fees to help recuperate the cost of installing a station). Include information on the number of EVs registered in Massachusetts and projected growth, how charging stations work, maintenance and networking fees, and other commonly asked questions about EVs and charging.

Finding #2: The Charging Program is increasing the number of publicly accessible charging stations in the Commonwealth. Approximately 63% of the activated stations are classified as publicly accessible, which was identified as a priority by the MA DPU in its 17-13 Order.[1]

Finding #3: National Grid's internal processes and communication practices are effective and appropriate for the program design. Interviewed staff were positive about the program processes and communications – they recognized that this is a new program with some elements to iron out but that overall it works smoothly. In particular, staff highlighted the high uptake of Level 2 stations, the recent improvements to program status tracking, and the launch of the Charging Station Installer (CSI) initiative as program successes.

- **Consideration #3-A: Ensure that sales team members have the information and materials necessary to support discussions with prospective site hosts about the program.** Sales representatives noted that it would be helpful to have more information, such as statistics and program benefits, to discuss the program with prospective site hosts. It may be useful to include the number of EVs registered in Massachusetts, the number of existing charging stations in Massachusetts, state and municipal goals for EV adoption, and program success stories. This information should also include details about each charging station provider's offerings and the unique benefits of each so that sales representatives can help direct prospective site hosts to the EVSE supplier that might best meet their needs and help streamline the selection process.

1.2 Program Challenges and Barriers

Finding #4: There are many barriers to installing DCFC stations. The Charging Program has only one active DCFC station and four stations with applications submitted as of December 31, 2019, against a target of 80. The high cost of DCFC stations is the primary barrier, which also makes it difficult to establish a compelling business case for customers to install them without incentives for the equipment cost. National Grid anticipated that Volkswagen settlement and/or other funds would be available to complement the Charging Program, but that funding has not yet been made available.[2] Other significant DCFC barriers include the difficulties of navigating leasing agreements and corporate decision-making processes, the limited availability of investment capital from sources other than Tesla and Electrify America, and the relatively small

[1] MA D.P.U. 17-13 Order, September 10, 2018, page 30.
[2] Revised Exhibit KAB/BJC-1, page 29, lines 18-21 and Response to AG-1-11.

number of vendors promoting and selling DCFC stations (compared to Level 2 stations). EVSE vendors report that significant relationship building is needed for DCFC stations, often taking 10–15 conversations prior to site host buy-in. Interviews with DCFC experts identified that prospective site hosts may lack knowledge and awareness of the EV charging market and do not feel a sense of urgency to pursue DCFC stations.[3]

- **Recommendation #4-1:** Identify additional funding sources for equipment incentives to offset the cost of the DCFC EVSE equipment. We recommend further engaging with stakeholders to communicate the impact of this barrier on the program's ability to work with site hosts to install DCFC stations, and how allocating Volkswagen settlement funds or other funding sources to reduce DCFC equipment costs could benefit the program and increase EV adoption in Massachusetts.
- **Recommendation #4-2:** Use the charging station utilization data collected through the program to build a business case supporting the economics of DCFC charging stations. Consider adding additional support to the utilization data findings by soliciting feedback from early participants on how installing charging stations has affected their business to further support the business case.
- **Consideration #4-A:** To shorten the DCFC sales cycle, develop sales and marketing strategies for different segments of businesses targeted for DCFC installations. Different business types face different barriers, have different levels of EV charging awareness, and may have different preferences for ownership models. For instance, two of the gas station/convenience store representatives we interviewed were interested in investing in owning and operating stations because they see potential for profit, while the retailer and grocery representatives preferred ownership options that limited the amount of their investment because they see the stations as amenities for their customers.
- **Consideration #4-B:** Establish short-term DCFC-related goals and activities that recognize the amount of time it takes to develop relationships necessary to sell DCFC stations. Recognizing that the program is still in the "building" phase for DCFC stations, such short-term activities could include:
  - Goals for specific efforts to expand the program's reach to prospective site hosts such as a certain number of EVSE suppliers, installation vendors, and suppliers to industries targeted for DCFC stations.
  - Goals related to relationship building with locations targeted for DCFC stations, such as identifying potential site hosts that could be optimal targets and tracking progress to develop opportunities with those targets.

[3] MA DPU 17-13, Exhibit KAB/BJC-4, Page 1, Line 7.

Finding #5: The networking fees, which are required for a minimum of five years, are a significant barrier to some customers. The sales and implementation team members reported that the Level 2 station networking fees represent a significant barrier to prospective site hosts with limited budgets, particularly cities, towns, and nonprofits. These fees can deter site hosts from installing any stations or reduce the number they are able to install. National Grid addressed this barrier by offering networking cost funding for qualifying projects for a limited time in the fall of 2019. The program attributed an influx of applications received in the second half of December 2019 to the availability of this funding. The ERS Team will continue to explore the extent of this barrier during participant and non-participant site host interviews.

- **Recommendation #5-1**: If necessary to achieve Level 2 station goals or to encourage station installation among municipalities and nonprofits, provide ongoing funding for networking costs similar to the limited-time funding offered in the fall of 2019.

1.3 Process Improvement Opportunities

Finding #6: Program project tracking is a manual process, resulting in occasional inconsistent charging station information across multiple data sources and limited insight into the status of station installations. The Charging Program tracks project-specific information, program-level progress against goals, and cost data in a Microsoft Excel workbook. This workbook serves as the system of record for the programs. The ERS Team identified inconsistencies in these workbooks, including projects with missing statuses and activation dates. The National Grid program implementation team has recently developed processes to improve tracking project statuses, including regular meetings with sales staff, following up with prospective site hosts after 90 days without an update, and requiring updates from the CSIs. In addition, with the experience of implementing the program for a year, National Grid is currently developing business requirements for a more robust program tracking platform.

- **Recommendation #6-1: Standardize and enhance program tracking methods and accurately capture the status of all stations.** Strengthening these tracking systems, ideally by migrating to a customer relationship management (CRM) or other robust platform, would expand accessibility both internally and for others (e.g., evaluators), and would better enable National Grid to expand the Charging Program in the future. National Grid is already implementing some changes by consolidating several workbooks into a single tracking spreadsheet; we recommend continuing to standardize and enhance this over time.
- **Consideration #6-A: Update project statuses more frequently** to better monitor projects and for more accurate program forecasting. National Grid has begun assigning applications to individual staff member so that regular status updates on the Charging Program projects can be provided to the sales team**.** Consider also providing project

reminders to installation vendors, and EVSE suppliers where known, to encourage two-way communication about project progress. Check in with all projects near their commitment letter deadlines for project completion.

1.4 EV Owner Insights

The following findings identify key takeaways from the EV owner survey that can help the Charging Program efforts to recruit additional site hosts:

Finding #7: While EV owners are generally satisfied with their EV, prospective EV buyers need more convincing regarding the value of EVs and whether the EVs on the market could meet their daily needs. EV owners indicate that EVs are fun to drive and appreciate their low operating costs and minimal maintenance. Many residential customers identified concerns about upfront price, driving range, and where to charge, but among EV owners, pre-purchase concerns regarding driving range seem to diminish with ownership. Additional concerns regarding long trips, which was an issue reported by some EV owners as well, and the need for all-wheel or four-wheel drive, may hamper EV adoption and suggest that residential customers could benefit from more direct education.

Finding #8: When selecting a charging station away from home, EV owners rate proximity to driving route and charging speed or power as the most important factors; most EV owners will not go out of their way to use fast charging stations. About one-third (32%) of EV owners have access to free DCFC charging, but, ultimately, most EV owners use Level 2 chargers for charging both at home and elsewhere. This may signal that, while range anxiety and long trips are top considerations for prospective EV buyers, fast charging stations are not a regular part of EV owners' day-to-day travel and that Level 2 stations – for example, at workplaces – might be utilized more regularly. In the three months prior to the survey, aside from home, EV owners reported they had most often charged their vehicles at retail stores (42%), municipal or government parking (38%), or public parking (36%) locations.

Finding #9: While most EV owners primarily charge their vehicles at home, workplace charging is not yet available to most EV owners surveyed. In the three months prior to the survey, 94% of the EV owners surveyed had charged their vehicle at home at least once, and 14% of those had only charged their vehicle at home. Among those who had charged in multiple locations, nearly three-quarters (74%) most frequently charged at home. Workplace charging is desired, but only about one-third of EV owners surveyed currently have access to workplace charging.

- **EV Owner Consideration #7-A (for Findings 7 through 9):** Use the data collected from the EV owner survey to educate prospective site hosts on insights about EV charging to inform decision-making. Based on these findings, this information could be used to:

- Demonstrate interest from existing EV owners in workplace charging to prospective Level 2 site hosts.
- Show that EV owners value both charging speed and proximity to their driving routes, an important point for prospective DCFC site hosts.
- Justify siting charging infrastructure at retail locations, as retail was the most commonly mentioned non-home charging location utilized.

The remainder of this report presents a summary of the EV Charging Station Program, the ERS Team's evaluation methodology, and the results of evaluation research and analyses.

2 INTRODUCTION

This section describes National Grid's EV Charging Station Program (Charging Program) in Massachusetts and the evaluation approach and objectives for Program Year 1 (PY1), running from January 1, 2019, to December 31, 2019. The ERS Team – including ERS, Illume, and Dunsky – was contracted in August 2019 to conduct an independent evaluation of the Charging Program for each of the three program years.

2.1 Electric Vehicle Charging Station Program Overview

National Grid's EV Charging Program seeks to increase the deployment of Level 2[4] and Direct Current Fast Charging (DCFC)[5] stations throughout Massachusetts. For approved projects, National Grid funds 100% of the cost of electric service upgrades and distribution equipment needed to power and install the charging stations. The program also provides rebates for the cost of the electric vehicle supply equipment (EVSE). Rebates for Level 2 station equipment costs vary depending on the targeted charging segment, covering 50% of the cost of Level 2 stations at workplace facilities, 75% of the cost at public/municipal facilities, and 100% at facilities located in environmental justice (EJ) communities meeting two or more criteria. Equipment costs for DCFC stations are not eligible for rebates from National Grid because at the time the program was filed, National Grid believed public and private subsidies for DCFC stations from non-utility ratepayer sources, such as the Volkswagen settlement funding, would be available to site hosts.

The program requires network and station monitoring for a minimum of five years after installation for all participants.

Roles and Responsibilities

There are five primary market actors engaged in National Grid's Charging Program:

- **Product growth team:** This group was responsible for developing the Charging Program strategy, focusing on program design and budgets. They also worked on rate cases in support of the program. Once the program was running, the implementation team took on responsibility for the program.
- **Implementation team:** This group's primary focus is on delivering the Charging Program. They are responsible for the day-to-day operations including evaluating and approving

[4] Level 2 charging uses a 240-volt AC service and typically has a power rating between 6 and 19.2 kW. Level 2 charging stations deliver charging speeds faster than Level 1 chargers (which use a standard 120-volt wall socket and charge at less than 1.8 kW) but slower than DCFC, defined below.
[5] Direct Current Fast Charging (DCFC) is the fastest type of commercially available EV charging. It typically features charging speeds of at least 50 kW and can restore approximately 80% of an EV's charge in about 30 minutes.

site host projects and determining the strategic direction of the program. They also develop and maintain relationships with manufacturers, vendors, and other program stakeholders.

- **Sales team:** The National Grid sales team works closely with the implementation team to deliver the Charging Program. The primary role of the sales team is to generate leads for the program from assigned customers. However, unlike the implementation team, the sales team is responsible for bringing all National Grid offerings to their customers, including energy efficiency and demand response (DR) programs.
- **Installation vendors:** The Charging Program encourages potential site hosts to work with installation vendors familiar with their facilities. In the event the site host does not have a vendor, National Grid will provide a list of experienced EVSE installers. At the program's onset, there were a limited number of installation vendors familiar with EVSE installation. National Grid has since provided EVSE information and workshops to vendors, including its energy efficiency vendors ("ProjectExpediters"), to encourage them to enter this new business. Most site hosts choose to work with these vendors to facilitate project installation given the relationships established from delivering energy efficiency projects. In addition to generating leads and projects, the installation vendors perform site assessments for potential site hosts to provide price quotes, station location recommendations, and additional information about the charging stations and program. The installation vendors typically manage scheduling electricians, ordering EVSE equipment and managing delivery, completing the program application, and delivering invoices and proof of station activation.
  - As of Q1 2020, National Grid launched a team of qualified EVSE installation vendors, EV Charging Station Installers (CSIs), similar to ProjectExpediters who have worked with customers to identify energy efficiency projects. The EV CSIs sell the projects and then manage the installations and program paperwork.
- **EVSE vendors/suppliers:** EVSE suppliers provide the charging hardware for the projects. National Grid maintains a list of qualified EVSE models for Level 2 and DCFC stations. The EVSE vendors typically work closely with installation vendors in station siting, and some EVSE vendors assist in lead generation.

2.2 Evaluation Objectives

The overall objectives of this evaluation are to measure the technical impacts of the Charging Program, including progress against charging station development goals, costs of installed stations, and station utilization. Additional objectives include assessing consumer awareness,

attitudes, and behaviors toward EVs and understanding the characteristics and experiences of site hosts participating in the program.[6]

The PY1 evaluation objectives are to:

- Gather information on consumer awareness, knowledge, attitudes, and behaviors regarding EVs and their charging infrastructure.
- Assess progress against charging station development goals.
- Measure technical impacts such as station utilization and development costs.
- Develop early recommendations to enhance the Charging Program.

In PY2 and PY3, the ERS Team will assess annual progress against charging station development goals, conduct additional interviews with Level 2 and DCFC site hosts, and complete additional survey efforts with EV owners and site host employees. Through this three-year evaluation, the ERS Team will develop recommendations designed to help National Grid understand site host motivations to install charging infrastructure, program successes, and opportunities to maximize participation for future program delivery.

[6] MA D.P.U. 17-13 Order, September 10, 2018, page 38.

3 Evaluation Approach and Methodology

To evaluate National Grid's EV Charging Station Program, the ERS Team developed an evaluation approach in coordination with National Grid. This approach is organized into four discrete tasks:

1. **Task 1: Residential customer surveys**. The ERS Team conducted a general population survey during PY1 to collect perspectives on EVs and EV charging from a simple random sample of National Grid residential customers.
2. **Task 2: Host site employee and resident surveys**. The team designed these surveys to capture perspectives from EV owners as well as non-EV owners who are likely to have the opportunity to use the charging stations installed through the program. During PY1, the evaluators conducted a survey of existing EV owners and baseline surveys for three communities that recently installed EV charging stations through the program. PY2 activities will include follow-up community surveys, as well as additional surveys of employees at workplaces installing charging stations.
3. **Task 3: Participant and non-participant site host interviews**. The team completed in-depth interviews with site host decision-makers installing charging stations and comparable decision-makers at locations that are not participating in the Charging Program. The ERS Team conducted five interviews with DCFC site hosts in PY1; additional site host interviews for Level 2 and DCFC site hosts are planned in PY2. The ERS Team also completed additional research and in-depth interviews with DCFC experts to support National Grid in exploring barriers and potential solutions for site hosts who face challenges with DCFC station implementation.
4. **Task 4: Program data analysis**. The ERS Team analyzed program progress against its goals, reviewing and analyzing program data, tracking spreadsheets, and charging station utilization data. This activity will be repeated during each of the three program years.

The ERS Team completed the following activities during PY1 of this evaluation:

- **Program information review** – We reviewed program materials for the Charging Program to inform the survey design, analysis approach, and our understanding of the program components and progress. Materials included marketing collateral and campaign analytics, program information, tracking spreadsheets, and other materials.
- **National Grid staff interviews** – The ERS Team completed interviews with a sample (n=8) of National Grid sales and implementation staff to learn about their experiences with the program and their perceptions of benefits and barriers faced by prospective site hosts.

- **DCFC program expert interviews** – To learn about their experiences with successful DCFC charging station programs, the ERS Team interviewed a program manager of a successful utility-run DCFC program and three EVSE suppliers who have experience working with a large number of DCFC programs.
- **Customer surveys** – The ERS Team developed one survey instrument used to gather data on attitudes toward and awareness of EVs and EV charging from three distinct groups: the general population, EV owners, and members of communities where charging equipment was recently installed. The survey included batteries of questions addressing vehicle ownership and travel behaviors, EV awareness and knowledge, likeliness to purchase an EV, charging station awareness, and demographics. The survey also included specific batteries of questions about purchase decision and charging behaviors for EV owners. Survey activities included:
  - **Pre-survey workshop** – The ERS Team held a webinar workshop with the MA National Grid team to align program metrics and critical survey design elements. The workshop was held with National Grid staff, using an interactive online platform, to identify the critical program metrics and research questions that the primary data collection should address.
  - **General population survey** – The ERS Team completed a web-based general population survey with a simple random sample of National Grid customers. National Grid provided a list of 1,122,459 accounts on residential rate codes; the team removed approximately 3.5% of these accounts due to keywords appearing in the customer name that are associated with non-residential accounts. From the remaining accounts, the study selected 13,440 premises on residential rate codes in National Grid's electric and dual-fuel service territory, assuming a response rate of 6%–8% to achieve 800 completed surveys.[7] The ERS Team mailed survey invitation postcards to sampled addresses and also emailed invitations to those with email addresses. Non-responders without email addresses received a reminder postcard and those with email addresses received two reminder emails. This report contains results from 642 residential customers who completed the survey between November 4 and 24 and confirmed they lived or worked in National Grid's electric or dual-fuel territory for our analysis. All general population survey responses are unweighted.

[7] The ERS Team removed records with business or non-residential names. In addition, the team removed residents of Lawrence, Andover, and North Andover, as residents of these communities may have negative utility service provider perceptions due to a recent natural gas explosion in the Columbia Gas of Massachusetts service area.

- **EV owner survey** – The ERS Team recruited EV owner survey respondents through multiple methods. First, we mailed survey invitation postcards to a list of EV owners purchased through a third-party vendor. Second, we worked with organizations including Massachusetts Clean Cities, the Green Energy Consumers Alliance, Plug in America, and the New England Electric Auto Association to share the survey link with their supporters (by email or Facebook). For both these sample sources, the survey asked customers where they live and work; anyone who reported living or working in National Grid's electric or dual-fuel service territory was included in the analysis. Finally, the general population survey captured EV owners and asked a specific subset of questions to those who self-reported EV ownership. All EV owner responses are unweighted.
- **Site host community survey** – The ERS Team worked with National Grid to identify three communities that have recently installed publicly accessible EV charging equipment: Lowell, Haverhill, and Boxford. The team selected these communities because of the number of recently installed charging stations. The team randomly oversampled residential customers within these communities with the objective of achieving 70 additional completes within the selected areas to understand resident awareness and perceptions of EVs and charging opportunities. The community survey leveraged the general population survey using the same survey instrument and methodology and was administered in the same time frame.

- **Data analysis** – The ERS Team conducted data analysis to understand progress against program goals, assess charging station utilization and greenhouse gas (GHG) impacts, and develop charging station load profiles.
  - **Tracking data review/analysis.** We analyzed program tracking data provided by National Grid to assess progress against program goals and identify trends in station costs. This data included a Project Tracking spreadsheet that contained site host information for stations at each milestone from in-development to committed, installed, and activated. Data collection and analysis of program progress reflects activity from January 1, 2019, through December 31, 2019.
  - **Charging station data analysis**. The ERS Team analyzed charging session data from 87 Level 2 and DCFC charging stations from three different EVSE vendors in PY1. Data sets were provided to National Grid and included continuous program charging activity covering all program charging from January 1, 2019, through December 31, 2019.
    - The ERS Team performed quality control (QC) checks to ensure that blank, invalid, and inaccurate data were flagged for removal from the analysis.

Through QC, the evaluators flagged blank or negative charging data (kWh and max kW) and charging sessions that lasted less than one minute or that recorded 0 kWh. These short sessions were assumed to be "false starts" and would not have contributed meaningfully to station utilization because of their short duration and low energy consumption. In total, 91% of the charging station data passed all QC checks, suggesting that overall data quality is sound.

- Charging station utilization metrics include the number of unique charging sessions, total energy consumption (kWh), and total duration of charging (hours). The ERS Team also assessed the GHG impacts, using a methodology that accounted for avoided tailpipe emissions from the enablement of electric driving and increased grid load from charging. This methodology is described in Appendix A.
- The ERS Team developed charging station load profiles for initial assessment of potential future opportunities for DR and load management through EV charging stations. In developing these profiles, the ERS Team accounted for time periods during which the station was not in use (zero-charging intervals),which ensures that the load profiles accurately reflect average charging activity. Data points that failed QC checks were removed from the analysis prior to this step.

4 RESULTS AND FINDINGS

This section contains the results and findings from the PY1 evaluation activities completed by the ERS Team, structured to first provide insights from interviews, followed by program data analysis, and then finally insights from the surveys conducted with the general population, EV owners, and site host communities. The structure of this section is outlined below for ease of navigation through these results:

- Section 4.1. Sales and Implementation Team Interviews (Results and findings)
- Section 4.2: Supplemental Research into DCFC Barriers and Solutions
- Section 4.3: DCFC Non-Participant Site Host Interviews
- Section 4.4: Charging Program Data Analysis
- Section 4.5: General Population Survey
- Section 4.6: Baseline Electric Vehicle Owner Survey
- Section 4.7: Baseline Participant Community Member Survey

4.1 Sales and Implementation Team Interviews

During the fall of 2019 (PY1), the ERS Team interviewed four sales representatives and four members of the implementation and product growth teams responsible for implementing the Charging Program. The team's key findings from these interviews are presented below, with additional interview details in the following sections: lead generation process, application and follow-up processes, installation barriers, and interview-reported successes and opportunities.

4.1.1 Initial Sales and Implementation/Product Growth Teams Interview Findings

The key findings from the internal team interviews are summarized here:

- **Program processes are generally working well for the internal team.** Interviewed staff from National Grid were positive about the program processes and communications – they recognized that this is a new program with some elements to iron out but that overall it works smoothly.
- **There are many barriers to installing DCFC stations.** The high cost to purchase DCFC stations and current low utilization rates are significant barriers, making it difficult for site hosts to establish a solid business case to justify investing in them. Additional challenges arise from leasing agreements and the lack of definitive and documented examples of DCFC station installations that result in improved business profits or revenues.
- **National Grid's expectation at the time the program was filed in January 2017 was that additional DCFC funding would be available from Volkswagen settlement funds,**

though that has not materialized to date. National Grid structured incentives for the program based on expectations of potential non-rate payer sources of investment to develop public, non-proprietary DCFC sites. Potential sources of non-rate payer investment included DCFC vendors, Electrify America, and the Volkswagen settlement funding allocated for DCFC EVSE expected to be available for the Commonwealth.

- **Once a project is approved and a commitment letter is issued, National Grid has limited insight into if and when a prospective site host will install and activate charging stations.** After the program sends the commitment letter, the customer or vendor controls whether to move the project forward. Initially, there was no mechanism or incentive for sales representatives to systematically track projects through completion, as sales goals pertain to committed stations. However, National Grid recently established a system to follow up with committed prospective site hosts that have not provided updates in over 90 days. Charging Program projects are currently tracked outside the main energy efficiency project tracking system.
- **The networking fees, which are required for a minimum of five years, are a significant barrier to some customers (e.g., cities and towns, nonprofits),** deterring these customers from installing any Level 2 stations or reducing the number they are able to install.
- **Lack of site host awareness and knowledge of EVs and EV charging is a substantial barrier to installing charging stations, particularly DCFC stations.** Potential site hosts typically have little to no knowledge or awareness of EVs and charging stations, which can impact the value they perceive of getting a station installed. While many early adopters of Level 2 stations are motivated by sustainability-related goals or employee recruitment and retention, the benefit of installing DCFC stations is less clear to prospective site hosts.
- **Sales team members are not properly motivated to move projects through to activation.** With the Charging Program in its inaugural year, National Grid established sales team goals and commissions based on committed, not activated, stations. However, the program overall is assessed against a goal of activated stations.

4.1.2 Lead Generation Process

National Grid relies on the sales team and vendors to generate leads and introduce customers to the program. Each are discussed below, followed by reported barriers to generating leads and/or moving leads to action.

Sales Team

The sales team leverages relationships with their assigned customers to generate leads. One sales representative reported initiating outreach to their customers specifically for the Charging

Program; however, interviews indicate that most sales representatives reference the program and determine interest in participating through their routine contacts with customers.

Interviews revealed that there are varying levels of understanding and familiarity with EVs, EV charging stations, and the Charging Program among sales staff. Some staff are highly engaged and knowledgeable, preferring to help guide customers through the program. Other sales staff are less knowledgeable and therefore more inclined to direct the customer to a vendor who can guide the customer through the program, which is consistent with how sales staff approach energy efficiency products and services.

Beginning in June 2019, National Grid has implemented a monthly call with the sales team to review the program and the Company's progress toward its goals. In addition, quarterly in-person meetings and interim conference calls are held with the EV CSIs and sales teams to discuss program changes or new offerings.

Installation Vendors

National Grid also leverages installation vendors to promote the Charging Program to customers. Many of these vendors have longstanding relationships with customers for whom they have been doing energy efficiency work. These customers may be excellent prospects for the Charging Program.

National Grid has been working to expand its vendor partnerships through the EV CSI initiative with the expectation that these vendors will, over time, contribute significantly to installing charging stations at scale, similar to the Company's ProjectExpeditor initiative, which has grown to support National Grid's energy efficiency programs for 20 years.

The initiative kicked off in February 2020 when National Grid selected over 20 installation vendors to be part of the program. The EV CSI Program Manager hosts quarterly in-person meetings with these vendors and the sales team where program information and policies can be discussed. In addition, these meetings provide an opportunity to raise awareness and education about EVSE.

While the Company believes that EV CSIs will be the most active vendors promoting the Charging Program, **all** approved vendors are eligible to:

- Promote the Charging Program to customers
- Assist customers in installing charging stations
- Leverage Charging Program funding

4.1.3 Application and Follow-Up Processes

Once a customer decides to move forward, the customer and vendor work together to submit an application. If needed, the sales team supports the customer and/or vendor in completing the application.

The implementation team then reviews and approves the application and ultimately sends out the commitment letter to the customer, vendor, and salesperson. As part of the approval process, implementation staff evaluate the application to make sure that the application is cost-effective, installation costs are reasonable, and the station design will work well now and in the future.

Our interviews with the internal teams indicate that the application process moves smoothly. Once a project is committed, it is up to the customer or vendor to move the project forward and install the EV charging stations. At least one sales staff noted that some customers may have submitted applications to see how much it would cost (after rebates) before presenting a proposal or getting approval from their internal stakeholders, suggesting that some committed projects may not have internal approval. The ERS Team identified a number of process-related issues related to follow-up, which National Grid has been addressing:

- Initially, when a lead was generated from a vendor, that lead was not always associated with a National Grid staff member in the tracking system, resulting in the sales team members being removed from the process entirely. A process was implemented in early 2020 to identify and assign sales team members to these projects, which has resulted in the majority of projects having assigned sales team members.
- Initially, National Grid did not have a systematic process for updating projects after their status changed to "Committed." The implementation team has recently implemented a process to regularly follow up with sales staff, vendors, and site hosts who have not provided updates in over 90 days.
- Sales staff are used to managing their energy efficiency projects through the energy efficiency tracking system, but the Charging Program is currently tracked in an Excel spreadsheet that is not accessible to the entire sales staff. The implementation team has recently begun summarizing data from the program tracking spreadsheet to share project details with the entire sales staff.
- Goals set for the sales staff are a group goal and are for the number of committed, not installed or activated, charging stations. Since progress toward sales team goals is quantified by committed stations, sales staff are not properly motivated to follow up with customers after they receive approval to see if there are any additional barriers to

installation. However, installation and EVSE vendors continue to follow up with customers to help move projects forward to installation.

4.1.4 Installation Motivations and Barriers

Sales and implementation staff felt that some of the early-adopter customers, such as municipalities installing Level 2 stations, are primarily motivated by green or sustainability goals, a desire to "do the right thing," or, in the cases of workplaces, to provide EV stations for employee recruitment and retention. Additionally, some customers show interest in enhancing their company's brand by appearing "forward thinking" and providing a perk for their patrons, employees, and vendors.

Among municipal customers, the desire to achieve or retain the Massachusetts Green Communities designation may be a driver. Having an EV strategy, infrastructure, or resulting energy use reductions can fulfill several criteria for the program. The ERS Team will explore motivations for installation among prospective and participating site hosts as part of site host interviews in 2020.

Challenges and Barriers

There are a number of barriers to recruiting customers to install charging stations (Level 2 or DCFC), but the barriers to installing DCFC stations have been more challenging for the program to overcome. The Charging Program had only one active DCFC station and four stations in development as of December 31, 2019. National Grid is concerned about achieving the DCFC charging station target of commitments for 80 stations by the end of PY3.

The sales and implementation team reported the following barriers specific to installing DCFC stations:

- **Lack of funding for incentives for the DCFC equipment costs** – High upfront cost of EVSE is the primary barrier for installing DCFC stations. In its original filing in January 2017, the Company anticipated other funding sources including Appendix D of the Volkswagen settlement to complement the Company's Charging Program. As a result, the Company structured incentives for the program assuming the availability of this funding and other external sources of funding or investment capital to develop public, non-proprietary DCFC sites. In addition to the Volkswagen settlement funding, the Company expected funding from vendors and Electrify America for funding of DCFC stations in the Commonwealth. To date, other funding sources are either not available (e.g., Appendix D funding) or other constraints have limited their availability (e.g., scarce investment capital).
- **Tesla and Electrify America stations** – These two organizations are installing stations in prime high-traffic locations such as Walmart parking lots, further reducing the impetus

for EV drivers to use DCFC stations installed through the National Grid Charging Program. Further, Tesla sales in Massachusetts represented approximately one-third of EV sales; prospective DCFC site hosts recognize that these vehicles would not use the stations installed through the Charging Program.

Sales and implementation team members most commonly reported the following barriers that apply to both Level 2 and DCFC:

- **Education and awareness** – Both sales and implementation team staff noted limited customer knowledge and awareness of the program, EVs, and charging stations, representing a barrier for the program; lack of awareness of the program itself is not surprising, as it had only been in the field for one year. As a result, the team must spend more time educating customers about the program as well as the need for EVSE and the functionality of EVSE, including the benefits of hosting DCFC and Level 2 charging stations. According to interviewees, customers questioned the need for charging stations and whether they will be used. For example, one member of the sales team noted that, while the organizations he works with have the financial means to install and maintain charging stations, the value is not clear to them because the people in their organization "drive F150s, not EVs" and there is concern that the parking spots will sit empty.
- **Networking requirement** – Networking fees, especially for Level 2 stations (which represent a significantly larger percentage of the customers' costs than DCFC stations) are one of the main barriers for prospective site hosts. Site hosts have to pay up to $2,000 per station (approximately $200 per port/year × 2 ports × 5 years) for five years. This represents a significant additional expense to site hosts with limited budgets, for example cities or towns. In order to help reduce this cost, National Grid offered funding for networking costs for qualifying projects in the fall of 2019. These incentives were intended to mitigate a barrier that prevented some prospective site hosts from proceeding with a project or reduced the number of stations installed. The program received an influx of applications during the second half of December as the networking incentives were ending, which it attributed to the funding for networking costs.
- **Charging station placement** – Some site hosts wanted to have the stations prominently placed on-site so that the brand boosting value was maximized; however, this desire can become a barrier if the prominent location is not near the electrical access and would thus increase the project cost and reduce cost-effectiveness for the program.

4.1.5 Interview-Reported Program Successes and Opportunities

Overall, the sales and implementation teams reported that the program processes and communications have been working well, especially given this is a new program. Additionally, they reported the following key program successes:

- **There has been a high uptake of Level 2 charging stations**, many of which are publicly accessible charging stations.[8]
- **Level 2 incentives are generating interest in this new offering.** They commented that the current incentive levels are creating interest among customers because it is a new offering.
- **The program is seeing rapid growth in the number of installation vendors**, including some traditional energy efficiency vendors who are functioning as installers. National Grid increased the number of installation vendors from 4 to over 20 installation vendors when the CSI initiative launched. Furthermore, these vendors are excited to have a new service to offer their customers.
- **The addition of the prescriptive application[9] form helped to streamline the application process** and remove barriers to entry and participation. This application can be used by customers installing four or fewer Level 2 dual-port EV stations, and includes rebate amounts, which assists vendors when they make proposals to prospective site hosts by facilitating decision-making on the customer side.

When asked if they had any recommendations for program improvement, the sales and implementation teams made the following suggestions:

- **Continue efforts to improve the uptake of DCFC stations.** Currently, the higher DCFC equipment costs and absence of incentives for the fast charging stations have been a barrier for generating customer interest in installing DCFC stations.
- **Develop a more formal type of tracking system for the program, similar to the energy efficiency programs that originated with a spreadsheet-type tracking system and then implemented a formal system as the energy efficiency programs expanded.** However, some noted that there are still a lot of unknowns about the program at this time.
- **Develop a system for following up with customers** after the application has been submitted and approved**.**

[8] As of December 31, 2019, 63% of installed stations were classified as publicly accessible.
[9] Prior to the addition of the prescriptive application, the program only had the standard application form, which requires that National Grid staff evaluate the application and provide incentive information after the application is submitted.

- **Work with sales staff to ensure that they have the information** on the program, EVs, and EV charging stations they need to guide discussions with customers.

While not necessarily suggestions for improvement, we did hear that it can be challenging for salespeople to balance internal time constraints and competing priorities, making it difficult for them to dedicate the necessary time to the program.

While there are many successes, program staff noted the following opportunities to help achieve program goals, particularly with DCFC stations. These opportunities are ideas mentioned by one or more interviewees; these do not necessarily take into account program design or cost implications.

- **Focus on specific segments of the population**, such as:
  - Highway corridor (rest stop) and grocery and convenience stores – Program staff identified these types of locations as good candidates for DCFC stations and have been targeting these segments. Barriers associated with leasing and corporate decision-making are a factor within these segments.
  - Rental properties and landlords – Program staff mentioned rental and multi-unit buildings as an opportunity for the program. The program design included installing stations within these multi-unit properties, which face unique challenges. Program staff mentioned they will be working to develop relationships with landlords to help overcome barriers to installing stations for customers who rent. Additionally, they have selected an installation vendor to target multi-unit buildings with a goal of 75 charging stations installed by May 31, 2020. To date, the vendor has not had success convincing multi-unit building landlords and property owners to install Level 2 charging stations, partly due to the networking costs described earlier in Section 4.1.4.
- **Consider program design opportunities**, such as:
  - Identify funding sources for DCFC incentives – Lack of funding for DCFC charging stations was identified as a barrier to installing DCFC charging stations. Identifying alternative sources of funding for these stations would support the adoption of DCFC stations as evidenced in other states such as Rhode Island where state funding from Electrify Rhode Island program resulted in an uptick in DCFC applications.
  - Include Level 1 Charging Stations in Program Design – Staff believe there may be a case to support Level 1 charging stations in certain use cases where drivers' vehicles are parked for longer periods of time – e.g., park and rides, train stations, or parking garages. The Level 1 charging station with its slower charging rate is more compatible with the length of time vehicles are parked.

- **Work with Electrify America** – Program staff noted that they are working with Electrify America to determine if there is an opportunity for the program to install additional DCFC stations at sites where Electrify America is installing stations to increase the total number of installations without substituting rate-payer funding for Electrify America funding.
- **Consider modifying the networking requirement** – One suggestion was for the program to require networking only where it provides the greatest public value. For example, the program could require networking in cases where there is more value in drivers being able to see station availability, and not require it at charging stations such as apartment complexes, workplaces, and for fleet charging.

4.1.6 Upcoming Activities for PY2

There are no additional National Grid staff interviews planned for PY2.

4.2 Supplemental Research into DCFC Barriers and Solutions

Given the importance of DCFC deployment in alleviating concerns about limited driving range and long charging times, the National Grid implementation team has been conducting their own research and developing strategies to further encourage DCFC adoption. To support National Grid in meeting their program goals, the ERS Team conducted a secondary literature review and interviewed four DCFC program experts (three EVSE suppliers who have experience working with a large number of DCFC programs and one program manager of a successful utility-run DCFC program). All three EVSE suppliers work with a variety of utility programs, are approved for National Grid's program, and have staff actively working in National Grid territory to promote the program with a focus on DCFC stations.

As shown in Table 4-1, each of the three EVSE suppliers offers a slightly different business model, including both purchasing and/or leasing agreements.

Table 4-1. EVSE Supplier Business Model

EVSE Supplier	Solution Offered
EVSE Supplier A	Offers site hosts the ability to own and operate or lease charging stations. The lease includes networking and maintenance.
EVSE Supplier B	Leases space from site host and incurs all costs associated with the charging station (electrical updates, equipment and installation, energy/demand charges, and networking).
EVSE Supplier C	Lower price point for charging stations and flexibility in network provider, with the ability to select from different providers and change network providers. Offers site host branding.

4.2.1 Initial DCFC Interview and Literature Review Findings

The key findings from the DCFC literature review and interviews are summarized below. Additional details regarding DCFC research and interviews are presented in the following sections.

- **DCFC costs are higher than many prospective site hosts are willing to pay**; incentives may increase adoption of DCFC stations by improving the business case or return on investment for site hosts or DCFC suppliers. With the high costs of installing and operating DCFC stations, most site hosts are not motivated to install them. DCFC site hosts need a good business case to support their decision to purchase. Research shows that states with funding programs that include funding for DCFC equipment costs have more DCFC stations installed. Additionally, the utility program manager and EVSE suppliers we interviewed shared the success of several utility DCFC programs offering incentives for DCFC equipment costs.
- **Utilities can play a valuable role in educating prospective site hosts about DCFC installation and help build the business case to facilitate decision-making.** A direct relationship with utility personnel can be a valuable resource, especially for education and specific guidance on how to participate, from vendor and equipment selection through the construction process. Identifying ways to help site hosts overcome their specific barriers through vendor and equipment selection can also help streamline participation. Programs can also increase their outreach through mass marketing, case studies, education, and internal champions at prospective site hosts.
- **Installation vendors and EVSE suppliers play a key role in the DCFC sales cycle**. Successful programs rely on program-approved vendors to do the marketing, outreach, and education for the program. Vendors are also critical in developing the relationship necessary for selling DCFC equipment.
- **Highway corridors and locations where end-use customers typically make short-term visits are ideal candidates for DCFC stations.** Interviewees highlighted the importance of installing stations where they will be most valuable and used, such as highway corridors to meet the needs of travelers and longer-distance commuters. Grants and funding are specifically targeting these sites. Additionally, interviewees discussed grocery and convenience stores and retail settings as good candidates for DCFC stations, although uptake in these locations has been limited to-date due to what is believed to be the most critical barrier, which is high DCFC equipment costs and low utilization (at this time and perceived for the next few years), resulting in a business case with a return of investment exceeding 10 years.

- **Most prospective site hosts lack familiarity and knowledge of EVs and EV charging**, and how anticipated growth in EVs will affect the need for charging among their customers. Many prospective site hosts may not see the "upside" of the DCFC business case due to low awareness of EVs and the EV growth trajectory. As a result, many are hesitant to move forward at this time. We will investigate this further in participating and non-participating site host interviews in early PY2.

4.2.2 DCFC Overview and Landscape

Today's DCFCs, also commonly known as Level 3 chargers,[10] can typically provide 75–100 miles of range during a 30-minute charge.[11] According to a study commissioned by the California Energy Commission, the typical DCFC equipment costs range from $15,000 to $40,000 and the typical installation costs range from $8,000 to $50,000 per charger.[12] Throughout the United States, DCFC stations are frequently located at car dealerships (e.g., Nissan, Chevrolet), at highway service plazas, along high-traffic interstate corridors, and at commercial locations like malls or large grocery stores to provide rapid charging for plug-in EVs. According to data downloaded from the Department of Energy's Alternative Fuels Data Center, current Massachusetts DCFC stations are primarily located in car dealerships, highway service plazas, and commercial locations (primarily malls).[13]

National Grid set a target of installing 80 DCFC stations in its service territory through its three-year program by December 31, 2021. As of December 31, 2019, the program has installed only one station with five more in development. Section 4.4 provides more details regarding National Grid program results.

Across the United States, the DCFC network is expanding through investment in public infrastructure. As of December 5, 2019, the Department of Energy's Alternative Fuel Data Center reports that there are 3,297 locations with publicly accessible DCFC charging stations and 11,727 DCFC charging outlets, or ports, across the United States. California leads the country with the most public DCFC stations and outlets, followed by Florida. Table 4-2 presents the states with the greatest number of stations and the associated outlet count as well as the number of incentive programs.

[10] DCFC is the fastest type of commercially available EV charging. DCFC typically features charging speeds of at least 50 kW and can restore approximately 80% of an EV's charge in about 30 minutes.
[11] Katelyn Bocklund, "Close-up of DC Fast Chargers in Minnesota," Drive Electric Minnesota, January 22, 2018, https://www.driveelectricmn.org/close-up-of-dc-fast-chargers-in-minnesota/.
[12] California Energy Commission, Electric Vehicle Charger Selection Guide, January 2018, https://afdc.energy.gov/files/u/publication/EV_Charger_Selection_Guide_2018-01-112.pdf.
[13] "Alternative Fueling Station Locator," Alternative Fuels Data Center: Alternative Fueling Station Locator, accessed December 5, 2019, https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast&ev_levels=3.

Table 4-2. States Leading with Number of Public DCFC Stations[1]

State	DCFC Station Locations	Charging Outlets	# of Incentive Programs
California	845	3,318	8
Florida	176	636	3
Texas	164	587	3
Washington	142	443	4
Georgia[2]	124	323	-
Oregon[2]	123	300	-

[1] Includes non-workplace charging stations open to the public, including Tesla Superchargers.

[2] Georgia and Oregon do not have any incentive programs listed on Clipper Creek website.

Source: Department of Energy's Alternative Fuel Data Center[14] and Clipper Creek website[15] (list of incentives by state).

Massachusetts has 80 publicly accessibly DCFC stations and 272 charging outlets, or ports. Massachusetts has two incentive utility incentive programs that are focused on installing DCFC charging infrastructure, but neither provide rebates to site-host customers to mitigate the cost of DCFC equipment.

Programs that provide funding or incentives for DCFC equipment and installation are offered at the state and local level as well as by utilities. These programs often leverage additional funding from private or non-utility sources like EV registration fees or air quality programs to maximize the incentives to site hosts.

Several states – including Idaho, Oklahoma, Pennsylvania, and Rhode Island – allocated money from the Volkswagen settlement toward DCFC equipment installation. In October 2016, Volkswagen reached a settlement agreement for violating the Clean Air Act. Settlement funds were split into three different programs: vehicle recall, mitigation trust fund, and zero-emission vehicles (ZEV) investment. Money is allocated to states based on the number of affected Volkswagen vehicles registered in the state. States may use a limited amount of money in the mitigation fund for charging infrastructure for light-duty zero emission passenger vehicles. Volkswagen created Electrify America, LLC, to implement the zero-emission vehicle component

[14] "Alternative Fueling Station Locator," Alternative Fuels Data Center: Alternative Fueling Station Locator, accessed December 5, 2019, https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast&ev_levels=3.

[15] Clipper Creek is a wholesale distributor of EV Charging Stations. The ERS Team compiled a list of available DCFC incentives using their website and gathered additional information from individual program websites. While this list may not include every DCFC incentive available, it does provide a good overview of incentives available, with 44 incentives in 29 different states represented.

of the settlement, which requires Volkswagen to invest $2 billion in ZEV charging infrastructure and promotion of ZEVs.[16]

4.2.3 Site Host Motivations and Decision-Making

EVSE suppliers and the utility program manager reported many of the same motivations for installing DCFC stations that we heard from the National Grid sales and implementation teams about Level 2 installations. However, they also acknowledged the need to have a good business case or return on investment when making the significantly more expensive expenditures in DCFC stations.

The utility program manager interviewed by the ERS Team stated that many site hosts see EVs as "how the world is going" and that charging station development, specifically DCFC, is "the right thing to do." National Grid staff heard a similar sentiment from site hosts installing Level 2 stations. According to the utility program manager, DCFC site hosts are interested in promotional benefits that DCFC stations provide with their end-use customers and/or employees. Small towns and large retailers are often interested in DCFC stations for the economic benefits, giving EV owners a reason to stop in their town or at their store and spend money while charging their vehicle.

In addition to being motivated by the potential financial benefit that could come from installing DCFC stations, some site hosts are trying to be ready for what is to come, rather than playing catch-up in the future.

Interviewees reported that the sales process can take time and effort. Multiple vendors and the utility program manager stated that relationships develop over months and could take 10 to 15 meetings. These experiences are useful for framing expectations for National Grid's program, especially given this is the first year the program has been in the market. As National Grid is experiencing, it will take concerted effort (and therefore time) to reach DCFC goals. It may be worthwhile to establish short-term goals (e.g., establish a certain number of relationships in a given year) and recognize the DCFC installations will be a longer-term process.

4.2.4 Best Locations for DCFC Stations

There is general agreement among those interviewed that the best candidates for DCFC stations are highway corridors (where EV drivers may need to charge during longer-distance travel) and locations where the typical shorter length of stay aligns roughly with the decreased time needed

[16] United States Environmental Protection Agency, "Volkswagen Clean Air Act Civil Settlement," https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement#elements (accessed December 6, 2019).

for charging. We also heard from one EVSE supplier that dense urban areas, where EV owners may be less likely to have access to charging at home, are good candidates.

Both California and New York have strategies or incentives to increase DCFC charging on highway corridors:

- In support of California's goal of having 1.5 million ZEVs (including plug-in EVs) on the road by 2025, the California Energy Commission awarded ChargePoint a $9.2 million grant to install charging stations along major corridors in California. Three-quarters of 54 awarded sites will have multiple DCFC charging stations. In addition, all sites will be constructed to accommodate future additions of DCFC charging stations.[17]
- As part of the EVolve NY $250 million initiative to encourage electric car adoption by 2021, New York plans to deploy 200 DCFC stations in more than two dozen locations along major traffic corridors and at JFK airport. Along major corridors, the stations will be placed at intervals of less than 75 miles, with 150 kW chargers supporting a charging speed of over 200 miles in 30 minutes.[18]

In Massachusetts there are already DCFC stations at 80 locations across 58 different zip codes.[19] Approximately 31% of the current DCFC sites are Tesla or Electrify America. Table 4-3 provides additional detail on the existing DCFC stations in Massachusetts.

[17] California Energy Commission, "Driving to Cleaner Transportation Plug-In Electric Charging Infrastructure," California Energy Commission, accessed October 15, 2019, https://ww2.energy.ca.gov/transportation/tour/ev_infrastructure/.

[18] "New Statewide Initiatives to Spur Widespread Adoption of Electric Vehicles and Increase Charging Infrastructure," 20181119-Evolve (NY Power Authority, November 19, 2018), https://www.nypa.gov/news/press-releases/2018/20181119-evolve.

[19] "Alternative Fueling Station Locator," Alternative Fuels Data Center: Alternative Fueling Station Locator, accessed December 5, 2019, https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast&ev_levels=3.

Table 4-3. Massachusetts DCFC Station Characteristics

Location Type (n=80 station locations with information)	
Shopping centers	25
Nissan dealerships	18
Service plazas	6
Grocery stores	5
Restaurants	4
Hotels	4
Others (<4 locations each)	18
Network (n=80 station locations with information)	
Evgo	23
Non-networked	19
Tesla	17
ChargePoint	12
Electrify America	6
Greenlots	3
Fee Structure (n=37 stations with information)	
13 are free; 19 charge per kWh; 5 based on length of time	
Open Date (n=37, date provided for non-networked, Tesla, and 1 Greenlots station)	
12 DCFC installed at Nissan dealers in 2012; first few Tesla Superchargers installed in 2015, but most installed during 2018	

Source: Department of Energy's Alternative Fuel Data Center[20]

EVSE suppliers often cited retail settings and convenience stores as good candidates for DCFC stations. Retail shopping centers like indoor and outdoor malls and mixed-use centers with grocery store anchors are good locations for DCFC stations, as the length of time someone spends at these locations aligns with charging time. Generally, the more variety of stores and restaurants at these locations, the better.

Interviewees also noted convenience stores, especially those in the fuel market, as good candidates. While there are challenges to establishing a business case for the expense, particularly for "mom and pop" stations, this is a market that understands that a portion of their revenue is being lost as EV adoption increases. One EVSE supplier regularly fields calls from convenience store owners looking for information on what it means to own and operate a charging station. According to the Department of Energy's Alternative Fuels Data Center, there are currently very few DCFC stations at convenience or gas stations in Massachusetts.[14]

[20] "Alternative Fueling Station Locator," Alternative Fuels Data Center: Alternative Fueling Station Locator, accessed December 5, 2019, https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast&ev_levels=3.

The utility program we reviewed offers DCFC and Level 2 incentives for government and non-government public charging stations but offers only Level 2 incentives for workplaces and multifamily complexes. The program provides higher incentives for government than non-government locations but reports that DCFC participants have been evenly split between the two groups and that they will achieve their DCFC station. Cities and towns comprise most of the government stations, while big retail, hospitals, medical facilities, and colleges make up the bulk of the non-government public stations. They reported installations in grocery stores as well, but not at convenience stores, which have been mentioned as good targets by both National Grid and EVSE suppliers.

4.2.5 Challenges and Barriers to Installing DCFC Stations

Study interviewees, including with National Grid staff, identified the following as significant barriers to installing DCFC stations:

- **Cost of installation and operation** – This is the primary barrier for DCFC. Not only are there substantially higher equipment costs and no incentives for the charging station equipment, but customers also experience higher demand charges after installing the stations, lengthening the return on investment for the business and making it a less attractive capital investment for corporate decision-makers.
- **Low utilization** – While DCFC stations are critical to enabling EV adoption, EV adoption in Massachusetts is just over 1%[21] and for this reason DCFC station owners cannot amortize the costs – capital and operating costs such as demand charges – to the EV drivers without making their stations cost-prohibitive. This is exacerbated by many drivers charging at home or at work.
- **Poor business case for some businesses** – Unlike Level 2 stations, which are often installed to attract employees and tenants or serve as a public amenity, DCFC stations are typically installed if they make economic sense – which is rarely the case – or to support EV sales (Tesla) or by government edict (Electrify America). Further, site hosts may not fully grasp the nuances of different EV station ownership models.
- **Loss of revenue**– The concern about parking spots being underutilized was a particular barrier for DCFC stations at locations such as convenience and grocery stores – locations that sales and implementation staff identified as the best candidates for DCFC stations. Interviewees noted concern among these businesses that underutilized charging stations could adversely affect their sales potential because the volume of EV owners using those parking spaces and making purchases would be less than if those spaces were available to

[21] Auto Alliance, "Advanced Technology Vehicle Sales Dashboard," accessed March 23, 2020, https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

everyone. Some businesses also doubted that EV charging station users would patronize their business.

- **Leasing agreements** – Program participation becomes more difficult when an interested customer does not own their building, meaning the program must also work with the property owner.
- **Corporate decision-making** – In many instances, particularly with chain stores that may be good candidates for DCFC stations, decisions are made at a corporate level, not locally. This can be a deterrent for the local staff who may be interested but unable to reach the centrally located decision makers to get corporate approval, assuming they are able to present the business case.
- **Lack of knowledge and awareness of EV-related topics** – EVSE suppliers felt that most prospective site hosts are unaware of the investments that vehicle manufacturers (other than Tesla) are making into EV development and how that will impact the number of EVs on the road, thereby increasing the demand for EV charging among their customers and/or employees. Additionally, prospective site hosts need education on how EV charging works (e.g., the three different DCFC charging plugs and which vehicles can use which plugs, length of time to charge, amount that EV drivers are willing to pay to use the chargers, etc.).

National Grid staff interviewees also identified a few additional barriers listed below. Note that when our team discussed these barriers with EVSE suppliers, they believed these barriers are lower priority than those mentioned above.

- **Demand charges can cause complications**, although vendors said this is not a significant barrier for National Grid at this time because of National Grid's current rates.
- **Electrify America and Tesla offerings may affect site host expectations** of how much money is available for funding charging stations but do not significantly affect potential sites for DCFC stations. Electrify America and Tesla fund 100% of the DCFC stations infrastructure, DCFC equipment, and operating and maintenance costs while also providing site hosts with revenue for the parking spots. The National Grid Charging Program offering does not provide this level of support.
- **Station placement at a given site can be an issue** but does not usually prevent a site host from moving forward, as the make-ready funding available helps offset that expense.

The ERS Team's DCFC interviews identified the following additional barriers, not identified during interviews with National Grid sales and implementation team members:

- **Long sales cycle** – All parties interviewed remarked that selling DCFC stations is very complicated and requires relationship building over a period of time. This is not a routine purchase or equipment that most people are familiar with, and even with make-ready and/or equipment incentives, the expense to a company can still be significant, requiring lengthy stakeholder processes.
- **Lack of urgency** – We heard from EVSE suppliers that currently, possibly due to a lack of awareness and knowledge about EVs, many prospective site hosts are taking a "wait and see" approach. While EVSE suppliers feel that there will be a much higher demand for EV charging in two to three years, and the same funding opportunities may not be available at that time, prospective site hosts do not seem to be thinking that far ahead. This lack of urgency may also be related to the lack of visibility of brands other than Tesla – some potential site hosts see only Tesla EVs who can use Tesla Superchargers, so they don't see a need to install charging stations.

The ERS Team's secondary literature review confirmed many of the barriers to DCFC installation raised by interviewees and introduced additional barriers. Data collected by Smart Electric Power Alliance (SEPA) from a small sample of non-utility stakeholders identified barriers to installing charging stations in general. This included a lack of a compelling business case, closely followed by the design and construction process to support the electrical infrastructure, which has not been a barrier for National Grid's program to date. The SEPA study also identified site selection, low EV adoption, low charger utilization, and uncertainty around the process, costs, and timelines for utility service upgrades as barriers to EV charging infrastructure installation.[22]

[22] Smart Electric Power Alliance, *Preparing for an Electric Vehicle Future: How Utilities Can Succeed*, PDF file, October 2019, https://sepapower.org/resource/preparing-for-an-electric-vehicle-future-how-utilities-can-succeed/.

Figure 4-1. Barriers to EV Charging Installation

Source: Smart Electric Power Alliance. 2019. N=30. Respondents selected all that applied.

4.2.6 Removing Barriers to DCFC Installation

Several characteristics of successful DCFC programs and strategies for removing barriers emerged during our interviews and literature review. However, interviewees also acknowledged that there are often circumstances outside of a program's direct control, like the number of EVs on the road in a jurisdiction or other funding sources to complement utility incentives, that can help a program's success. Availability of Volkswagen settlement funding is one such example. Successful characteristics and strategies include the following:

- **Incentives.** The interviewed utility program manager confirmed that having incentives available for both the "make ready" and charging station equipment helped drive participation. Additionally, EVSE suppliers noted that in their experience, programs that have had the most success either a) have incentives available or b) the utility purchases the charging stations and then distributes them (through RFP or other means). Further, information about four successful programs provided by one EVSE supplier showed that all four programs included incentives for both EVSE and installation costs, and three of the four programs also included planning, engineering, network services (up to 5 years), and warranty/maintenance services as eligible program costs.[23] As evidenced by these programs, incentives for DCFC equipment, and reducing the out-of-pocket costs to site hosts, can significantly reduce barriers to installation. One EVSE supplier suggested that based on their experience, keeping out-of-pocket costs below $40,000 for two DCFC stations could increase program uptake.

[23] One program pays 100% of eligible costs at government or LMI sites ($100,000 cap) and 80% at non-government owned sites ($50,000 cap). One program pays 100% of eligible costs for publicly owned land and 80% for privately owned land. One provides max incentives of $70,000 for new stations, and the remaining program funds 75% of eligible costs up to $500,000 per application.

- **Continue to leverage existing and recruit additional EVSE suppliers and installation vendors.** The utility program manager we spoke with explained that they rely almost exclusively on their three program-approved EVSE suppliers to do the marketing, outreach, and education for the program. The EVSE suppliers also guide the site hosts through the program, with the utility staff only following up if approved projects aren't completed within the required timeline. While the utility account managers will also discuss the program with their assigned customers, they are not actively selling it.
- **Guide prospective site hosts to the solution that best meets their needs.** The business models of each of the EVSE suppliers we spoke with offered potential solutions for some of the common DCFC barriers, and different models may be appropriate for different site hosts (e.g., depending on whether they own or lease their site or would like to brand their charging stations). However, given that the typical sales cycle may take 10–15 meetings, some site hosts may benefit from decision-making support. By helping site hosts identify which EVSE offers the solution that works best for their situation, National Grid could help streamline the process for site hosts and educate them on the different alternatives available. Leasing, whether the charging station or the land, can help alleviate some of the risk associated with owning and operating charging stations.
- **Education and outreach**. All who we spoke with agreed that the market needs education on EVs, EV charging, and the Charging Program. Getting the word out about the program can be accomplished through mass marketing, vendors, word of mouth from early participants, and program materials and website. Additionally, education on how site hosts can implement charging fees, promotions like discounted charging if they use the site host business, and non-use fees could help business owners understand how they might recuperate the cost of installing a station.
- **Build out the business case.** Develop case studies or sales tools that show how having charging stations translates into increased traffic and spending for a business, not just a lost parking space. EVSE suppliers have made some progress in this area. One vendor cited an existing case study about a retailer that was able to show increased spending tied to charging stations and another vendor has surveyed their network members to gain insight into their purchasing habits while charging. Additionally, one vendor has launched an effort to collect data by sending in-app coupons to customers for businesses near where they are charging as a way to track purchases tied to EV charging. Additionally, National Grid may be able to start developing its own case studies by analyzing its charging station data to show utilization and talking to site hosts about the effect of the charging station to bolster the information available to site hosts.

- **Provide strong utility support and clear program messaging.** The non-utility stakeholders interviewed for the SEPA report indicated that a direct relationship with utility personnel provided the most useful resources and support needed for EV charging infrastructure development guidance,[24] including resources for:
  - Easy-to-understand FAQs, websites, and informational material to guide site hosts through equipment selection, design, permitting, and construction processes that National Grid has implemented.
  - Customer outreach programs including EV ride and drive events, education campaigns, and process guides can be effective in helping to educate potential site hosts about EVs and effective charging infrastructure planning and deployment.
  - Customer contact center hotlines with specially trained customer service representatives who can help guide prospective site hosts through the program.
- **Build relationships**. Successful programs also allow for, and recognize, the time it takes to develop the relationships needed to sell a DCFC charger. Interviewees reported that these take time, and that relationships develop over months and could take 10 to 15 meetings.
- **Create a competitive marketplace.** One EVSE supplier noted that the more successful programs are the ones that use multiple market players to encourage competition. The utility program we spoke with is evidence of how this can be successful; as noted above, this program uses three program-approved vendors and relies heavily on them to market the program. National Grid's program also relies on EVSE vendors to assist in lead generation, and National Grid has continued efforts to grow the competitive marketplace like increasing its CSI network to broaden the program's reach.
- **Lower demand charges**. While an increase in demand charges from charging station use was not mentioned as a significant barrier to installing DCFC stations in National Grid's Massachusetts service area, several states and cities have established programs designed to address the barrier around demand charges. A few examples of these types of programs include:
  - National Grid Rhode Island's DCFC Discount Pilot program, which seeks to accelerate third-party DCFC stations by providing an electric rate discount equal to 100% of the DCFC's distribution demand charges for a three-year period.

[24] Smart Electric Power Alliance, *Preparing for an Electric Vehicle Future: How Utilities Can Succeed*, PDF file, October 2019, https://sepapower.org/resource/preparing-for-an-electric-vehicle-future-how-utilities-can-succeed/.

- Tacoma Power, which is offering a new rate schedule that reduces demand charges through 2031 to help remove barriers to private investment in fast charging infrastructure and recover costs.[25]
- The City and County of Denver, Department of Environmental Health, is working with utilities to reduce or eliminate demand charges while still allowing the recovery of costs through measures such as time of use energy charges rather than demand charges for DCFC stations. These allowances improve the business model.[26]
- New York Public Service Commission modified the DCFC rate structure available to commercial customers to encourage higher installation and utilization.[27]

- **Find an internal champion**. Being able to find the appropriate local person, with the interest and ability to champion DCFC stations, can be one way to address challenges that come when decisions are made by a landlord or someone at a corporate office.

Recent efforts by National Grid to remove or reduce barriers to DCFC station installation include a grocery store summit and stakeholder engagement meeting. National Grid invited grocery stores to participate in an all-day event that included discussion of the Charging Program and how they could get involved. National Grid also held a stakeholder engagement meeting to discuss how to address barriers and increase DCFC adoption in the state.

4.2.7 Upcoming Activities for PY2 and PY3

While there are no additional interviews with vendors or other utility staff planned for the future, our PY2 interviews with participating and non-participating site hosts will delve deeper into the motivations and barriers to installing DCFC stations. There are no related research activities planned for PY3.

The ERS Team will conduct one wave of in-depth interviews in PY2. This task will use semi-structured in-depth interviews with site host decision-makers and comparable decision-makers at locations that are not hosting National Grid's charging infrastructure (which will be a mix of true non-participants and those in contact with program staff but not yet committed). We will also attempt to interview individuals working with a variety of different EVSE suppliers. This task will help the team understand what drove participants to install charging infrastructure,

[25] https://www.mytpu.org/tacoma-power-and-electrify-america-introduce-new-electric-vehicle-charging-stations-in-tacoma/
[26] Svitak, Salisbury, and Toor, "Opportunities for Vehicle Electrification in The Denver Metro Area and Across Colorado"
[27] Energy Innovation, "How New York, Maryland, Michigan Are Overcoming the Looming Electric Vehicle Charging Infrastructure Gap," Energy Central, May 18, 2019, https://www.energycentral.com/c/gr/how-new-york-maryland-michigan-are-overcoming-looming-electric-vehicle-charging.

what is working well with the existing program, and how to adapt future programs to maximize participation and accelerate deployment of EVSE.

4.3 DCFC Non-Participant Site Host Interviews

For PY1, the ERS Team interviewed five individuals whose companies considered installing DCFC stations through National Grid's Charging Program. At the time of the interviews, two of the five prospects had submitted applications for DCFC stations in Massachusetts.

This section summarizes the key findings from these initial interviews. Full findings and recommendations will be provided in the PY2 report. The intent of this research is to provide National Grid with early feedback; the team will conduct up to 30 additional interviews with site hosts and prospective site hosts in PY2, which will build on these results.

4.3.1 Initial Non-Participant DCFC Site Host Interview Findings

The ERS Team's preliminary findings from the five initial non-participant DCFC site host interviews are summarized here:

- **Prospective site hosts rely on EVSE vendors to steer them toward opportunities and through station planning.** Each prospective host we interviewed has a close relationship with at least one vendor who they consider a partner and who they rely on for information about available funding from states and/or other funding sources including utility programs.
- **Funding differences between states drives locational decisions for multi-state businesses.** DCFC prospective hosts that operate in multiple states are more likely to invest in states that have higher funding opportunities. Interviewees consistently mentioned that funding for DCFC EVSE in Massachusetts is lower than other states based on guidance they received from EVSE vendors. This difference in funding could have implications for National Grid's Massachusetts EVSE program performance when working with large, multi-state businesses.
- **Prospective site hosts interviewed are interested in installing DCFC stations for different reasons.** Some prospective hosts believe owning and operating DCFC stations could be profitable, especially as EV adoption increases; this perspective was held by gas station and convenience store representatives interviewed. Others interviewed thought that hosting a station could provide a competitive advantage and improve their customers' experience. These prospective site hosts are not looking for a new revenue opportunity but, rather, are considering offering fast charging as an amenity that their competitors might not offer.

- **Prospective site hosts want to learn from their initial investments in DCFC stations to better understand if it results in a positive business case by attracting more customers and increasing revenue and profits.** Prospective site hosts consider their planned DCFC installations as "test cases." They are seeking and gathering data to analyze the business case for potential future investment and at what scale. All representatives interviewed view the EV market as emerging, with an unknown growth trajectory. Therefore, they are uncertain about customer usage and potential revenue. Several interviewees acknowledged that operating costs (including charging behavior impacts of electric bill demand charges) are also challenging to forecast.

4.3.2 DCFC Lead and Prospect Characteristics

National Grid identified 14 non-residential customers as current or former prospects for DCFC stations in Massachusetts. The list of prospects came from National Grid's grocery and convenience store account manager and EVSE vendors. About half of the 14 DCFC prospects were grocery store chains. DCFC prospects also included several gas station/convenience store chains, a large retailer, and two commercial real estate companies.

The ERS Team spoke with 5 of the 14 DCFC prospects; 3 gas station chains, 1 national retailer, and 1 grocery chain (referred to as "large retail"). All five organizations were multi-state businesses with locations in both Massachusetts and Rhode Island, and most had locations in other New England states as well, including New York. Their presence in New England ranged from several locations in three states to nearly 200 locations in the Northeast.

Four of the five representatives we spoke with were not regularly involved in other energy efficiency programs or account services with utilities; their roles focused on business strategy, property development, and project management. Only one representative manages energy efficiency projects and rebates with utilities.

Although several representatives had experience with Level 2 chargers in the past, they all believe that DCFC is most appropriate for their customers (due to short trip duration).[28] Four of the five are only considering fast-charging for future projects, while one large retailer was still somewhat open to Level 2 stations.

Two of the five prospects submitted applications for DCFC stations in Massachusetts but only one is actively pursuing a project in Massachusetts at present. The other four prospects said

[28] This is consistent with National Grid's plan for DCFC and is included in their filed plan: Revised Exhibit KAB/BJC-1, Page 40 of 65, Lines 9-13.

they were not actively pursuing projects in Massachusetts because they were focused on projects in other states.

Three of the five organizations had already installed DCFC or Level 2 stations, either in other states or in Massachusetts,[29] before National Grid's current program. Their previous charging station installation experience included:

- **Limited upfront capital investment** – The organizations who installed DCFC stations invested little, or none, of their own capital. Instead, they leveraged early funding opportunities from EVSE vendors (e.g., EVgo, Tesla, ChargePoint), vehicle and charging station manufacturers (e.g., Nissan, Tesla), utilities, and state funding (e.g., Volkswagen settlement).
- **A mix of DCFC and Level 2 stations** – Interviewees had installed DCFC stations through National Grid and vendors, and Level 2 stations through vendors and direct installations (i.e., using local contractors). Most prior experience with DCFC stations was hosting rather than owning/operating, leveraging earlier funding sources and business models.
- **Varied charging station ownership structures** – Depending on the station and the opportunities presented to the organization by development partners, the ownership structure could be different (discussed below).

4.3.3 Prospective DCFC Site Host Motivations

Four of the five representatives were interested in installing EV charging stations to be competitive as EVs gain greater market share. The fifth representative was primarily driven by corporate sustainability goals. All five representatives see a transition toward EVs as inevitable, though they do not expect rapid adoption of EVs and anticipate the number of charging sessions per day to be low to start.

Within these five interviews, motivations for pursuing EV charging stations varies by sector. Gas station representatives see charging stations as a potential source for revenue and profit, again not in the short run. Representatives from the national retailer and grocery chain see charging stations as a service or amenity that customers will increasingly expect. Future research will continue to identify differences by sector to inform strategy and outreach.

Gas Stations and Convenience Stores

The three gas station representatives all noted that EV charging stations could provide an opportunity to diversify revenue from fuel sales and generate additional in-store sales. For

[29] National Grid's previous program in Massachusetts funded 100% of the installation costs, 100% of the DCFC EVSE costs, and 100% of the networking and maintenance costs. Funding was provided by a grant from the MA Department of Energy Resources (DOER).

them, providing EV charging is a competitive imperative to draw EV drivers to their businesses. Two of the three are ready and eager to own and operate charging stations to see if they can profit from increased store sales, and, to a lesser extent, EV charging revenue. One is interested in piloting stations under a hosting model to gather data to determine if owning or operating stations may be worthwhile. All see increased revenue from in-store sales as more valuable than revenue from EV charging, given the higher margins on food and beverage sales.

Large Retail

The retail and grocery representatives do not view EV charging as a revenue opportunity but, rather, a way to meet customer (and stakeholder) expectations. They believe they will need to install charging stations to stay competitive with the market as it transitions. The retail and grocery representatives did not view the competitive imperative of EV charging as strongly as gas station representatives. They see it as a service or amenity that customers will increasingly expect; at some point, if they do not offer charging but the store across the street does, customers will be more likely to shop across the street instead.

4.3.4 DCFC Project Planning

Vendor Relationships

All the representatives we spoke with were heavily influenced and guided by EVSE vendors such as ChargePoint, EVgo, and Tesla (who they spoke of as "development partners," "manufacturers," and "partners"). These partners typically approach prospective site hosts with "opportunities" in states and locations where the development partner sees a) more available funding and b) locational advantages, like proximity to a highway.

All five site hosts consulted or worked with several vendors and consultants; two of the five are now working primarily with one vendor, while others may consider using different vendors depending on their offerings. Their vendor preferences are based on business model fit (e.g., own/operate vs. third-party-ownership opportunities), vendor communication, relationships (wanting a "good partner"), and vendor-specific siting requirements (one vendor requires more chargers and parking spaces).

The representatives we spoke with all have strong, positive relationships with at least one EVSE vendor, and they trust that vendor to direct them to the best opportunities for funding. In this way, their approach is somewhat passive when it comes to deciding what state or business location to focus on. This reliance on vendors for selecting locations and identifying funding sources reflects that most prospective site hosts are new to the DCFC charging station business. Several representatives acknowledged their reliance on EVSE vendors for identifying funding opportunities and thought they could be doing more to investigate DCFC EVSE funding in

Massachusetts on their own, though they stated this was not a top priority while they pursue EVSE projects in other states with more funding available.

Most representatives interviewed have a strong preference for working with vendors that provide "turnkey" services. Three of the five site hosts said they were interested in, or had experience with, "turnkey" planning, design, and installation. These site hosts expect their EVSE vendor (or consultant) to work out the funding sources, infrastructure planning and design, permitting, site work, utility work, and connections.[30] In contrast, two site hosts have staff and time to dedicate to project planning. The retailer with a property management group has planned and managed several DCFC and Level 2 installations from various vendors across the country; this retailer did most of the project planning, design, and permitting themselves. One gas station chain also had DCFC experience but wanted local support for planning, and they preferred to work with local contractors (for local knowledge as well as faster service for maintenance issues). However, based on this experience, their preference going forward would be for a make-ready or turnkey program that covers infrastructure costs (and ideally DCFC EVSE costs)[31] that also makes the local permitting, utility planning, site work, power supply, and connection easier.

Site Selection

The biggest decision the DCFC prospects are making (or have made) was which state to invest in. They decide where to invest first based on funding availability. As noted, vendors play a big role in directing prospective hosts to states with the best funding opportunities. A byproduct of this dynamic is that most of the representatives we spoke with are not focused on Massachusetts projects because they are pursuing projects in states with more available funding.

Overall, four of the five representatives reported that vendors told them Massachusetts had more limited funding, largely based on what vendors told them rather than their own investigation.[32] . One organization submitted a National Grid application in both Massachusetts

[30] For one site host, this statement applies to DCFC, but for Level 2 installations they were comfortable with planning themselves and preferred working with local contractors for installation rather than national EVSE vendors.

[31] As stated above, covering 100% of DCFC costs is not a deal-breaker for all customers, some of whom are willing to invest if they foresee positive payback. However, since some states do offer 100% funding for EVSE costs, multi-state site hosts may pursue this funding first.

[32] The site-hosts we spoke with spoke of "funding" in general terms and did not mention or make distinctions between funding for different purposes like infrastructure, DCFC EVSE, and networking and maintenance costs. This is likely due to their trust in vendors to identify and communicate the best funding opportunities. While National Grid funds 100% of the electrical infrastructure costs like other states, there is lower funding for DCFC EVSE, and networking and maintenance costs.

and Rhode Island but is only actively working on the Rhode Island project since, according to their vendor, there is more funding in Rhode Island.

After development partners help identify attractive locations, the prospective-site host is often heavily involved in the final locational decision of exactly what store could support charging stations. It can be challenging to find locations that can give up parking spaces for EV charging infrastructure and EV-only parking spaces. Sometimes a retail location may be at or close to the local code minimum number of spaces and cannot convert spaces to EV charging.

Ownership Models

The ownership models that prospective site hosts are seeking (or have used for previous installations) range from hosting with no capital or operating costs (and no revenue from EV charging sessions, though they may see additional revenue from in-store purchases by EV owners), to full ownership (with new revenue from charging sessions and in-store purchases by EV owners).

Ownership model decisions vary between sectors. Gas stations and convenience stores see charging stations as an important future revenue stream as EV adoption increases, to off-set potential declines in fuel sales and engage a new demographic (EV drivers) before their competitors do. Therefore, they are carefully testing and evaluating ownership options that fit their needs. In contrast, large retailers seem more content with third-party ownership models.

Gas stations and convenience stores – Representatives from gas stations and convenience stores are confident that DCFC stations will benefit their business in the long run but are tentative of spending more of their own capital and resources on installing/operating stations until they see more data. All three gas station representatives said they need to see positive cash flow and ROI from DCFC stations before investing further. Accordingly, the gas station and convenience store representatives see near-future New England DCFC installations (whether MA, RI, or NY) as test cases to understand 1) whether DCFC stations will generate a positive cash flow and ROI and then 2) which charging station ownership model works best for them, based on the data they collect.

Two of the three are confident that DCFC can yield a positive ROI, despite significant uncertainty regarding EV adoption rates. Therefore, they believe it is best to own and operate their DCFC stations and are willing to invest their own capital dollars (up to a point). The third said the company would not own or operate any DCFC stations until they have concrete data on usage, charging revenue, and in-store purchases.

All three are interested in research about the conversion rate between charging sessions to in-store purchases, which one gas station chain has started collecting and evaluating. One

interviewee felt that National Grid or the vendors could play a role in providing anonymized data on these questions to inform their models.[33]

In addition to revenue potential, one prospective site host wants to own the stations to have better control over the customer experience but still wants to monitor usage and charge related to peak demand and is investigating whether the revenue from the chargers offset those utility expenses.

Large retail– The two larger retailer/grocers we spoke with saw EV charging as an amenity or perk for their customers, not as central to their business. They seemed less concerned about finding an ownership model where the DCFC stations directly contribute to the retailer's bottom line. As a result, they were satisfied with third-party ownership models. It is important to note, however, that one retailer has a mixed portfolio already, with some stations they own/operate and some owned/operated by development partners. Based on those experiences, this retailer prefers to host if a development partner can find private funding to make up for the lack of equipment incentives. They are more interested in providing a service to customers than direct financial gain from the DCFC stations.

Another retailer hosts several DCFC charging stations (installed prior to the current Charging Program) and has not paid any upfront capital or ongoing operating costs for networking or maintenance, though they pay electricity costs for the DCFC stations. Although they want to install more DCFC stations to stay competitive, the representative does not imagine their organization will fund stations or operations and is looking for fully-funded DCFC opportunities that are "zero impact" to them – no cost or financial benefit.

4.3.5 Program Expectations and Awareness

All prospective site hosts stated they expect that utilities can and should cover a significant portion of DCFC equipment costs in addition to the make-ready costs. They also expect state funding, since several states are offering additional funds for DCFC equipment.

Related to National Grid offerings specifically, the prospective site hosts had varying awareness and knowledge of National Grid incentives. Two learned about incentives from vendors as part of vendors' proposals for opportunities in different states. Two have had enough previous experience with charging stations in other states (Level 2 and DCFC) that they are generally aware (and expect) that utilities provide incentives for charging stations, though they realize

[33] This desire reflects an interviewee's opinion and is not the opinion of the ERS Team. The ERS Team understands that National Grid does not have visibility into customers' business revenues. The interviewee imagined that National Grid or vendors could collect or share anonymized utilization data (e.g., sessions per day), and that some site hosts may be willing to voluntarily share other information as part of a case study,

there are differences in amounts offered and the additional assistance they can provide to facilitate planning, make-ready work, installation, and connection. One prospective site host first learned about the opportunity from their National Grid account manager, who helped facilitate an earlier National Grid station installation.

The interviewed prospective hosts questioned the growth opportunities in Massachusetts based on perceived lower levels of both utility and state-level funding in the state. One DCFC prospect specifically noted that they believe the EV market will grow more slowly in Massachusetts compared with other states that have active EV rebates, citing the discontinuation of the MOR-EV rebates. This made Massachusetts a slightly less attractive location for DCFC stations for this representative. This perception could have direct implications on program performance for National Grid's Charging Program.

4.3.6 Interactions with National Grid

The prospects we interviewed have generally limited interaction with National Grid. Three of the five prospects have had limited involvement with National Grid with respect to planning DCFC stations or the application process. Only one representative mentioned working directly with National Grid staff to plan a project.

The representatives involved in planning DCFC charging stations generally had limited or no experience working with utilities on electric service and site infrastructure. Therefore, even if their organization has a National Grid account manager, the people thinking about or planning EV charging stations may not hold the account manager relationships and messages to and from National Grid may not be getting through easily.

For example, one interviewee voiced frustration about trying to find a single person at National Grid to answer some specific questions about charging stations; they stated they were sent to three different people.[34] Another representative who has completed several EV station projects around the country explained that it can be difficult working with utilities in general because of the siloed departments.

> *"If there were a group department within National Grid that was dedicated to EV that I could talk to directly and cut out all these interim consultants and middlemen, that would be helpful…If there was a team that said, "we do the EV thing" and I could pick up the phone and I want to have [LOCATION] connected…and there was an easy to service where I don't NEED a*

[34] The same customer worked with a consultant for the "heavy lifting" of planning but wants to work directly with National Grid to figure out demand charges and load balancing.

consultant to do it for me because it's so simple and they just send me a link and I fill out a form and there you go. That would make life easier."

Prospective site host expectations for the utility also include providing more turnkey services; one felt that if a utility is interested in getting chargers installed at retail locations, then the utility should plan, install, own, and operate them.[35] Another said they would like to be able to call the utility and say they want to install fast chargers and have the utility play a large role in bringing the project together.

4.3.7 Other DCFC Challenges and Barriers

The previous sections highlight the most-mentioned barriers to installing DCFC stations: perception that Massachusetts has less funding (all five site-hosts) and the need for more data to understand the business potential and support the business case (four of five). In addition, DCFC station prospects also mentioned several other barriers, including:

- **Steep learning curve** – Three of the five representatives did not have prior experience with DCFC charging, infrastructure, or utility projects. To get up to speed, they had to collect information from various external organizations such as vendors, municipalities, different utility departments, and consultants, which takes time.
- **Disruption to normal business** – For existing stores, the site work, infrastructure, and DCFC station installation may disrupt traffic flow and parking availability at the store, sometimes for several weeks or months. Prospective site hosts think carefully about all projects that disrupt their customers' ability to access their stores. Three of the five have identified (or have tried to identify) sites currently planning for major retrofits or renovations. One retailer felt that the retrofit process – of installing stations in an existing parking lot – can be highly disruptive, especially for DCFC installations, which have much higher infrastructure installation needs, trenching, road closures, and disruptions. Some stores cannot support this disruption to customer traffic and parking. Three of the five prioritize locations where they are already planning major construction (new construction or renovation/retrofit).
- **Loss of parking spaces** – Some retail stores and gas stations, including those with parking lots, may be close to the minimum number of parking spots required by local regulations or corporate policy. Each company has had internal discussions about which locations can give up the parking spaces for EV charging equipment and dedicated parking spaces. Site hosts reported that Tesla typically wants to install more stations (6-8) per project and

[35] Note: The National Grid Charging Program does not provide for utility-ownership and operation of DCFC stations.

requires more spaces than other vendors; this space requirement limits which parking lots can support Tesla installations.

- **Demand charges** – One representative mentioned the risk of a very high monthly bill from demand charges due to one peak charging event (e.g., two vehicles with large battery capacities charging at the same time). This person would like to work with National Grid on an EV charging-friendly rate structure.
- **Load balancing** – The representative with concerns about demand charges expressed a related concern about load balancing and being able to manage their peak load to stay below a certain limit with concurrent charging. He described a couple of scenarios (not all) when concurrent charging, particularly the beginning of the charging cycle, could draw a larger load.

4.3.8 Upcoming Activities for PY2 and PY3

The team will conduct additional in-depth interviews with site hosts and prospective site hosts in PY2. This task will use semi-structured in-depth interviews with site host decision-makers (up to 20) and comparable decision-makers at locations that are not hosting National Grid's charging infrastructure (up to 15). The locations not hosting National Grid's charging infrastructure will include a mix of prospects: those in contact with program staff but not yet committed, and non-participants who were in contact with the program or a vendor at some point but have decided not to install a charging station. We will also attempt to interview individuals working with a variety of different vendors. This task will help the team understand what drove participants to install charging infrastructure, what is working well with the existing program, and how to adapt future programs to maximize participation and accelerate the deployment of EVSE throughout the Commonwealth.

4.4 Charging Program Data Analysis

This section presents the results of the National Grid's Charging Program for PY1, which includes program results through December 31, 2019. The high-level program findings are presented first, followed by additional detail regarding charging station and utilization results.

4.4.1 Initial Program Data Analysis Evaluation Findings

The ERS Team's initial findings from the Charging Program analysis are summarized here:

- **The Charging Program has activated 108 stations through December 31, 2019.** The overall program goal is 680 stations. Broken out by station type, the program has activated 107 Level 2 stations and 1 DCFC station. The PY1 activated stations represent 16% of the overall program goal.

- **The Charging Program has a strong pipeline of projects** across multiple stages of the lead generation and project development lifecycle. In addition to the 108 activated stations through December 31, 2019, there a total of 436 stations in the pipeline.
- **DCFC station development is not meeting program targets.** The program has only one active DCFC station and four stations with applications submitted as of December 31, 2019, against a program target of 80. There are several barriers to DCFC station development, including high costs, limited available capital, and complex decision-making requirements. These barriers are discussed in greater detail in Sections 4.2 and 4.3.
- **The Charging Program is succeeding in incentivizing publicly accessible stations and stations within environmental justice (EJ) communities.** Approximately 63% of activated stations are classified as publicly accessible, representing about 52% of all charging kWh recorded in 2019. Of the 131 activated and in-flight stations as of December 31, 2019, 27% are located in communities meeting two or more EJ criteria, compared to a goal of 10% of Level 2 stations installed in EJ communities.[36]
- **Program project tracking is a manual process resulting in occasional inconsistent data across multiple sources.** The program uses Microsoft Excel spreadsheets to track project-specific information and program-level progress against goals, and this workbook serves as the system of record for the programs. The ERS Team identified inconsistencies in its initial review of these workbooks, much of which was subsequently updated by National Grid. However, there are still some project statuses and details that are inconsistent. For example, some stations that were listed as "committed" in the project tracker (not installed or paid) were actually activated and EVSEs were reporting charging session activity. National Grid updated the tracking spreadsheet in advance of the additional analysis performed by the ERS Team, correcting some of these inconsistencies and better integrating station cost data.

4.4.2 Charging Station Development Results

National Grid made great progress toward its goal of 600 Level 2 stations, most notably in public areas (63% of activated Level 2 stations) and workplaces (35% of activated Level 2 stations). During PY1, there were 107 Level 2 stations and 1 DCFC station activated through the Charging Program, with a total of 204 activated ports. Together, these 108 stations represent 16% of the overall program goals, as shown in Table 4-4.

[36] DPU 17-13, Page 24, Line 10.

Table 4-4. Charging Program Activated Stations – PY1

Charging Level	Program Activation Station Goal	Activated Station Count	Progress Toward Goal (%)
Level 2	600	107	18%
DCFC	80	1	1%
Total	**680**	**108**	**16%**

National Grid has a strong pipeline of projects at various stages of development. For the purposes of this evaluation, the ERS Team, in conjunction with National Grid, has grouped the site statuses in the Charging Program tracking worksheet as follows:

- **Activated** status indicates sites that are complete and operational. They have tracking worksheet statuses of "paid."
- **Project pipeline** stages track project development from lead generation through construction as defined below.
  - **In-flight** status indicates sites that have been approved by National Grid but are not yet complete and activated. This includes the tracking worksheet statuses of "under construction" and "installation complete."
  - **Committed** status indicates sites that National Grid has reviewed and approved for funding, including sending a letter of commitment to the customer with the committed rebate amounts. These projects may or may not have begun construction. This includes the tracking worksheet status of "committed."
  - **Application submitted** status indicates sites that have submitted an application to the program and are awaiting formal approval to receive program incentives. This includes the tracking worksheet status of "submitted."
  - **Lead generation** status indicates sites that have expressed interest in the program but have not yet submitted an application. This includes the tracking worksheet status of "in development."

There are additional statuses in the tracking data representing projects that are not actively moving forward. These include tracking worksheet statuses of "cancelled," "duplicate," "not approved," and "on hold." These stations are not included in this analysis. Table 4-5 shows program progress by status for both activated stations and the project pipeline. National Grid projected at the end of PY1 that 5% of the overall program goal of 680 stations would be either committed, in-flight, or activated. National Grid exceeded this 5% commitment goal with 50% (342 stations) committed, in-flight, or activated during PY1.

Table 4-5. Charging Program Site and Station Status as of 12/31/19

Roll-Up Status (Ordered from most to least developed)	Site Count	Station Count
Activated	53	108
In-flight	12	23
Committed	86	211
Application Submitted	87	174
Lead Generation	18	28
Total	**280**	**589**

While the program has experienced significant progress in PY1 for public and workplace stations, progress has been slower for multi-unit dwelling (MUD) stations and DCFC stations. There are a total of 16 Level 2 stations at MUD sites in the lead generation and application submitted stages, and 4 DCFC stations with applications submitted, suggesting some uptick in progress in these segments. National Grid is actively engaging an installation vendor to target MUD customers.

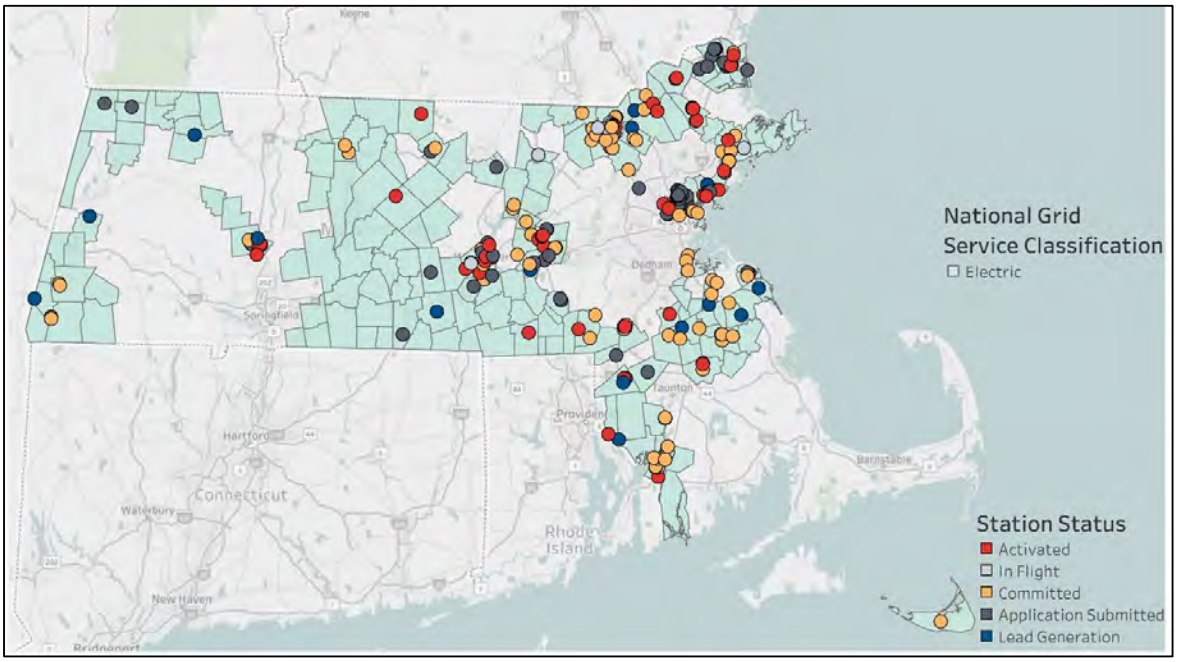
Table 4-6 presents the program progress for PY1 for both Level 2 and DCFC stations, measured in the number of charging stations. Note that MUD and workplace sites are not identified as locations intended for DCFC station deployment and are thus excluded.

Table 4-6. Charging Program Progress – Station Counts – PY1

Station Use	Lead Generation	Application Submitted	Committed	In Flight	Activated
Level 2					
MUD	4	12	9	0	3
Public	19	132	163	13	67
Workplace	5	26	38	10	37
Total Level 2	**28**	**170**	**210**	**23**	**107**
DCFC					
Public	0	4	1	0	1
Total DCFC	**0**	**4**	**1**	**0**	**1**
Total	**28**	**174**	**211**	**23**	**108**

Figure 4-2, below, shows the statewide distribution of the activated, in flight, committed, application submitted, and lead generation Level 2 and DCFC stations throughout Massachusetts as of December 31, 2019, overlaid with National Grid's service territory.

Figure 4-2. Level 2 and DCFC Stations in Massachusetts – PY1



Charging Program Station Development Cost Analysis

The Charging Program funds 100% of the costs of electric service upgrades needed for Level 2 and DCFC stations. These "infrastructure costs" include all utility infrastructure necessary for the station installation, but do not include costs for signs, painting, aesthetics, or other in-house work performed at the sites.

The program also provides rebates for the EVSE costs for Level 2 stations. These EVSE rebates range from 50% to 100%, based on the targeted charging segment for Level 2 stations. The program covers 50% of the EVSE costs of Level 2 stations at workplace and MUD facilities, 75% of the EVSE costs at public/municipal facilities, and 100% of the EVSE costs at facilities located in communities meeting two or more EJ criteria. The equipment costs for DCFC stations are not eligible for rebates from National Grid. Additionally, networking and maintenance fees are typically not eligible for EVSE rebates, though National Grid did run a promotion to fund networking fees from August through December 2019; a total of seven projects had networking fees funded in PY1.

The ERS Team analyzed the infrastructure and EVSE costs for PY1 to summarize the "reported costs," which include all costs listed in project invoices, and the "rebated costs," which reflect only the portion of the reported costs that are eligible for rebates through the program. Total rebated and reported costs are presented in Tables 4-7 and 4-9, respectively, while Tables 4-8

and 4-10 present average per-station rebated and reported costs. This analysis is based on the 108 activated stations included in National Grid's program tracking spreadsheet.

The 107 Level 2 stations reporting data span three segments: MUD, publicly accessible, and workplace stations. The average total per-station cost (including installation and EVSE costs) was $15,317, and the infrastructure costs represented 47% of overall project costs.

Only one DCFC station reported costs, with a total reported project cost (including installation and EVSE costs) of $86,118; the infrastructure portion of this station cost, which was eligible for National Grid rebates, was $46,825. EVSE costs for DCFC stations are not eligible for rebates under the Charging Program. Note that this DCFC station was co-installed alongside five Level 2 stations at the same facility and shared infrastructure costs could not be precisely allocated to the two charger types; as such, this infrastructure cost should be considered approximate but reflective of expected DCFC infrastructure costs.

It should also be noted that the total rebated electrical infrastructure costs (shown in Table 4-7) exceed the total reported electrical infrastructure costs (shown in Table 4-9). Based on discussions with the implementation team, the ERS Team determined that this was the result of several factors, primarily that approximately 13 projects processed through the prescriptive application were paid a fixed installation rebate of $4,000 per port regardless of the actual installation cost. National Grid has since updated the prescriptive application language to limit the rebate to not exceed actual costs. Program-wide, 79% of reported costs and 55% of EVSE costs were funded by the program.

Table 4-7. Charging Program Rebated Costs (Total) – PY1

Charging Level	Segment	Number of Stations	Total Rebated Costs		
			Electrical Infrastructure Rebates (Total)	EVSE Rebates (Total)	Charging Program Rebates (Total)
Level 2	MUD	3	$23,288	$16,696	$39,984
	Public	67	$497,912	$346,002	$843,913
	Workplace	37	$307,169	$131,098	$438,267
Total Level 2		**107**	**$828,368**	**$493,796**	**$1,322,164**
DCFC	Public	1	$46,825	$0	$46,825
All		**108**	**$875,193**	**$493,796**	**$1,368,989**

Table 4-8. Charging Program Rebated Costs (Per Station) – PY1

Charging Level	Segment	Number of Stations	Per Station Rebated Costs		
			Electrical Infrastructure Rebates (Per Station)	EVSE Rebates (Per Station)	Charging Program Rebates (Per Station)
Level 2	MUD	3	$7,763	$5,565	$13,328
	Public	67	$7,432	$5,164	$12,596
	Workplace	37	$8,302	$3,543	$11,845
Total Level 2		**107**	**$7,742**	**$4,615**	**$12,357**
Total DCFC		**1**	**$46,825**	**$0**	**$46,825**

Table 4-9. Charging Program Reported Project Costs (Total) – PY1

Charging Level	Segment	Number of Stations	Total Reported Costs		
			Reported Electrical Infrastructure Cost (Total)	Reported EVSE Cost (Total)	Reported Charging Program Costs (Total)
Level 2	MUD	3	$27,288	$32,323	$59,611
	Public	67	$441,944	$483,599	$925,543
	Workplace	37	$307,093	$346,656	$653,750
Total Level 2		**107**	**$776,325**	**$862,578**	**$1,638,903**
DCFC	Public	1	$48,625	$37,493	$86,118
All		**108**	**$824,950**	**$900,071**	**$1,725,021**

Table 4-10. Charging Program Reported Project Costs (Per Station) – PY1

Charging Level	Segment	Number of Stations	Per Station Reported Costs		
			Reported Electrical Infrastructure Cost (Per Station)	Reported EVSE Cost (Per Station)	Reported Charging Program Costs (Per Station)
Level 2	MUD	3	$9,096	$10,774	$19,870
	Public	67	$6,596	$7,218	$13,814
	Workplace	37	$8,300	$9,369	$17,669
Total Level 2		**107**	**$7,255**	**$8,061**	**$15,317**
Total DCFC		**1**	**$48,625**	**$37,493**	**$86,118**

Environmental Justice Communities

In addition to paying for infrastructure and service upgrades, National Grid provides rebates for 100% of the EVSE costs for Level 2 charging stations located in EJ communities. EJ communities, as defined by the program, are locations that meet two or more of the following criteria:

1. Annual median household income is less than or equal to 65% of the statewide median
2. 25% or more of the residents identify as a race other than white

3. 25% or more of the households in the community have no one over the age of 14 who speaks fluent English

The ERS Team verified the tracked EJ community status for the activated and in-flight charging stations by overlaying geospatial data for these stations with EJ map data downloaded from Mass.gov; the team conducted additional verification using the Environmental Justice Viewer, available through the Massachusetts Geographic Information System (GIS) website.[37] This analysis identified several stations that did not align with the Project Tracking spreadsheet. The ERS Team will seek to resolve these discrepancies with National Grid once the full PY1 report is finalized.

Based on the verification results, shown below in Table 4-11, 20% of the activated and in-flight sites – and 27% of the activated and in-flight stations – meet the program's EJ requirements as of December 31, 2019, which exceeds National Grid's program goal of developing 10% of Level 2 projects in EJ communities.[38] In total, 54% of the programs' activated and in-flight sites (and 60% of stations) are located in communities that meet at least one of the EJ criteria. Note that this analysis only covered activated and in-flight stations, which are more likely to have near-complete address information and are the most developed projects.

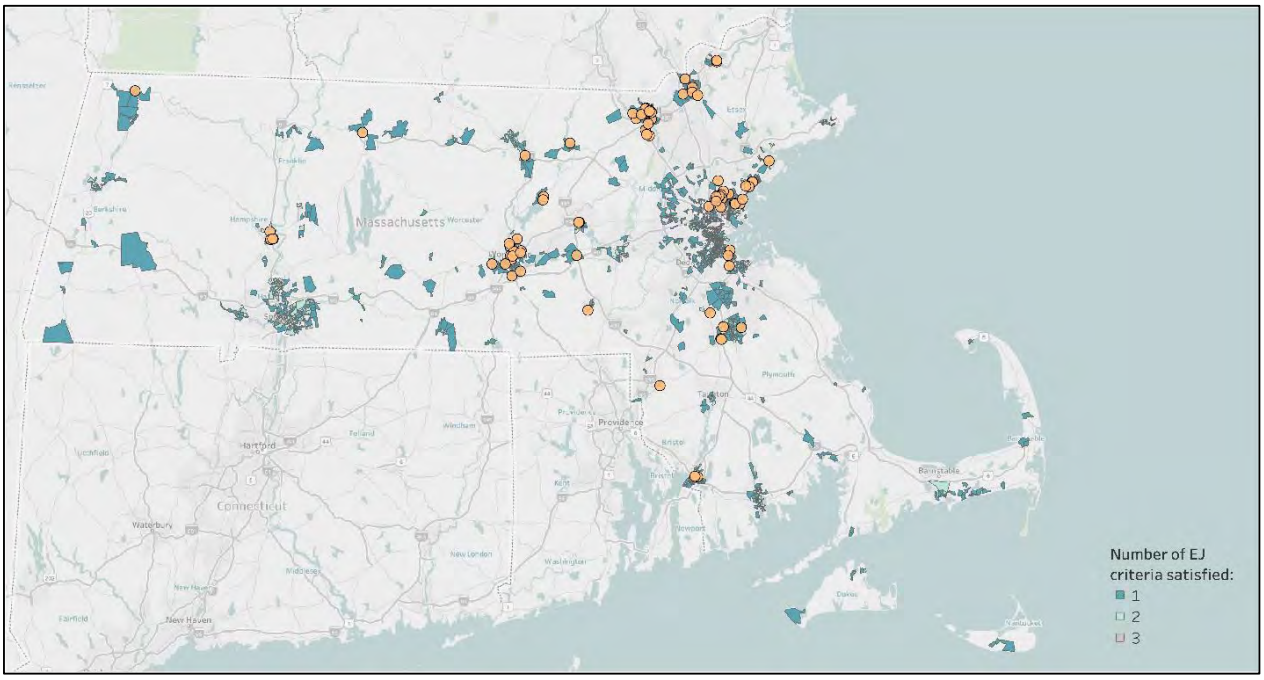
Table 4-11. Results of ERS Environmental Justice Community Status Verification

EJ Community Status	Station Count: Tracking	Station Count: Verified	Station Count: Percent of Total (Verified)	Site Count: Tracking	Site Count: Verified	Site Count: Percent of Total (Verified)
No	68	53	40%	36	30	46%
One criterion	25	43	33%	15	22	34%
2+ criteria	38	35	27%	14	13	20%
Total	**131**	**131**	**100%**	**65**	**65**	**100%**

The map below presents a visual look at the concentration and distribution of EJ communities in Massachusetts overlaid with points representing the charging stations located in EJ communities; charging stations not located in EJ communities are not shown in this figure. The shaded blocks represent EJ communities across the Commonwealth; some of these regions are outside of National Grid's service territory. Most of the EJ community charging stations within National Grid territory are concentrated in a handful of localities, including Brockton, Worcester, Lowell, and communities north of Boston.

[37] Massachusetts Environmental Justice Viewer, http://maps.massgis.state.ma.us/map_ol/ej.php.
[38] Revised Exhibit KAB/BJC-1, Page 35 of 65, Lines 8-10.

Figure 4-3. Massachusetts Environmental Justice Community EV Charging Stations



In the statewide map, it is difficult to decipher the individual EJ criteria. The context can be better understood by examining a regional map zoomed in on the Worcester metro area. In Figure 4-4, below, dark blue areas are communities that meet one EJ criterion, light blue areas satisfy two, and gray areas meet all three; the yellow dots represent station locations, as in the figure above.

Figure 4-4. Massachusetts Environmental Justice Community Worcester Regional Map

4.4.3 Charging Station Utilization Analysis

The Charging Program requires a minimum of five years of network monitoring for each station installed through the program. Charging data are reported to National Grid by the EVSE suppliers. The ERS Team analyzed charging data from 86 Level 2 Stations and 1 DCFC Station (165 ports in total) in PY1 to help National Grid understand station utilization in Massachusetts. The actively-reporting stations were all activated between January 2019 and December 2019; charging data were available from February 2019 through December 2019.

It should be noted that, while charging station utilization is a valuable metric to track, it should not be seen as the only indicator of a successful installation. Charging stations deployed throughout National Grid's service territory (as illustrated in Figure 4-2) can help to improve the awareness of EVs and the availability of charging infrastructure for drivers who currently drive gas-powered vehicles, and provide reassurance for EV drivers with range anxiety. That said, tracking station utilization provides insight into how often, how long, and when charging stations are used, all information that can be used to inform future station deployment and charging infrastructure programs, support new rate designs, and develop marketing materials for prospective program participants.

Charging Station Data Description

Data from participating stations was provided to the ERS Team by the EVSEs via National Grid. For each charging session, the charging data includes, but is not limited to, the following fields:

- Charging session starting and ending timestamp
- Unique station identification code (Station ID)
- Unique charging session identification code (Session ID)
- The total charged energy per plug-in event (kWh)

The ERS Team observed that the quality and amount of data varied across vendors, though all vendors that delivered data provided all of the fields listed above. One vendor provided additional data, including a unique driver ID for each charging session and the ZIP code in which the charging vehicle was registered. While not required for the purposes of this evaluation effort, these additional fields could enable ERS to further assess station utilization for that vendor's stations to gain an understanding of how many drivers and localities are impacted by a given charging station. This analysis is planned for PY2 and PY3 pending that provider's continued provision of those data fields and the potential expansion of this data to other EVSE suppliers.

Utilization Results

Table 4-12 provides an overview of the charging data analyzed in PY1. Overall, 98% of charging sessions and 97% of the total charged energy (kWh) came from Level 2 stations. Note that this utilization analysis does not include all stations in the Project Tracking spreadsheet that have an "installation complete" or "activated" status; charging data were only provided for 87 stations in PY1, and the analysis is therefore limited to only those stations for which data sets were available. Further, all of the analysis results in this section are based on charging data from chargers that could be matched to a project in the tracker and that passed quality control checks designed to flag invalid or inaccurate data.

Table 4-12. PY1 Charging Station Utilization Data Overview

Data	Level 2	DCFC	Total
Number of stations	86	1	87
Number of ports	164	1	165
Number of charging sessions	9,795	162	9,957
Charging energy consumed (kWh)	106,011	2,826	108,837
GHG savings (kg)	64,687	1,724	66,412
Average charging energy per station (kWh)	1,233	2,826	1,251
Average charging energy per session (kWh)	11	17	11

The 87 charging stations that reported data in PY1 are located at a total of 42 facilities, with several facilities containing multiple stations. Because drivers tend to choose whichever port or station is available when they arrive at a charging location with multiple options, it is reasonable to consider co-located stations as a single station-location; this approach also streamlines the utilization analysis. Table 4-13 summarizes the utilization of the co-located chargers for PY1 across multiple metrics; the anonymized stations are ordered from earliest to latest "first charge" date. The methodology employed to calculate GHG savings is described below the table.

Table 4-13. Charging Station Utilization by Station

Station Identifier[a]	Station Activation Date	Station Use	Number of Stations	Charging Session Count	Energy Charged (kWh)	Average kWh per Session	Average Charging Sessions Per Week	GHG Savings (kg)
EVSE 27	02/05/19	Public	1	37	207	6	1	126
EVSE 16	03/02/19	Public	1	18	274	15	0	167
EVSE 6	03/29/19	Public	1	311	4,813	15	8	2,937
EVSE 7	03/29/19	Public	3	115	1,128	10	3	688
EVSE 26	04/17/19	Public	1	571	6,120	11	15	3,734
EVSE 29	05/04/19	Public	3	1,371	11,884	9	40	7,252
EVSE 33	05/21/19	Workplace	4	490	7,898	16	15	4,819

Station Identifier[a]	Station Activation Date	Station Use	Number of Stations	Charging Session Count	Energy Charged (kWh)	Average kWh per Session	Average Charging Sessions Per Week	GHG Savings (kg)
EVSE 21	05/22/19	Public	1	135	1,022	8	4	623
EVSE 34	05/29/19	Workplace	2	565	6,302	11	19	3,845
EVSE 20	05/30/19	Public	1	214	1,618	8	7	988
EVSE 8	05/30/19	Public	1	91	898	10	3	548
EVSE 13	06/02/19	Public	4	394	3,225	8	13	1,968
EVSE 11	06/04/19	Public	4	181	1,487	8	6	907
EVSE 12	06/04/19	Public	4	547	6,994	13	18	4,267
EVSE 9	06/05/19	Public	2	37	326	9	1	199
EVSE 35	06/06/19	Public	2	140	2,373	17	5	1,448
EVSE 10	06/07/19	Workplace	1	63	1,185	19	2	723
EVSE 36	06/10/19	Public	2	293	2,444	8	10	1,491
EVSE 37	06/16/19	Public	2	347	2,549	7	12	1,555
EVSE 19	06/20/19	Public	1	39	309	8	1	188
EVSE 17	06/26/19	Public	1	417	4,632	11	15	2,826
EVSE 31[b]	06/27/19	Public	1	90	846	9	3	516
EVSE 30[b]	06/29/19	Public	2	349	3,876	11	13	2,365
EVSE 18	07/02/19	Public	2	153	1,032	7	6	630
EVSE 1	07/20/19	Public	5	239	1,765	7	10	1,077
EVSE 2 (DCFC)	07/23/19	Public	1	162	2,826	17	7	1,724
EVSE 38	07/29/19	Workplace	8	900	11,730	13	41	7,157
EVSE 5	08/05/19	Public	1	42	351	8	2	214
EVSE 32	08/06/19	Public	1	12	64	5	1	39
EVSE 23	08/08/19	Public	1	671	5,006	7	34	3,054
EVSE 22	08/13/19	Public	1	438	4,571	10	22	2,789
EVSE 3	08/14/19	Public	1	2	22	11	0	13
EVSE 4	08/25/19	Public	1	30	119	4	2	73
EVSE 15	09/13/19	Workplace	4	194	3,332	17	13	2,033
EVSE 28[b]	10/07/19	Workplace	1	60	1,625	27	5	992
EVSE 14	10/11/19	Public	2	17	65	4	2	40
EVSE 161	11/13/19	Public	2	16	160	10	2	97
EVSE 191	11/21/19	Workplace	2	98	1,969	20	20	1,202
EVSE 138	11/24/19	Workplace	3	16	244	15	3	149
EVSE 171	11/27/19	Workplace	2	57	1,088	19	11	664
EVSE 202	12/11/19	Workplace	4	35	461	13	14	281
Total			**87**	**9,957**	**108,837**			**66,412**

[a] All stations, unless otherwise noted, are Level 2 charging stations.

[b] EVSEs 28, 30, and 31 are listed as "Committed" customers in the Project Tracker; all other stations have a status of "Activated."

GHG emissions impacts – As part of the utilization analysis, the ERS Team assessed the GHG emissions impact of the charging stations incentivized by the program. The analysis assumes that the electric-driven miles enabled by the program-incentivized charging stations would have otherwise been driven with internal combustion engine vehicles (ICEVs). Savings are calculated as the difference between offset tailpipe emissions and the added grid load from EV charging. The methodology for this analysis was developed by ERS and National Grid and is outlined in Appendix A. Please note the following regarding this analysis:

- The ERS Team does not attribute GHG savings to the program; that is, ERS does not imply that any National Grid customers purchased EVs (and drove electric miles) as a direct result of program activity. ERS did not evaluate incremental EV adoption for PY1, but in consultation with National Grid, we may elect to asses any impacts in PY2 or PY3.
- The program explicitly increases grid load, and thus GHG emissions, relative to the baseline condition (fewer charging stations) by facilitating the deployment of EV charging stations. GHG emissions savings can be realized relative to a baseline scenario in which all driving is done with ICEVs through the enablement of electric driving that would have otherwise been conducted using an ICEV. However, it is likely that existing EV owners still would have been able to charge their vehicles in the absence of this program, most likely via home charging as evidenced in the baseline general population survey results.
- This analysis considered CO_2 impacts alone and did not consider other criteria pollutants, such as SO_x and NO_x.

Most utilized Level 2 stations – Additionally, the ERS Team conducted a deeper analysis of the five Level 2 stations with the greatest number of charging sessions per week in order to identify commonalities between high-utilization installations. Table 4-14 highlights the utilization metrics of these stations.

Table 4-14. Charging Station Utilization of Top 5 Charging Stations

Station Identifier	Station Use	Number of Stations	Charging Session Count	Energy Charged (kWh)	Average Charging Sessions Per Week	Average kWh per Session
EVSE 38	Workplace	8	900	11,730	41	13
EVSE 29	Public	3	1,371	11,884	40	9
EVSE 23	Public	1	671	5,006	34	7
EVSE 22	Public	1	438	4,571	22	10
EVSE 191	Workplace	2	98	1,969	20	20

A review of these sites shows that three of them are located in parking garages in large cities and two are located at workplaces. Drivers at all of these locations have the opportunity to charge for several hours while they work or shop in town. This suggests that charging stations

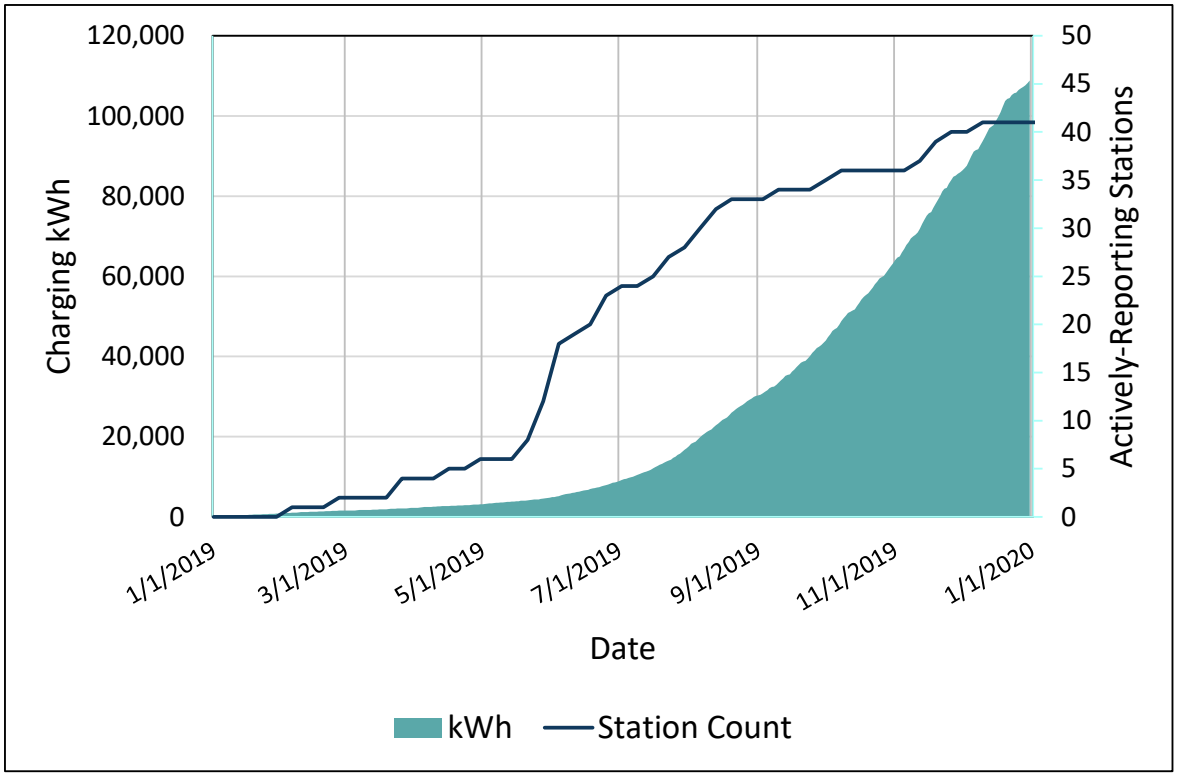
in high-traffic or high-visibility areas, or at workplaces where employees own EVs, may achieve high utilization because EV drivers are aware of them and are able to integrate them into their day-to-day habits. Further research would be required to determine whether signage, the station's fee structure, additional marketing by site hosts, or other factors contributed to the high utilization of these stations.

Figure 4-5, below, shows the spatial distribution of the five stations with the highest number of charging sessions per week; note that there are two overlapping stations in the Northampton area.

Figure 4-5. Map of Five Highest-Utilization Level 2 Stations by Charging Sessions per Week

Station development and charging kWh – As noted above, the program is making steady progress towards its goals, with 108 activated stations and 87 stations actively reporting charging data since January 2019. While the amount of charging (kWh) initially lagged the growth in the number of active charging stations, it began to increase rapidly starting around June 2019, as shown in Figure 4-6, below. This suggests there may be a natural time lag between station activation and when EV drivers become aware of a new charging station in their area.

Figure 4-6. Growth in Reporting Station Count and Charging Activity Over PY1



Station Utilization by Station Use and Segment

In PY1, 64% of the 87 stations reporting charging data were classified as "public" in the Project Tracking spreadsheet, with the remaining 36% classified as "workplace" charging stations. While three Level 2 MUD stations have been activated through PY1, none reported data prior to December 31, 2019. Program staff indicated that they received significant interest from municipalities and other public entities for Level 2 stations, which is reflected in the program's progress to date, as well as the amount of charging that has taken place at public charging stations. Table 4-15 provides an overview of the utilization data by segment.

Table 4-15. Charging Station Utilization Breakdown by Station Use and Segment (Level 2 and DCFC)

Segment		Station Count	Percent of Total Stations	Total kWh	Percent of Total kWh
Public	Hospital	10	11%	9,408	9%
	Municipal	38	44%	56,167	52%
	Office	3	3%	434	0%
	Recreational/sports	3	3%	1,341	1%
	Retail	1	1%	4,632	4%
	School/University Parking	1	1%	1,022	1%
Total Public		**56**	**64%**	**73,004**	**67%**
Workplace	Hospital	2	2%	6,302	6%
	Industrial	18	21%	15,147	14%
	Municipal	1	1%	1,185	1%
	Office	2	2%	1,969	2%
	School/University Parking	8	9%	11,230	10%
Total Workplace		**31**	**36%**	**35,833**	**33%**
Overall Total		**87**	**100%**	**108,837**	**100%**

Table 4-15, above, shows that the stations installed at "municipal" sites – which consist primarily of public parking lots and garages – represent 52% of the total weekly charging sessions recorded in PY1. The second and third most-utilized segments are industrial, which is mostly office buildings, and school/university parking, both of which offer opportunities for long-dwell-time charging.

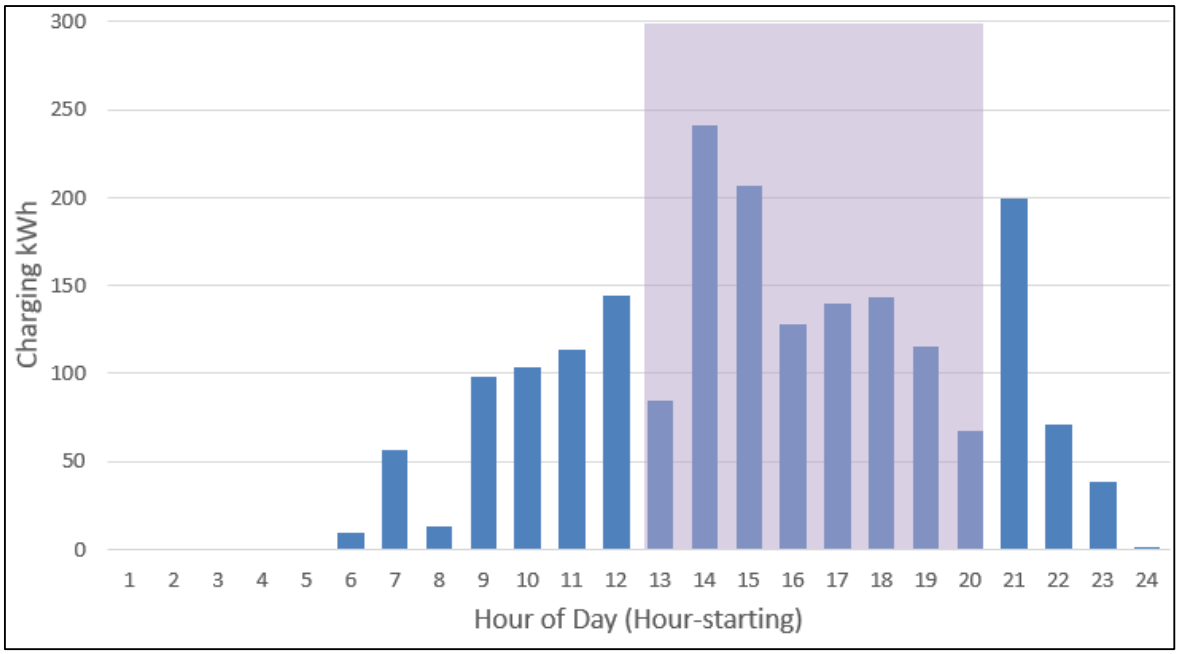
Case Study: Massachusetts DCFC Station

As part of the PY1 analysis, the ERS Team developed 24-hour charging load profiles for each of the actively reporting charging stations. For each charging station, we calculated the total hourly load (in kWh) across all days in each station's active window (from the charger's first recorded charge through December 31, 2019). Only data that passed QC was included in the analysis. The load profile of the program's lone DCFC station was analyzed to determine the extent to which its peak coincided with National Grid's 1 p.m. to 9 p.m. peak period in Massachusetts. This profile serves as the backdrop for a brief discussion of how an energy storage system (ESS), co-located with this station, could help manage EV charging load.[39]

[39] The ERS Team understands that capital costs are already a significant barrier to DCFC station deployment, and co-located energy storage would only increase upfront costs. However, this discussion is intended to highlight the potential for future interaction between mutually beneficial distributed energy resources to encourage greater grid participation, ease grid congestion, and facilitate cost and load management for both site hosts and National Grid.

The load profile presented in Figure 4-7, below, is for the program's only DCFC station, which has one charging port. The light purple box indicates the on-peak period hours of 1 p.m. to 9 p.m.; note that the box cuts off slightly before the 9 p.m. data point to make clear that the overhanging point represents off-peak charging activity (in the 9 p.m. to 10 p.m. hour).

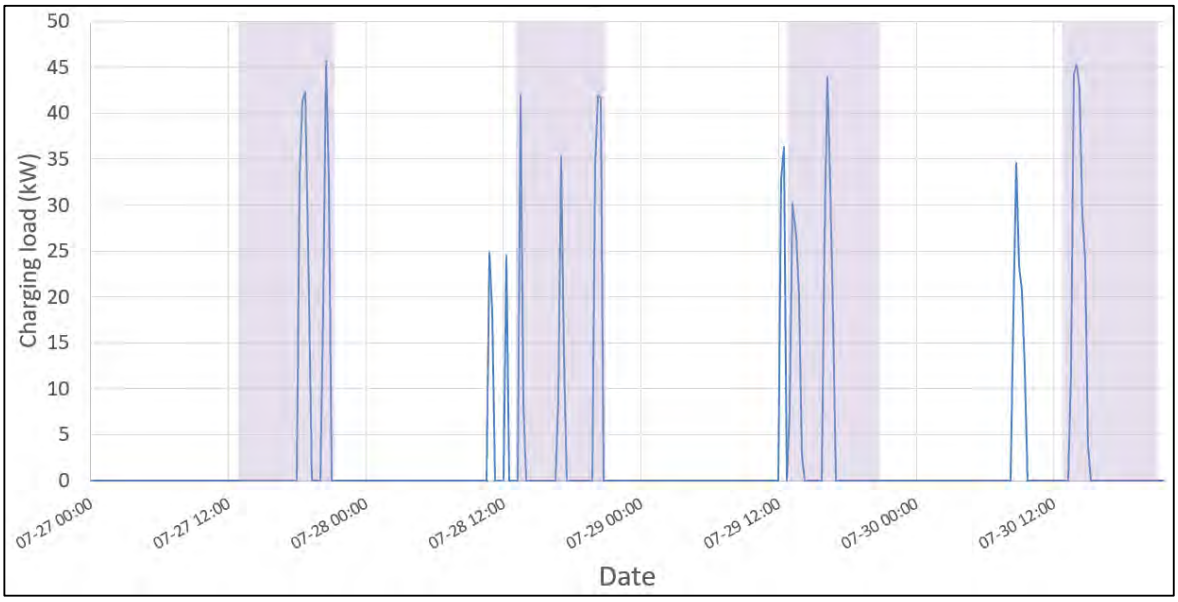
Figure 4-7. 24-Hour Average Charging Load Profile – DCFC Station



This charging station is publicly accessible and is located at a small office park off of Interstate 495 in northern Massachusetts; it is classified as a workplace site. The station experiences intermittent utilization throughout the day, as demonstrated by its spiky shape, and is effectively unused overnight, as would be expected for a public charger. On average, the station provided eight charging sessions per week in PY1. A significant portion of the load occurs within the peak period.

Figure 4-8, below, shows the station's activity across four days in late July. The station is used sporadically but draws a significant amount of power when in use. Several of the approximately 45 kW demand spikes occur on-peak, which is indicated by the purple shaded boxes.

Figure 4-8. DCFC Station Load Profile – 7/27/19–7/30/19



To manage load at a DCFC station such as this one, a charging station operator might choose to co-locate an ESS alongside the charger to provide non-grid power for charging EVs. Energy storage, most commonly using lithium-ion batteries, is well-suited for high-power, short-duration applications such as DCFC, and has experienced rapidly decreasing costs and expanding deployment in recent years. An ESS would allow the station operator to clip charging load peaks throughout the year to manage utility demand charges and to earn additional revenue through participation in utility DR programs. Recent research suggests that existing demand charge structures may hinder the continued deployment of DCFC stations in all but the highest-traffic corridors.[40] Outside of high-traffic corridors that experience high utilization, station operators may lack confidence that they will make up the cost of demand charges through user volume.

4.4.4 Upcoming Activities for PY2 and PY3

The ERS Team will conduct similar analyses of program progress and station utilization during PY2 and PY3 to report annual progress against program goals.

[40] Great Plains Institute, "Analytical White Paper: Overcoming Barriers to Expanding Fast Charging Infrastructure in the Midcontinent Region," July 2019, https://www.betterenergy.org/wp-content/uploads/2019/08/GPI_DCFC-Analysis.pdf.

4.5 General Population Survey

This section summarizes key takeaways from the general population survey executed by the ERS Team to provide insight into the attitudes, awareness, and likely adoption of EVs among National Grid customers. We received 642 survey responses from residential customers who live or work in National Grid's electric or combination-fuel (electric and gas) service territory (referred to as general population). The ERS Team administered the survey from November 5 through November 24, 2019. About two-thirds of the respondents are electric-only National Grid customers and 30% are combination-fuel; the remaining 4% confirmed that they work in National Grid's electric or combination territory but did not confirm that they live there.

Of the 642 general population completes, 13 are EV owners and 44 live or work in the three communities targeted for the community survey (Lowell, Haverhill, and Boxford). As such, there is limited overlap with the EV owner survey results, and some overlap with the community survey results. This section describes the results of the general population survey with the following subsections:

- Vehicles and travel behavior
- Market awareness of EVs
- Perceptions and purchase consideration of EVs
- Charging station awareness
- Demographics

4.5.1 Initial Evaluation Findings: General Population Surveys

The key findings from the general population survey are summarized here:

- **While the general population is aware that EVs exist and many can name a make or model, few customers feel they know a lot about EVs, and many don't know how EVs compare to conventional vehicles.** About two-thirds of non-EV owners (69%) said, *"I know a little about this"* to one of four aspects of EVs – driving range, makes/models, how or where to charge, and difference between battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). However, only about 10% of non-EV owners felt they knew a lot about each one of the four aspects of EVs. Just under three-quarters (72%) felt that they could name at least one EV make or model. Tesla and Prius were the most common mentions.
- **The value proposition of EVs may be unclear, and many customers aren't sure if the EVs on the market could meet their daily needs.** Nearly half of customers (48%) answered "don't know" or "neutral" to whether EVs could meet their daily needs. Even more customers were unsure or neutral about whether EVs are more fun to drive than

conventional vehicles (75%), as reliable (56%), more expensive to maintain (54%), or better for the environment (48%). In EV owner surveys, many owners expressed surprise at the performance and fun of their vehicle, indicating performance benefits may not have been evident prior to purchase. These findings suggest that customers could benefit from more direct education.

- **Upfront price and driving range emerged as the biggest questions and concerns that non-EV owners have about EVs. Questions about where to charge also rose to the top.** Customers would also consider the following factors before purchasing an EV: maintenance needs, the cost of ownership, how long the battery will last before it needs replacement, and how much charging will cost. However, these practical concerns were not mentioned as much in open-ended questions, where perceptions of high cost, insufficient driving range, and limited charging options (despite 72% having seen stations in MA) dominated the comments.
- **Long trips – across Massachusetts and out-of-state – are top-of-mind for non-EV owners thinking about whether an EV could meet their needs.** Nearly half (47%) of non-owners felt that the EVs on the market wouldn't meet their needs for long trips. Concerns about longer trips centered on driving range and a perception that there aren't enough places to charge. Some mentioned a specific range that would meet their criteria, most commonly 300 miles (and some wanted 400 miles). When customers described a "long trip" scenario they mentioned places outside of National Grid's territory like Cape Cod, Western Massachusetts, New Hampshire, Maine, and New York. This suggests that if National Grid were to perform mass market education in the future, consumer education campaigns about charging station availability could integrate information across and outside of National Grid territory to demonstrate the emerging network growing around and near highway corridors throughout the Northeast.
- **Many non-EV owners have seen charging stations in Massachusetts, including stations close to their home or work.** Nearly three-quarters (72%) of non-EV owners reported seeing EV charging stations in Massachusetts, most commonly at retail locations (including restaurants, convenience stores, pharmacies, and malls) and paid public parking. Just under one-quarter (24%) have seen one in a travel plaza or highway rest stop, and 12% at a gas station. About one-third of commuters have seen a charging station within 10 minutes of work, and 10% report a charging station at their work or school. About 20% of non-EV owners think there is a charging station within 10 minutes of their home.
- **Despite seeing charging stations in public locations, around home or work, these personal experiences have not yet translated to reduced anxiety about charging options**

and range. About 62% of non-EV owners felt that, "*If I had an electric vehicle, I'd always worry about where to charge it,*" and 61% felt that, "*If I had an electric vehicle, I'd constantly worry about running out of battery*." Respondent comments showed a sentiment that charging stations were few and far between, sometimes based on what they could or couldn't personally see, suggesting that the visibility (and recognition) of charging stations may be important. Some customers expressed an expectation that they should be as common as gas stations. Given non-EV owner concerns about charging on longer trips, there may be a mismatch between the locations where people have seen charging stations versus where they may expect to find them on long trips (highway corridors, gas stations).

- **Some customers felt that the EVs on the market may not meet their needs due to drivetrain, towing, trailering, or cargo capacity.** In addition to concerns about where to change, the drivetrain may be a short-term hurdle: nearly two-thirds of respondents said their primary vehicle is all-wheel drive (AWD) or four-wheel drive (47% and 16%, respectively; 63% together), which may present short-term challenges for EV options in Massachusetts.
- **Although customers are taking action to learn about and experience EVs, more direct education may be helpful if National Grid is approved for outreach and education in the future.** About 20% of non-EV owners said they've spoken with an EV owner (friend, family, colleague, etc.), and 9% reported driving someone else's EV. Nearly one-quarter (22%) have read customer reviews, 19% have researched pricing, and 12% have looked at vehicle specifications. Slightly fewer customers reported actions relating to charging – 14% had looked for nearby charging stations and 5% had researched charging costs.

4.5.2 Vehicles and Travel Behavior

Vehicle Ownership

About 92% of respondents own at least one household vehicle. Almost half (47%) of these households have two vehicles, while one-third (33%) reported one vehicle, and 20% reported three or more.

The survey asked about the characteristics of the vehicle the respondent drives most often. Very few respondents (2%) reported driving an EV (either a BEV or PHEV). In total, 92% of respondents reported a gas-only vehicle, 5% reported a conventional hybrid, 1.2% reported a PHEV, 1% reported a BEV, and less than 1% reported diesel. A total of 4% of respondents reported owning an EV in response to the question, "*How many electric vehicles does your household own?*" However, when asked about its engine and fuel type, many of these respondents reported a conventional hybrid rather than an all-electric or PHEV. This points to market confusion around EVs compared to hybrids, which we discuss further below.

The survey asked about the characteristics of the vehicle the respondent drove most often. Nearly two-thirds of respondents said their primary vehicle was AWD or four-wheel drive (47% and 16% respectively; 63% together). Some customers expressed in comments to other questions that the EVs on the market today would need to be AWD or 4WD to meet their needs. The most common body styles are passenger car (46%) and SUV (41%). Considerably fewer drive a truck (8%) or van/minivan (3%), both of which have limited availability among EVs currently on the market.

The majority of respondents have private parking, either in a driveway (48%) or a garage or carport (33%). About 16% park in some kind of shared space, either a shared parking lot (e.g., condo parking, 6%), shared driveway (5%), or shared garage or carport (4%). About 3% use on-street parking. Among those using shared parking, most (61%) have a dedicated or assigned space. This means that only about 10% of respondents park somewhere without a dedicated space (where setting up a personal charging station may be more challenging).

Travel and Commuting Behaviors

Nearly 70% of respondents reported that they travel regularly (commute) to work or school via car, public transportation, bicycle, or other means. Of these commuters, 64% work within National Grid's electric or combination fuel territory and 36% work outside of it. Considering that 30% of people don't commute, this means that fewer than half of all respondents (44%) commute for work within National Grid's electric or combination-fuel territory where they may encounter or need charging stations while commuting.

Among commuters who drive to work (the majority), average commuting time is highly variable, with one-third (33%) reporting a less-than-15-minute drive to work, while 37% drive 30 minutes or more. Among the 30% of respondents who do not commute regularly for work or school, 96% use a personal vehicle for most of their trips.

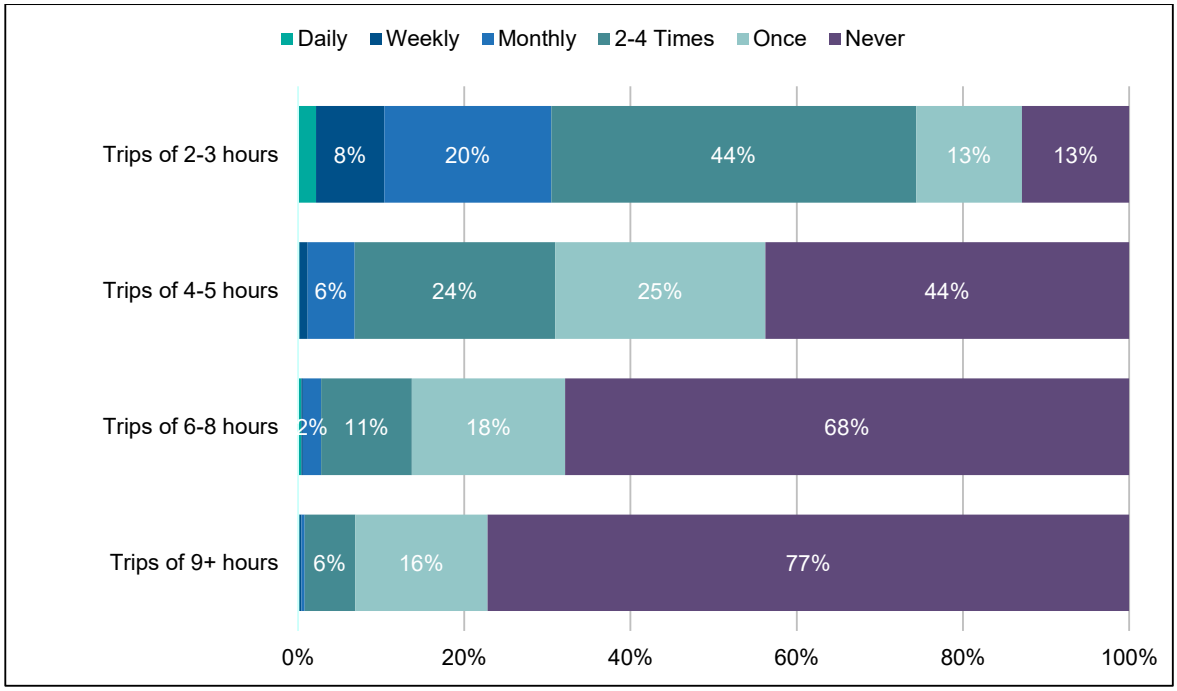
The majority of respondents drive 6,000 to 15,000 miles per year (59%), with 32% reporting 6,000 to 10,000 miles and 27% reporting 11,000 to 15,000 miles. Neary one-quarter reported driving over 16,000 miles per year.

Longer Trips

Most respondents reported driving up to 3 hours multiple times a year; respondents are significantly less likely to drive for longer periods of time (4 or more hours) in a given year. The survey asked everyone with a personal vehicle how often, in the last 12 months, they used it for longer trips (2+ hours). The majority of respondents (74%) took at least two trips of 2–3 hours in the past year, with nearly one-third (30%) taking a 2–3 hour trip at least monthly. Significantly fewer took at least two trips of 4–5 hours in the past year (31%) though an additional 25% said

they took a trip of this length once in the past year. About 55% of respondents said they took trips over 6 hours, and these households typically reported only one trip of this length.

Figure 4-9. Frequency of Long-Distance Trips in Personal Vehicle in Last 12 Months (n=558)



4.5.3 Market Awareness of EVs

EV Awareness

The ERS Team developed four questions to determine respondent awareness of EVs. For each of the items below, respondents were asked to select *"I know nothing about this," "I know a little about this,"* or *"I know a lot about this."*

- The driving range of EVs
- Different makes/models of EVs
- How or where to charge an EV
- The difference between BEVs (also known as "all-electric" vehicles) and PHEVs

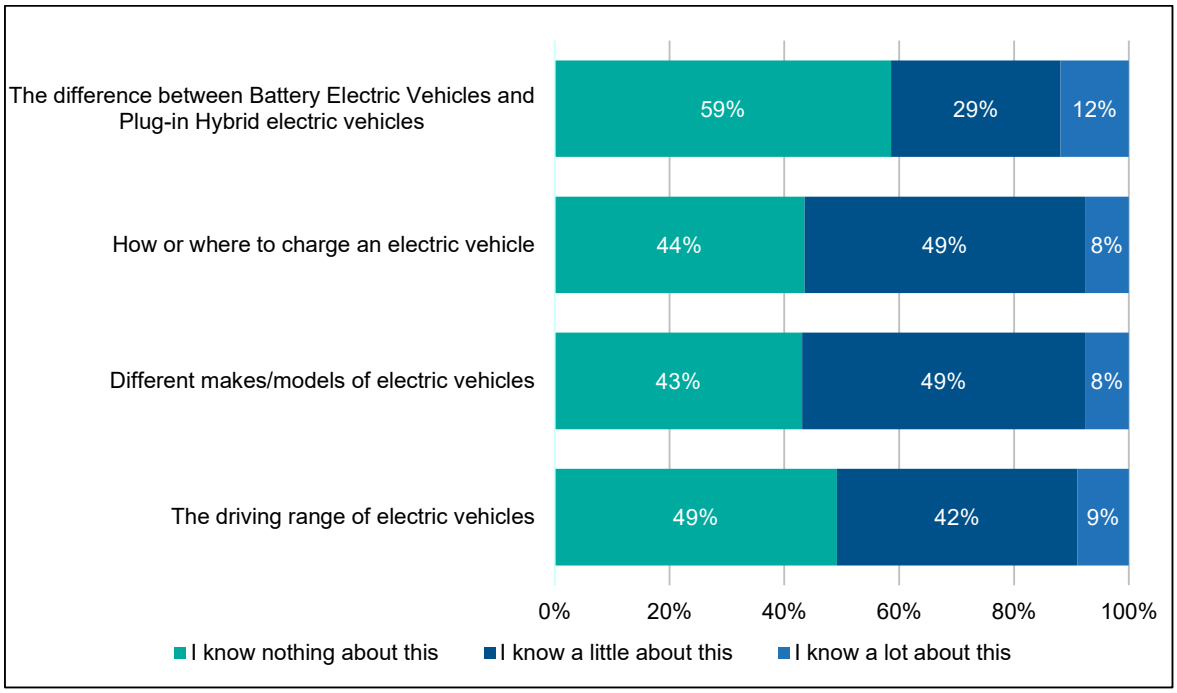
Anyone who reported at least *"I know a little about this"* to any of the four statements was classified as Aware. Anyone who reported *"I know nothing about this"* to all four statements was classified as Unaware.

About one-third (31%) of respondents reported they knew nothing about EVs (knew nothing about all four aspects) and most of those who reported some knowledge reported only knowing

a little about it. Figure 4-10, below, shows how respondents rated their knowledge of each aspect of EVs. Respondents were least aware of the difference between BEVs and PHEVs.

Related to the importance of infrastructure in overcoming barriers, nearly half of respondents (49%) said they knew a little about how or where to charge an EV, although only 8% said they knew a lot about this.

Figure 4-10. Knowledge of EVs Among Non-EV Owners (n=612)



Brand Awareness

We asked non-EV owners to list the first three makes and models of EVs that came to mind. Over one-quarter of respondents (28%) told us they "*don't know any makes or models of electric vehicles,*" while 72% of respondents provided at least one make or model as a response.

Of the non-owners who listed at least one make or model, Tesla and Prius were the most common mentions, with 71% of respondents mentioning a Tesla for the first, second, or third item. Of these, the majority (92%) said "Tesla" without a model name or number.

Nearly half of non-EV owners mentioned a Prius specifically as an EV (47%). An additional 10% mentioned Toyota in general or another Toyota model, such that 57% in total mentioned some type of Toyota. The third-most-common manufacturer mentioned was Chevrolet; 32% mentioned Chevrolet, and of these, the vast majority (92%) named the Bolt or Volt (Chevy's BEV and PHEV). Nissan came in fourth; 21% of respondents mentioned Nissan, and of these,

84% mentioned the Leaf by name. Appendix B has more detail on makes and models of EVs mentioned by non-EV owners.

While there is a Prius PHEV on the market (Prius Prime), only one respondent mentioned it by name ("Prius Prime"). The high number of Prius mentions (47% of all non-EV owners who provided a make or model) raises the question of whether some consumers may be conflating conventional hybrids like a Prius with EVs. On the other hand, since the Prius Prime is one of the highest-selling PHEVs, it is possible that some customers are aware that the Prius is available as a PHEV.[41]

Actions Taken Toward EV Education

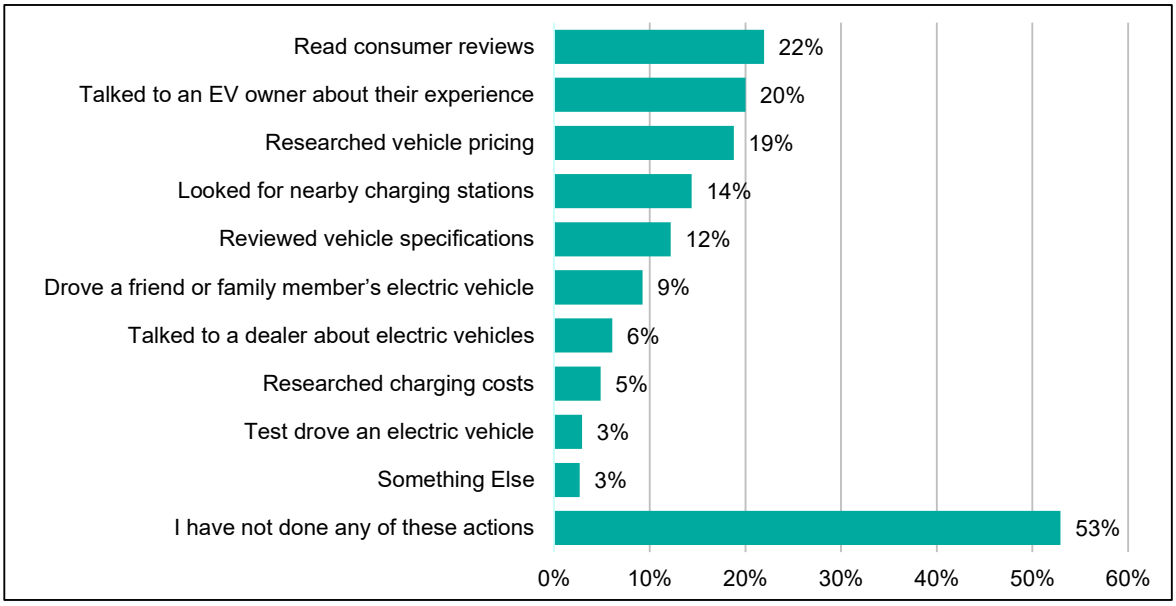
The survey asked the 69% of non-EV owners who were aware of EVs whether they had taken any specific actions toward learning more about EVs or driving them. Just under half (47%) reported taking some action related to EVs. Reading consumer reviews and research were common: 22% reported reading consumer reviews, 19% reported researching EV pricing, and 12% said they had reviewed vehicle specifications.

The second-most-reported action was talking to an EV owner about their EV experience (20%), and 9% said they test drove a friend or family member's EV. Respondents reported less interaction with dealers; only 6% reported talking to a dealer about EVs, and 3% reported test driving at a dealership.

Slightly fewer EV-aware, non-EV owners reported actions relating to charging – 14% had looked for nearby charging stations and 5% had researched charging costs.

[41] According to the website Inside EVs (https://insideevs.com/news/341931/toyota-prius-prime-was-us-1-selling-plug-in-hybrid-in-2018/), the Prius Prime was the highest-selling PHEV model nationally in 2018. In Massachusetts, Chevy Volt was the leader, with 25% of all PHEV registrations in MA, and the Toyota Prius Prime and Prius Plug-in together made up 21% of all PHEV registrations through Q2 2019. (Source: Analysis by ERS Team of IHS Markit Massachusetts EV Registration Data from Q2 2019. Data restricted to personal vehicles.)

Figure 4-11. Actions Taken Related to EVs (Among non-EV owners aware of EVs; n=410)



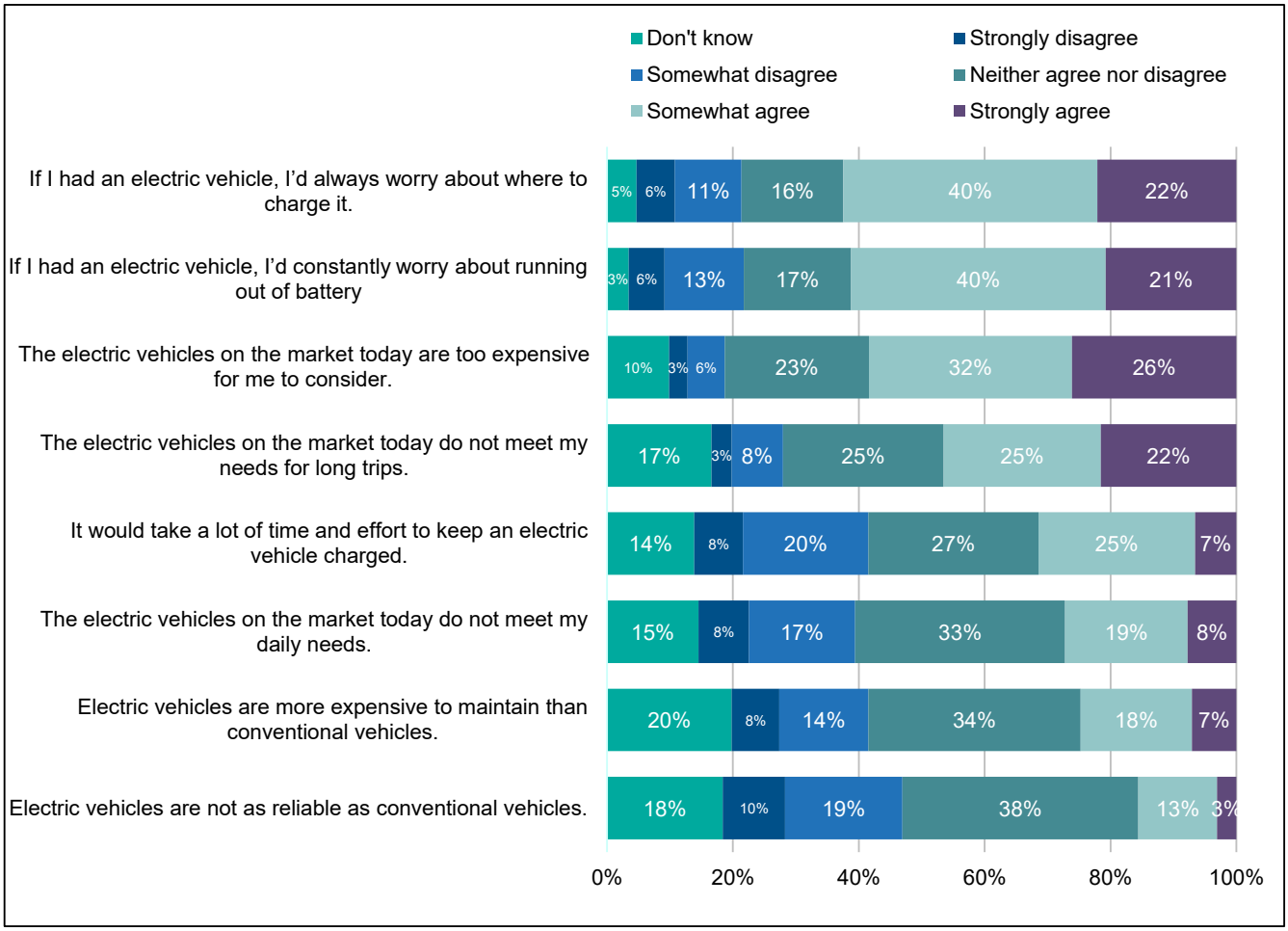
4.5.4 Perceptions and Barriers of EVs

According to the general population respondents, the top barriers to owning an EV are the price and concerns about range and charging. Nearly two-thirds (62%) of respondents agree (strongly or somewhat) that, *"If I had an electric vehicle, I'd always worry about where to charge it,"* and a similar proportion (61%) agree that, *"If I had an electric vehicle, I'd constantly worry about running out of battery."*

While about half (47%) of respondents strongly or somewhat agreed that the EVs on the market today would not meet their needs for long trips, only 27% thought that EVs wouldn't meet their daily needs, and 25% strongly or somewhat disagreed with this statement, suggesting that only about a quarter of people think an EV could meet their daily needs.

Perceived vehicle reliability and cost of maintaining EVs compared with conventional vehicles received the highest number of "don't know" and "neutral" responses. This suggests a lack of knowledge or understanding in these areas, indicating an opportunity for education.

Figure 4-12. Opinions of EVs Among Non-EV Owners
(Among non-EV owners aware of EVs; n=426)

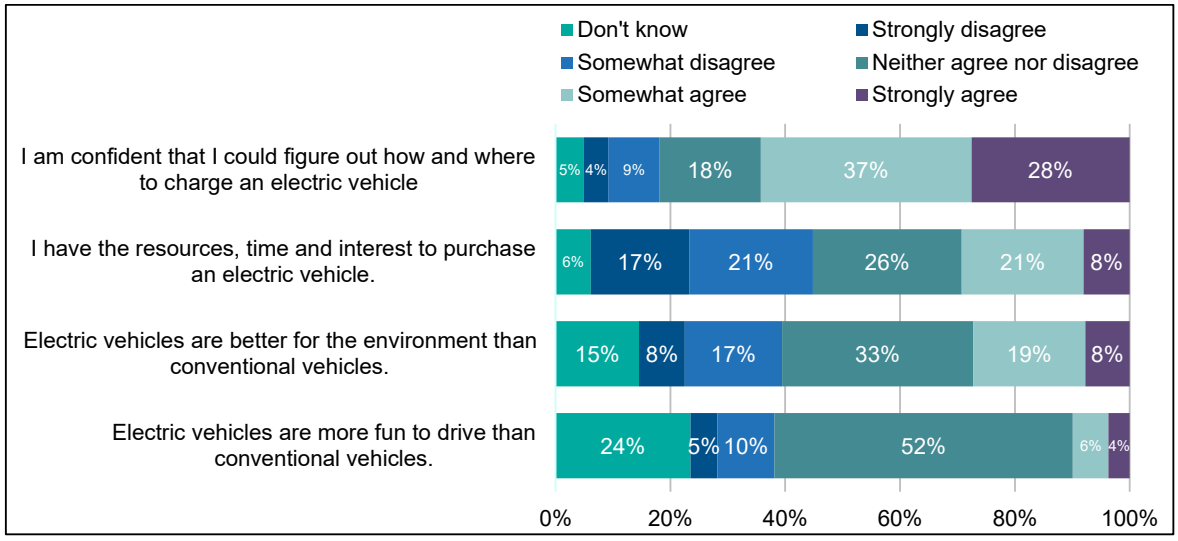


Regarding costs, while upfront costs were a primary concern, less than half (44%) of non-EV owners who were aware of EVs had not heard about any rebates or incentives for EVs. A similar percentage (44%) of non-EV owners who were aware of EVs had heard about federal tax credits for purchasing or leasing an EV. About one-quarter had heard about a state rebate or incentive like MOR-EV (27%). Some customers had heard of manufacturer rebates or incentives (16%) or dealer rebates or incentives (14%). About 8% believed there are utility rebates or incentives.

The survey also included four positively framed statements about EVs, where the percentage who disagree is an indicator of a barrier. Despite many customers' worries about where to charge or keep their battery charged, 64% were confident that they would figure out how and where to charge an EV. Still, the benefits of EVs seem unclear: just under one-third of respondents (29%) felt that they *"have the resources, time, and interest to purchase an electric*

vehicle"; 27% agreed that EVs are better for the environment than conventional vehicles; and only 10% thought they are more fun to drive.[42] Combining these findings with unclear perceptions of their reliability or maintenance costs and high perceived barriers in charging options (see in previous figure, Figure 4-12), this suggests that the value proposition of EVs may be unclear to many customers.

Figure 4-13. Opinions of EVs Among Non-EV Owners (Barriers Questions)



We asked anyone who expressed concerns or worries about charging or range (somewhat or strongly agree to one of four statements) about their specific concerns. Many respondents expressed that charging stations were few and far between:

- *"I don't think there are many places for charging."*
- *"Charging stations are too rare, and the time to recharge is too long."*
- *"My experience thus far is that the number of public chargers is grossly inadequate."*

Some respondents based this opinion on what they could or couldn't personally see, suggesting that the visibility (and recognition) of charging stations may be important:

- *"I don't see a lot of areas to charge batteries while I am out and about."*
- *"Don't see many places that offer charging in Lowell."*
- *"The amount of charging stations I see compared to gas stations is less."*

[42] As discussed in the EV Owners section, the performance and "fun to drive" element of EVs was a surprise to some owners.

- *"I don't know where charging stations are except for occasionally seeing Tesla stations. If I knew more about their availability perhaps I wouldn't say this."*

These comments point to the relative invisibility of charging stations to many consumers. While they may exist in places that customers frequent, they may not stand out like gas stations or Tesla superchargers.

Customers also highlighted the perceived unavailability of **public** charging stations locally or for longer trips.

- *"I don't see many public charging stations."*
- *"I'm not sure how a long-distance road trip would work, or how my life would change slightly if I got an electric vehicle. I'm not sure how long exactly it takes to charge an electric vehicle."*
- *"84 miles a day and 139 miles one way to Maine where National Grid isn't offering service."*

We asked anyone who agreed strongly that EVs don't meet their long-distance or daily needs why they think that. About half of respondents mentioned something related to charging or the range. Some mentioned a specific range that would meet their criteria, most commonly 300 miles (and some wanted 400 miles). A few other customers quantified their desired range in hours, ranging from two hours to 6–7 hours. Nearly all of the scenarios people described were long trips:

- *"Longer travel distances than 300 miles on a charge."*
- *"I drive all day long for work so I would need something that could accommodate long trips."*
- *"I'd like to see the battery that can hold charge for long distance (at least 300 miles range on full charge)."*
- *"Driving range to my summer home in Maine would require a charge before returning home."*

While most customers expressed their charging or range concern in terms of distance on a single charge, others seemed willing to stop to charge, but had questions about the location/availability of chargers, or the perception that they aren't as common as gas stations. These comments highlight an expectation that charging stations should be as common as gas stations:

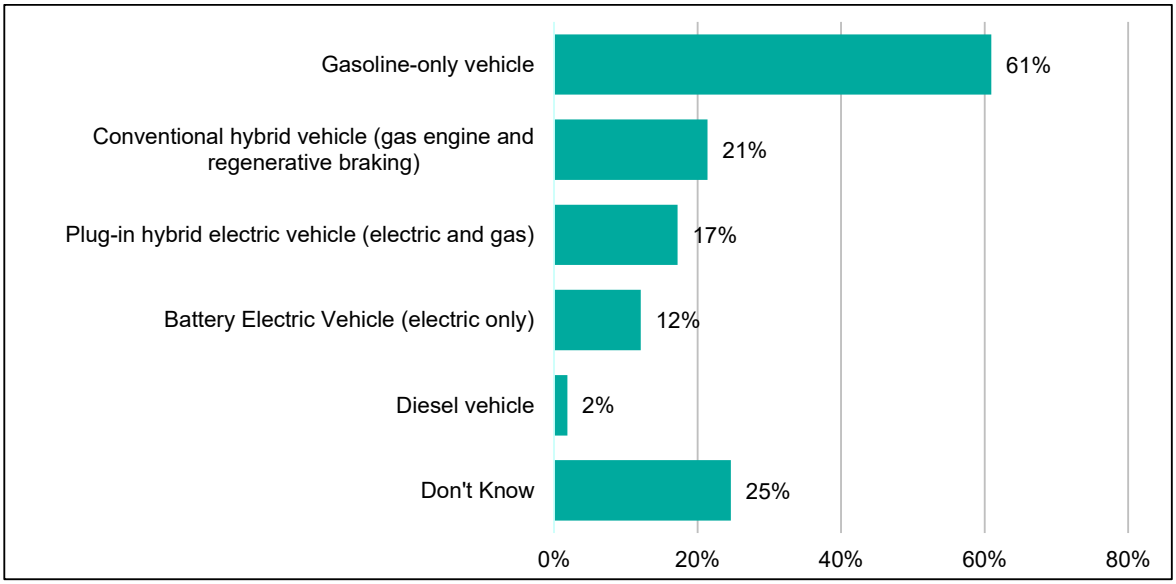
- *"Convenience of stopping to fill up fast like filling up a gas tank."*
- *"Complete recharge in 5 minutes or less, or swap out batteries for fully charged ones."*
- *"Not enough DC fast chargers available in New Hampshire/Maine for people in Massachusetts to be comfortable owning an electric vehicle."*
- *"...and more charging stations spread throughout the interstate in each state."*

Together, these comments show perceptual barriers in customer understanding of the distribution of charging stations.

4.5.5 Purchase Considerations for EVs

About one-third (34%) of respondents plan to purchase or lease a vehicle within two years. Of these, 17% said they are considering a PHEV, 12% are considering a BEV, and 23% are considering *any* electric vehicle (either PHEV or BEV).[43] A similar percentage (21%) are considering a conventional hybrid vehicle, and 61% are considering a gas-only vehicle. A further 25% don't know what type of vehicles they are considering yet. The ERS Team was surprised by the high percentage of respondents who stated they would consider EVs (among other vehicle types), and notes the possibility for social desirability bias in this question, as respondents likely understood that the survey was focused on EVs before they reached this question (and may understand EVs to be socially desirable from the media or other sources).

Figure 4-14. Consideration of Vehicles for Next Vehicle Purchase by Fuel Type (Among respondents who plan to purchase or lease their next vehicle in the next two years; n=215)



Among customers who said they would consider a PHEV (n=37), only 27% said they were *"very likely,"* while among customers who said they would consider a BEV (n=26), 58% said they were *"very likely."*

We asked respondents who said they were considering an EV for their next purchase but were only somewhat likely (or unsure) about purchasing one to explain their reasoning. The most common responses were about pricing or financial considerations (e.g., *"They are costly,"*

[43] Note that vehicle consideration is not mutually exclusive: Customers may also be considering, and more likely to purchase, other vehicle types.

"waiting for price to come down"). A couple comments suggested that some customers are considering operating costs *("Cost of operating electric vehicle [per mile] would have to be less than for purchasing gas, which is quite low right now"* or *"price, performance, cost, gas cost, tax, etc..."*). Some customers mentioned charging or range concerns, again centered on long trips:

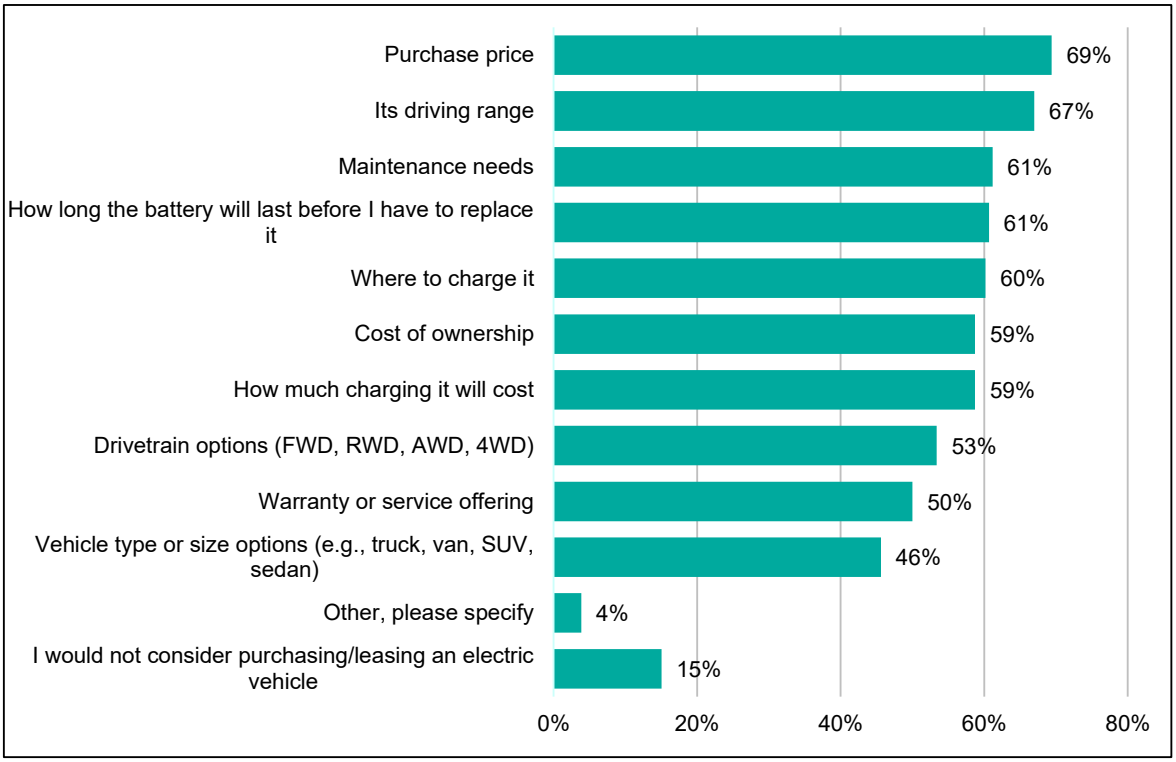
- *"I do not have easily accessible power outlets at my apartment to charge a battery electric vehicle."*
- *"Depends on infrastructure availability and range of 300 miles."*
- *"Have to do more research. Where to find plug in stations, etc."*
- *"I travel too far for an all electric vehicle."*
- *"Range for long drives and charging infrastructure in northern New England and Canada."*

A few customers mentioned characteristics that were important to them that weren't available in BEVs or PHEVs. Some customers were on the fence and wanted to do more research (*"I need to learn more about them"*).

Factors to Consider Before EV Purchase

The survey asked all non-EV owners who might purchase a vehicle in the next two years what factors they would consider before purchasing an EV. Purchase price and driving range topped the list (69% and 67%, respectively). Several factors were equally important to non-EV owners, with about 60% of non-EV owners saying they would need to consider one or more of the following before purchase: maintenance needs, the cost of ownership, how long the battery will last before it needs replacement, where to charge it, and the cost to charge. Some of these factors – purchase price, range, and where to charge – were major themes in customers' open-ended responses about reasons for not considering EVs, or concerns or barriers to EV purchase. However, a few of these factors – maintenance needs, operating costs, how long the battery will last, and the cost of charging – were mentioned by relatively fewer customers in open-ended responses. This indicates that while the latter factors may be important to consider for a vehicle purchase in general, these concerns may not be top-of-mind for potential EV customers.

Figure 4-15. Factors that Non-EV Owners would Need to Know before Purchasing or Leasing an EV (Among respondents in-market for vehicle in next two years; n=206)



Although multiple studies have shown that range anxiety is a perceived barrier among non-EV owners, some studies indicate that buyers are purchasing EVs either before researching infrastructure or with an awareness that there is a need for additional infrastructure – i.e., accepting the barriers/limitations around charging. For example, an August 2019 survey conducted by Cox Automotive identified issues related to EV adoption, looking at the gap between customer expectations and barriers to the EV market. Consumers (n=2,503) and dealers (n=308) were surveyed and results revealed that 68% of EV owners reported a need for more charging availability around their home, with 63% seeking more around their work.[44]

Finally, the survey asked those who are *"very or somewhat likely"* to purchase either a PHEV or BEV what factors would drive their selection of the specific make or model of EV. Again, driving range and purchase price were key factors, although in this case driving range topped the list at 53% and final purchase price was the second-leading factor (41%). Similar percentages of EV considerers (26%) selected drivetrain and charging stations near their home or work as top three factors. Maintenance, warranty and how long the battery will last before it needs

[44] https://www.coxautoinc.com/news/overcoming-electric-vehicle-misconceptions-is-crucial-to-converting-consideration-to-sales/

replacement were low on the list, supporting the finding above that although these are important and relevant for any vehicle purchase, they may not be top-of-mind or key drivers of an EV purchase decision.

4.5.6 Charging Station Awareness

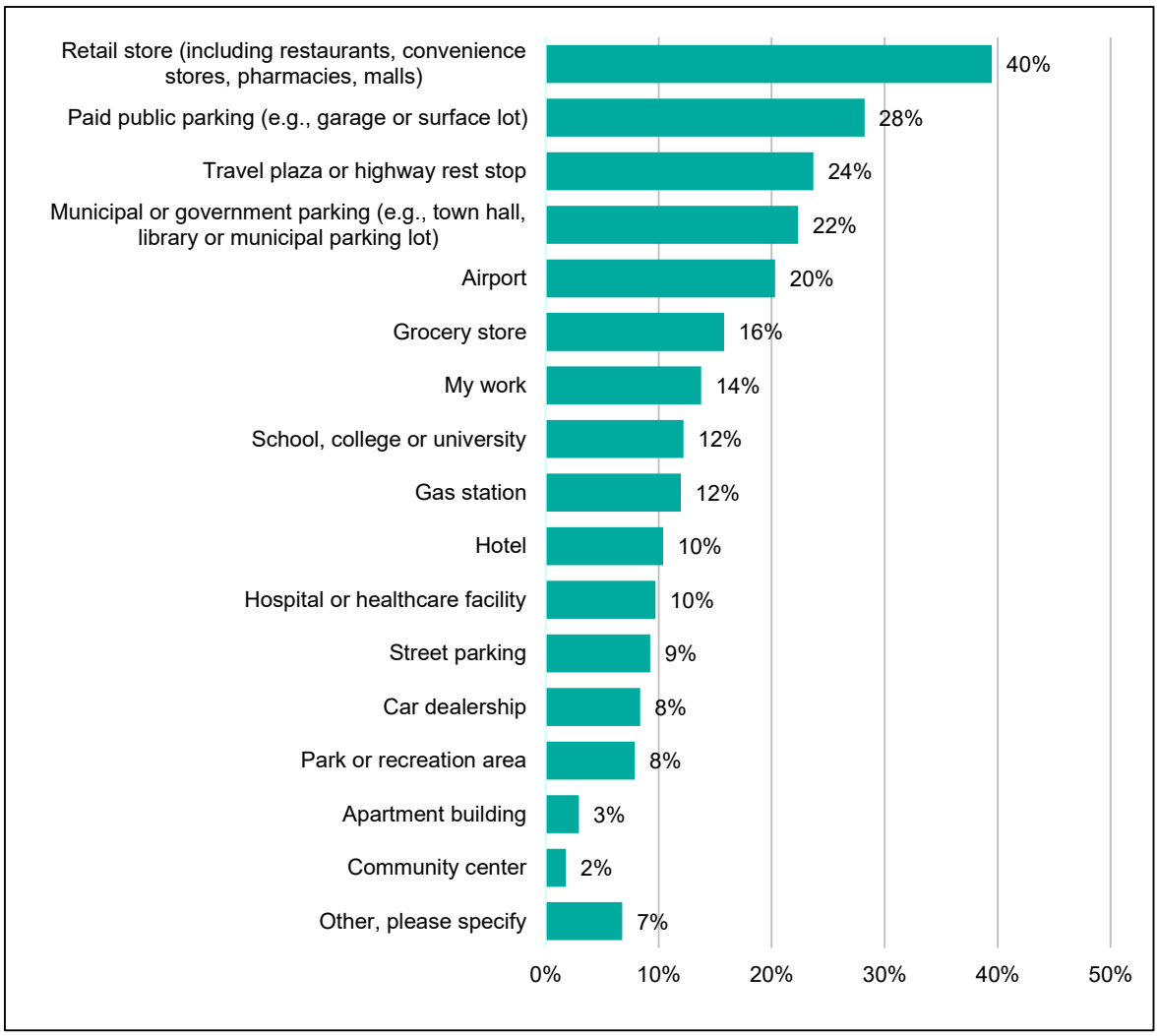
The survey presented several images of public-use EV charging stations (Figure 4-16, below) and asked non-owners if they had seen them in Massachusetts. Nearly three-quarters (72%) of non-owners reported seeing EV charging stations in Massachusetts.

Figure 4-16. Charging Station Examples shown in General Population Survey

Retail locations (including restaurants, convenience stores, pharmacies, and malls) are the most frequently reported locations that respondents recall seeing a charging station (40%). About one-quarter have seen station(s) in either paid public parking (28%) and travel plazas or highway rest stops (24%). Given non-EV owner concerns about charging on longer trips, this is an important location for non-EV owners to see stations (and sales and implementation staff have also suggested focusing on these corridors). Over 20% have seen stations in municipal or government parking.[45] Relatively fewer customers (16%) reported seeing stations at grocery stores specifically, though it's possible that some customers selected "retail" instead of "grocery store" for those stations.

[45] Per Section 4.3 above, about 79% of program stations installed to-date (through October 2019) have been installed by municipalities or school districts. Based on stakeholder interviews to-date, we've heard that several municipalities had charging stations before the National Grid program started, so it's unclear what percentage of municipal charging stations are program-funded.

Figure 4-17. Locations of Charging Stations that Respondents Recall (Among respondents who have seen charging stations in MA: n=410)



About 10% of commuters have seen a charging station at their work or school. About 39% of all commuters reported a charging station within 30 minutes of their work or school, and 32% think there is a station within 10 minutes of their work or school (including on-site). A similar percentage of respondents (42%) have seen a charging station within a 30-minute drive of their homes, and 20% think there is a station within 10 minutes.

Charging Payment Knowledge

The survey asked non-EV owners who are aware of EVs whether they thought drivers have to pay to charge an EV at a charging station. The majority (60%) of non-EV owners aware of EVs said they didn't know if you had to pay. About 21% reported that you do have to pay, 7% reported no, and a further 12% said *"it depends"* – of which, most thought that paying for charging depended on the station owner's decision to charge for charging.

4.5.7 Demographics

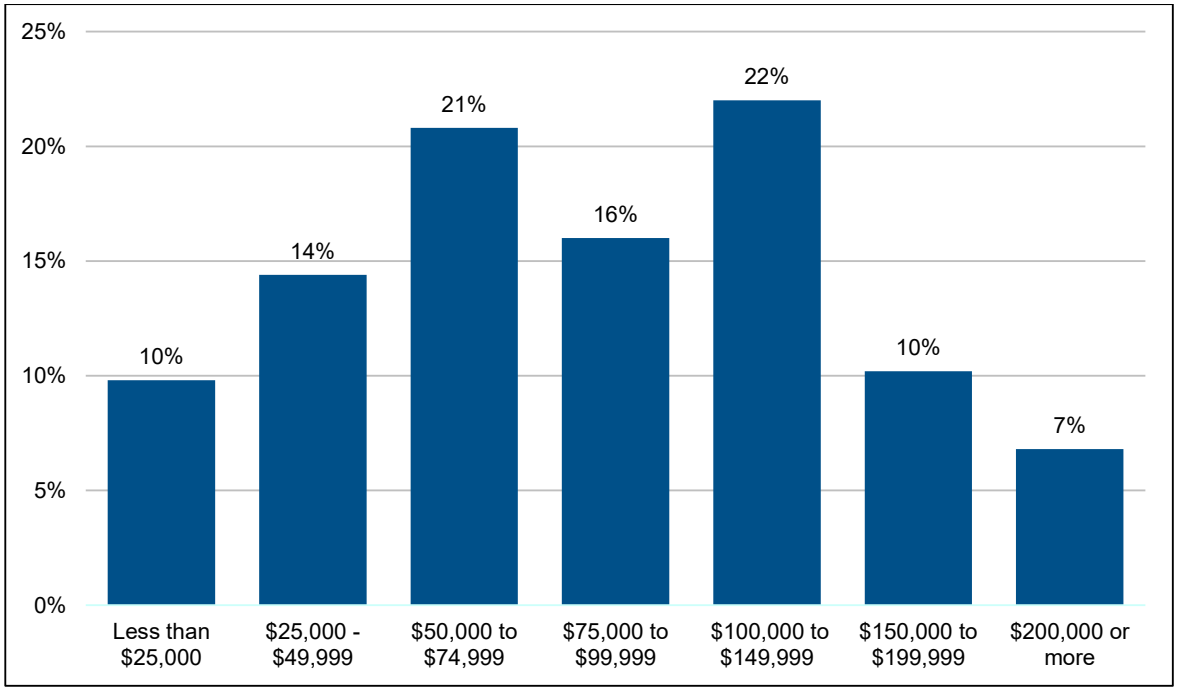
The majority of the general population survey respondents own their homes (79%). Two-thirds (67%) of respondents live in single-family detached homes. Rooftop solar is installed at about 7% of respondents' homes and buildings.

The average respondent household has 2.6 people, and two-person households are the most common (39%). Over half of respondent households have at least one person over age 55 (56%), and about one-quarter have children under age 18.

About 62% of households have at least one adult working or attending school full-time *out of* the home. There is at least one retired adult in 30% of homes. Some respondents reported adults working from home (11%); on medical, disability, or maternity leave (5%); unemployed (3%); or stay-at-home parents or caregivers (3%).

The sample included households with a wide range of incomes. Among those who reported income, 45% had a household income less than $75,000 in 2018, while 39% reported incomes of $100,000 or more (Figure 4-18). The majority of respondents had a bachelor's degree or higher (61%), and an additional 26% had an associate's degree or some college coursework.

Figure 4-18. Household Income of General Population Respondents
(Among those who reported income; n=500)



About half of the general population survey respondents identified as female (51%), 45% identified as male, and 4% preferred not to say or identified as non-binary or transgender.

4.5.8 Upcoming Activities for PY2 and PY3

The general population survey was used to provide insight into the attitudes, awareness, and likely adoption of EVs among National Grid customers. There are no general population survey activities planned in PY2 or PY3.

4.6 Baseline EV Owner Survey

This section presents the results of the EV owner survey conducted to provide insight into EV purchase considerations, travel and charging behaviors, and experience with workplace and home charging. The evaluation team received 182 survey responses from residential customers who live or work in National Grid's electric or combination-fuel service territory and drive an EV as their primary vehicle[46] ("EV owners"). The survey was administered from November 5, 2019, through November 24, 2019. About 47% of EV owners are electric-only National Grid customers, 39% are combination-fuel, and 6% are natural gas customers. The remaining 9% work, but could not confirm living, in National Grid's electric or combination territory (e.g., they may have moved recently or live elsewhere).

4.6.1 Initial Evaluation Findings: Baseline EV Owner Survey

The initial findings from the EV owner survey are presented below, followed by a more in-depth discussion of the survey results in the subsections that follow.

- **EV owners overall are satisfied with their EV, including the driving range.** Most EV owners were happy with their EV, indicating that it was fun to drive (which was a surprise to many) and that they were generally satisfied with the driving range. EV owners also appreciated the low operating cost of their EV and minimal maintenance, even though these were not the main factors that EV owners considered when purchasing their EV.
- **While driving range was a concern prior to purchase, it seems to diminish with EV ownership.** Driving range was a concern or question for far more EV owners than where to charge prior to purchase (81% vs. 37%, respectively), though after driving their EVs for a while, 90% of EV owners from the survey were satisfied with range. That said, the impact of cold weather on driving range was commonly noted as a surprise about EV ownership.
- **While most EV owners (86%) charged their vehicle in multiple locations, they most frequently charged their vehicles at home.** In the three months prior to the survey, 94% of the EV owners surveyed had charged their vehicle at home, and 14% of those had only

[46] All respondents who drove an EV as their primary vehicle (96%) or drove a non-EV as their primary vehicle but drove an EV in the household at least once per week (4%) were classified as EV owners.

charged their vehicle at home. Among those who had charged in multiple locations, nearly three-quarters (74%) most frequently charged at home.

- **School or workplace charging is not yet available to most EV owners surveyed.** While workplace charging is desired, it's only available to about one-third of EV owners who commute, and 28% percent of EV owners had used workplace charging in the 3 months prior to the survey. This information could be used by the program sales team in two ways:
  - As a data point for generating program interest among prospective site hosts, because it demonstrates interest among employees for charging options at work
  - To inform which organizations the sales team should target when promoting the program
- **Proximity to driving route and charging speed or power are the most important factors when selecting a charging station away from home**, with 60% of EV owners citing proximity and 49% citing charging speed or power as features they look for. EV owners also consider parking availability at destinations (36%), charging costs (33%), charging networks (33%), and plug compatibility (31%) when selecting locations away from home. In the three months prior to the survey, aside from home, EV owners had most often charged their vehicles at retail stores (42%), municipal or government parking (38%), or public parking (36%) locations.
- **Charging speed is important, but most EV owners will not go out of their way to use fast charging stations.** About one-third (32%) have access to free DCFC charging, but ultimately, most EV owners use Level 2 chargers for charging both at home and elsewhere. This may signal that, while range anxiety and long trips are top considerations for prospective EV buyers, fast charging stations are not a regular part of EV owners' day-to-day travel, and that Level 2 chargers – for example, at workplaces – might be utilized more regularly.
- **About half of EV owners reported issues finding a charging station in Massachusetts**, and many mentioned issues on longer trips beyond National Grid's territory. Issues finding charging stations seemed linked to these types of trips, which may contribute to EV owners still feeling some range anxiety, despite range anxiety generally diminishing for EV owners.
- Although range anxiety is a concern, especially for longer trips, **EV owners generally reported more travel than the general population.** Overall long trip patterns are similar between EV owners and the general population, but more EV owners reported taking long trips compared to the general population – although it's unclear what type of vehicle

they are using for these longer trips. Also, more EV owners commute than the general population (79% and 70%, respectively). EV owners are also commuting for longer than the general population, with about half of EV owners reporting 30-minute or longer commutes, compared to 37% of the general population.

- Almost half of EV owners have rooftop solar installed at their home, which is much higher than the general population (7%).

4.6.2 Vehicles and Travel Behavior

Vehicle Ownership

Most EV owners are a multi-vehicle household, with 86% reporting having two or more household vehicles. Most EV owners (75%) only have one EV in their household, with about one-quarter reporting two or more EVs.

Among all EV owners, 66% reported having a BEV and 34% reported having a PHEV, indicating that our sample is slightly weighted towards BEV owners compared to the Massachusetts personal vehicle registration data, where 43% of registered EVs are BEVs and 57% are PHEVs. The sample contains more Chevy PHEV and BEV owners (Volt and Bolt) than MA registrations, due to the high proportion of Chevy owners in the third-party list we purchased to contact customers.[47] Among BEV owners in the sample, 33% own a Tesla and 67% own something other than a Tesla, compared with 23% Tesla and 77% other makes among Massachusetts registrations.[48]

[47] Due to the differences in manufacturers between registration data and the third-party list of EV owners used for survey outreach, the evaluation team utilized several other distribution channels for the EV owner survey, including Massachusetts Clean Cities, the Green Energy Consumers Alliance, Plug in America, and the New England Electric Auto Association; we used these channels to share the survey link with their supporters (by email or Facebook).

[48] Source: Analysis by ERS Team of IHS Markit Massachusetts EV Registration Data from Q2 2019. Data restricted to personal vehicles.

Figure 4-19. PHEV Ownership – Comparison of EV Owners Sample and Massachusetts Personal Vehicle Registrations[49]

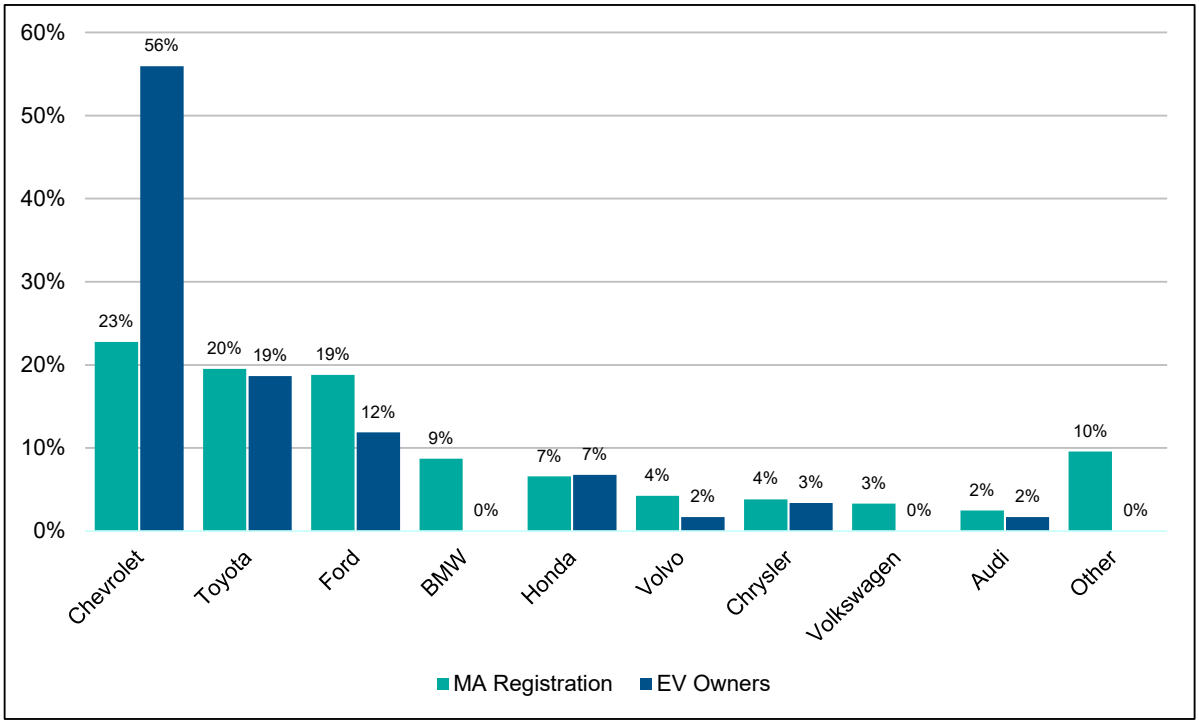
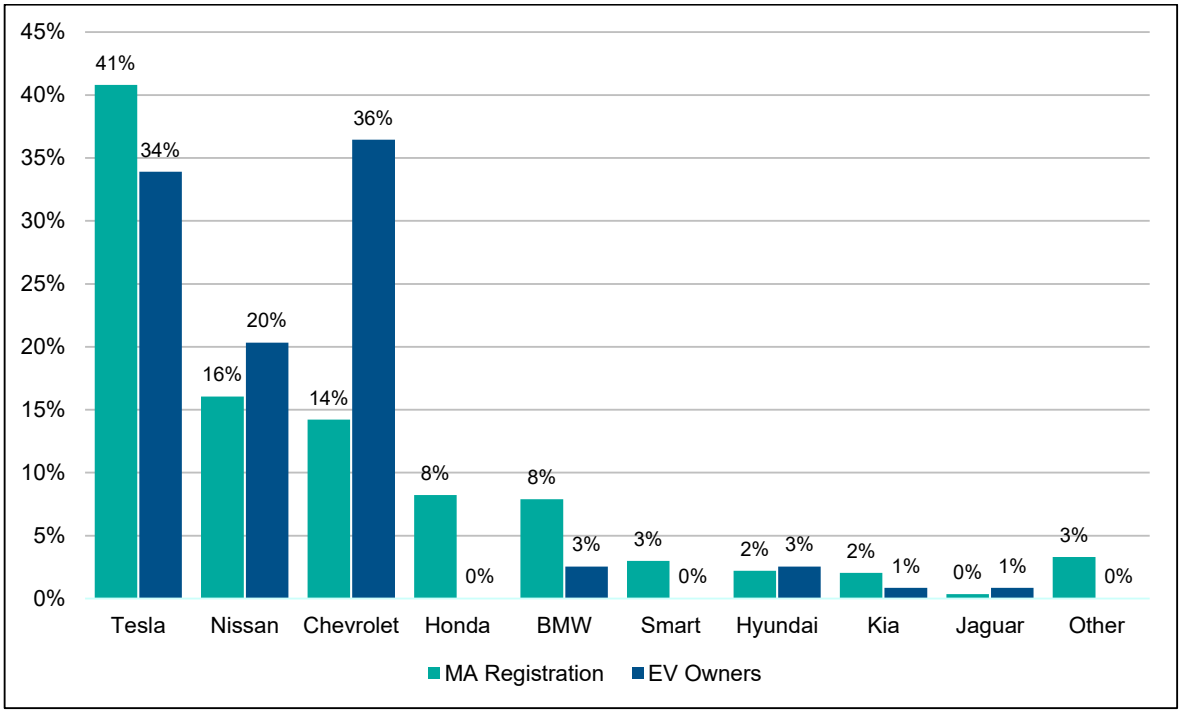


Figure 4-20. BEV Ownership – Comparison of EV Owners Sample and Massachusetts Registration Data[50]



Travel and Commuting Behaviors

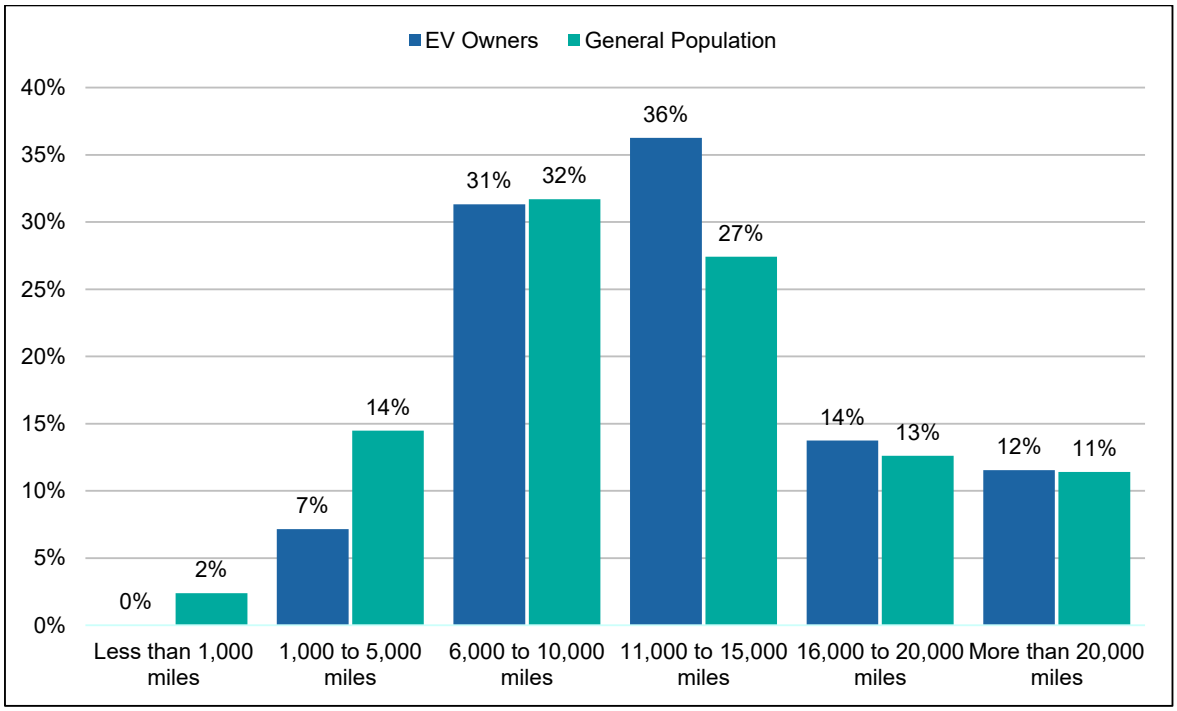
Compared to the general population, more EV owners commute to school or work (79% compared to 70%). Less than half of all EV owners (45%) commute for work within National Grid's electric or combination-fuel territory (where they may encounter or need charging stations while commuting), and the remaining 34% commute to work outside of National Grid's territory.

Average commuting times among EV owners were higher than respondents in the general population sample. About half of EV owners drive 30 minutes or more, compared to 37% in the general population; only about 15% of EV owners reported driving less than 15 minutes to work compared to 33% in the general population.

Among the 21% of EV owners who do not commute regularly for work or school, all use a personal vehicle for most of their trips. In total, 87% of the EV owners use a personal vehicle for most of their trips (whether commuting or conducting other trips or errands).

The majority of EV owners drive 6,000 to 15,000 miles per year (67%), with 31% reporting 6,000 to 10,000 miles and 36% reporting 11,000 to 15,000 miles (higher than the general population). About one-quarter (26%) reported driving over 16,000 miles per year.

Figure 4-21. Annual Miles Driven by EV Owners Compared with the General Population



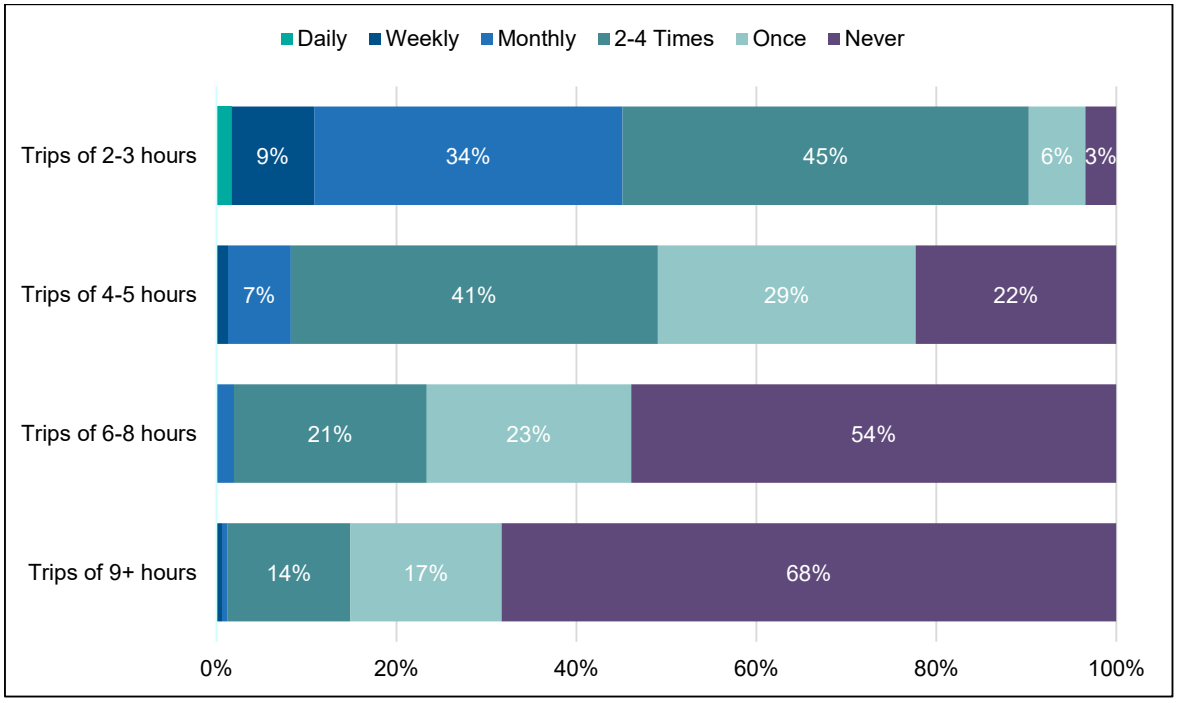
Of people who commute, 55% reported driving less on a typical day off compared with a work/school day, 26% reported driving more, and 19% said their driving time was about the same.

Longer Trips

Similar to the general population respondents, most EV owners reported driving trip lengths up to 3 hours multiple times a year. As seen with the general population, EV owners are less likely to drive for longer periods of time (4 or more consecutive hours) in a given year. That said, the rate with which EV owners reported taking long trips was higher than the general population. However, it is not clear whether EV owners are using their EV or other vehicle for these trips.

The survey asked all EV owners how often, in the last 12 months, they used their vehicle for longer trips (2+ hours). The majority of EV owners (90%) took at least two trips of 2–3 hours in the past year, with about 45% taking a 2–3 hour trip at least monthly – both of which are higher rates than reported by the general population (74% and 30% respectively). Just over three-quarters of EV owners (78%) took at least one trip of at least 4–5 hours in the past year, compared to 56% of the general population. About 78% of EV owners also took a trip over 6 hours – these households typically reported only a few trips of this length in a given year.

Figure 4-22. Frequency of Long-Distance Trips among EV Owners in Personal Vehicle in Last 12 Months (n=175)



4.6.3 EV Purchase Considerations

We asked EV owners to identify their top three questions or concerns about owning/leasing an EV, ***prior to purchasing*** their EV. Most (81%) EV owners indicated that the driving range was a top concern/question, followed by the purchase price (61%) and where to charge an EV (37%).

We also asked EV owners about the top three factors they considered when selecting the make/model of their EV (***their final decision***). In alignment with their top concerns or questions, most EV owners (71%) said that driving range was a deciding factor, along with final purchase price (42%) and available incentives or rebates (41%). About one-quarter of EV owners also took into consideration vehicle performance (24%) and consumer reviews and ratings (25%).

Fewer EV owners indicated that they were concerned or had questions about ongoing ownership factors prior to purchase, and even fewer identified these factors as top purchase considerations. Specifically, about one-quarter (26%) of EV owners had questions or concerns about how long the battery would last before they would need to replace it, but ultimately, only 6% reported that battery life was as top purchase consideration. Likewise, 13% of EV owners indicated that they had questions or concerns about the cost of charging their EV, but only about 3% identified the cost to charge the vehicle away from home as a top purchase consideration. These changes may indicate that as EV owners learned more about their EVs, their concerns/priorities shifted possibly because their questions were addressed.

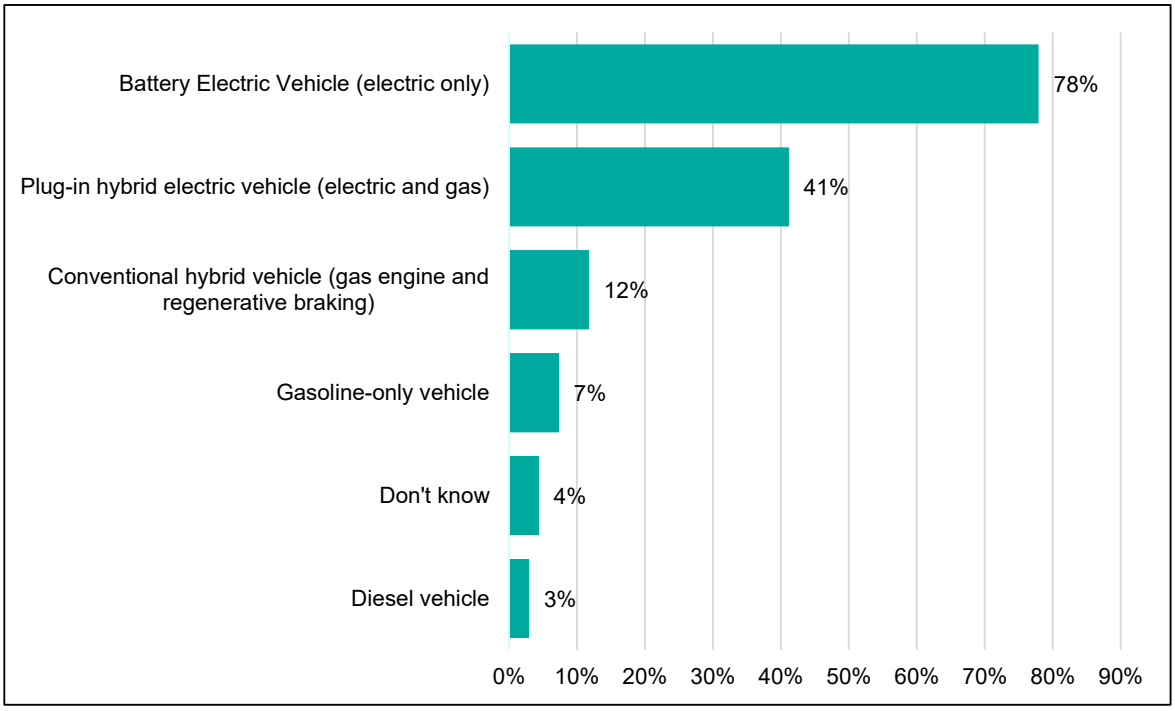
Cost of ownership was one factor that EV owners rated similarly both prior to purchase and at the time of their final vehicle decision – about 19% of EV owners had questions or concerns about the cost of ownership prior to purchase and about 18% of EV owners said that it was a top purchase consideration.

Future EV Purchase Considerations

About 37% of EV owners plan to purchase or lease another vehicle within two years. Of these, almost all (94%) are considering any type of EV – either PHEV or BEV. Most (78%) EV owners planning a purchase in the next two years are considering only a BEV, and 41% said they are considering only a PHEV.[51] Fewer EV owners (compared to the general population sample) are considering non-EV alternatives, like a conventional hybrid vehicle (12%), a gas-only vehicle (7%), or a diesel vehicle (3%).

[51] Note that vehicle consideration isn't mutually exclusive: customers may also be considering, and more likely to purchase, other vehicle types.

Figure 4-23. Consideration of Vehicles for Next Vehicle Purchase (By Fuel Type) (Among EV owners who plan to purchase or lease their next vehicle in the next two years)

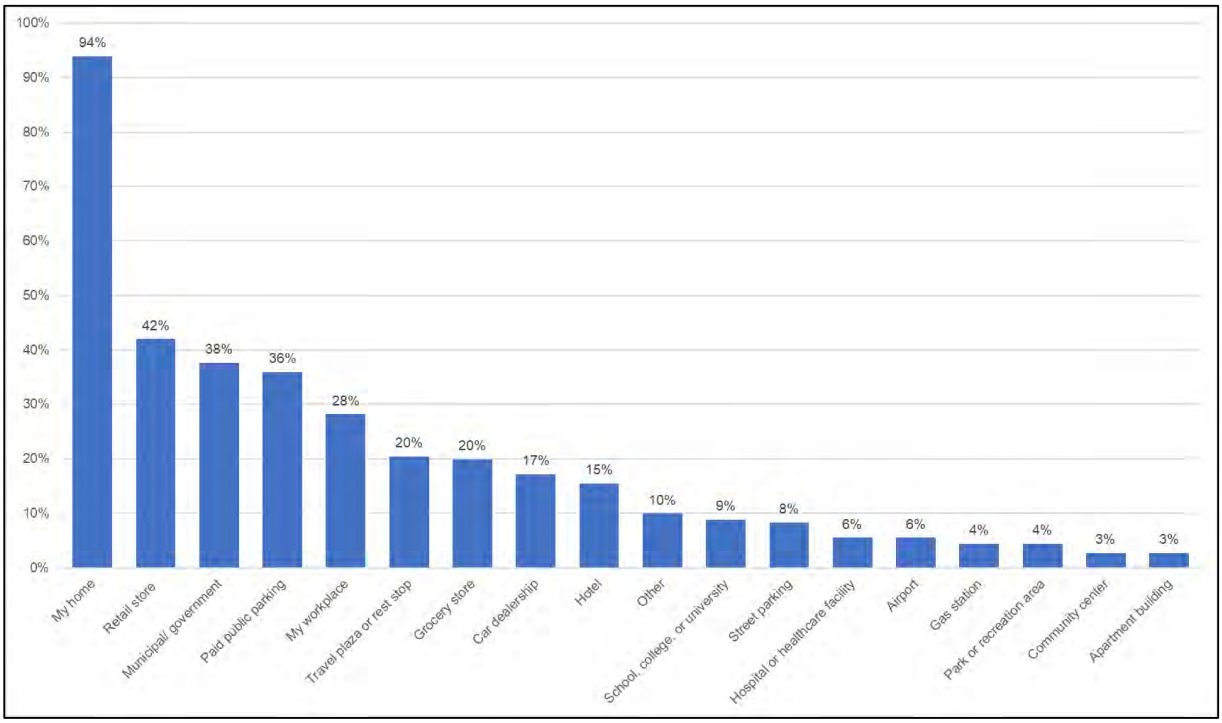


4.6.4 Charging Behaviors and Experiences

Most EV owners (92%) have private parking, either in a garage or carport (57%) or a driveway (35%). About 8% park in some kind of shared space, either a shared parking lot (e.g., condo parking, 3%), shared driveway (2%), or shared garage or carport (1%). About 2% use on-street parking. Among those using shared parking, most (83%) have a dedicated or assigned space. This means that only about 1% of EV owners park somewhere without a dedicated space, indicating that almost all EV owners could have access to a personal charging station.

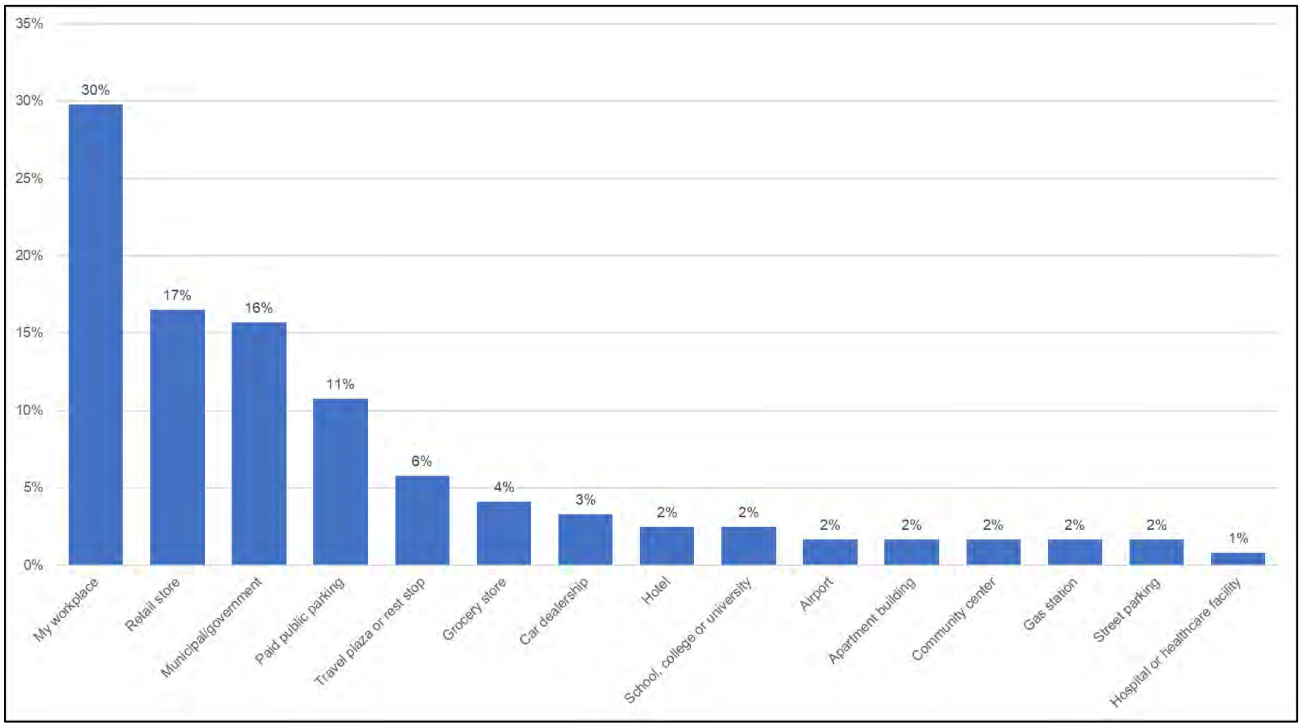
EV owners were asked to select all the locations they charged their EV in the past three months. At home was the most frequently selected option (94%), followed by retail stores (42%), municipal or government parking (38%), paid public parking (36%), and their workplace (28%). Of those who charged at home, 14% indicated that they *only* charged at home in the past three months. Six percent of EV owners indicated that they had not charged at home in the past three months, and instead charged at a variety of other locations. Five owners selected "my workplace," three selected "municipal/government parking," one said "hotel," and one said "gas station."

Figure 4-24. Charging Station Locations Used by EV Owners in the Past Three Months



In addition to understanding the *variety* of places EV owners charge their vehicle, we also wanted to know the *single* location where EV owners most frequently charged their vehicle, since most EV owners (86%) reported charging their EV in more than one location in the past three months. Among EV owners who reported charging in multiple locations, almost three-quarters (74%) reported charging most frequently at home. Aside from EV owners' home, we found that the most common place they charged was their workplace (30%), followed by retail stores (17%) and municipal/government parking (16%).

Figure 4-25. Most Frequently Used Non-Home Charging Station Location



Access to Workplace Charging

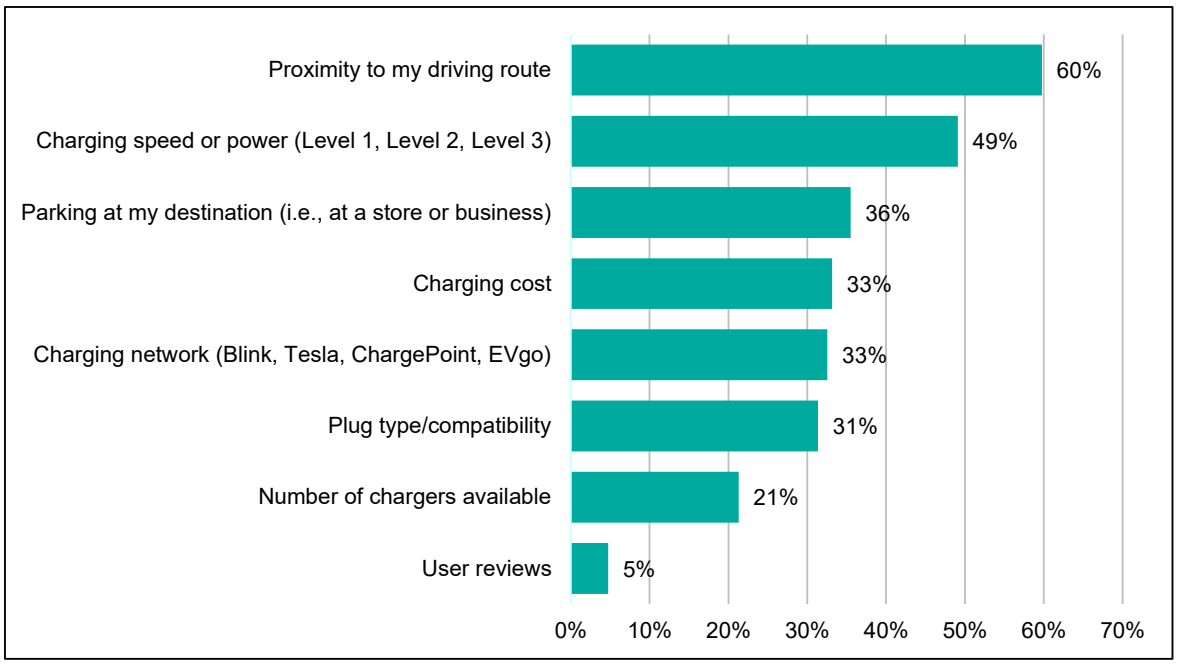
About one-third (38%) of EV owners who commute reported having access to a charging station at work or school. Among EV commuters with access to charging at work or school, 93% reported using a charging station at their workplace in the past three months. Just over half (54%) of EV commuters indicated that they did not have access to charging at their workplace or school, of which most (87%) said that they would use a workplace charging station if it was available. Only about 5% said that they had access to a workplace charging station but didn't use it.

Deciding Where to Charge

Most EV owners use some sort of web-based tool to find charging stations away from home, with just over half (54%) using an app, about 21% using in-car navigation, and 10% using a web search. About 8% of EV owners reported that they most often find stations just by seeing them.

EV owners look for a variety of features when selecting a charging station away from home. The top two features respondents considered when selecting a charging station were 1) proximity to their driving route (60%) and 2) charging speed or power (49%). Besides these top features, about a third of respondents also consider parking at destination (36%), charging costs (33%), charging networks (33%), and plug compatibility (31%). The charging station feature that EV owners considered the least often was user reviews (5%).

Figure 4-26. Features EV Owners Consider When Selecting a Charging Station Away from Home (n=169)



Fewer than half (43%) of EV owners have a subscription or membership to a charging network. Of those with a subscription/membership, almost all (99%) have a ChargePoint membership. EVgo was the next most common (43%) subscription/membership among EV owners, followed by Blink (13%) and Tesla (12%).

Types of Chargers

Overall, most EV owners use Level 2 chargers when charging at home or away from home (68%) and about one-third use a Level 1 charger.

PHEV owners account for about two-thirds (62%) of the EV owners who use a Level 1 charger at home, while 38% of those with Level 1 home chargers own BEVs. In contrast, over three-quarters (77%) of those who use a Level 2 charger at home are BEV owners. Among the BEV owners, only one respondent who owns a Tesla uses a Level 1 charger. Of the 77% of BEV owners who use a Level 2 charger at home, 40% are Tesla owners and 60% are non-Tesla EV owners.

Just under three-quarters (73%) of EV owners use a Level 2 station to charge their vehicle at their most-frequented non-home charging station, and 19% use a DCFC station. A further 5% reported using a Level 1 station away from home, and 3% were not sure the type of station they used most frequently away from home.

When asked whether they have to pay to charge their vehicle at their most-frequented, non-home charging station, about a quarter (23%) of EV owners said they did have to pay at that station while 73% of EV owners said that they did not have to pay.

EV owners were also asked about their access to free fast charging (DCFC). About one-third (32%) said that they have access to free DCFC, predominantly through a manufacturer or dealer network[52] (25%). Only 2% said they had access to a DCFC station at their workplace or school. The remaining 8% indicated access to a DCFC station at another location. Of the EV owners who said they did not have access to a DCFC station, most did not own a Tesla (73%).

When asked what factors EV owners look for when selecting a charging station away from home, almost half (49%) of EV owners identified charging speed or power as a feature they sought. Overall, 20% of EV owners indicated that they would go out of their way to find a DCFC station. About 13% said that while they prefer fast charging, it's not something that they go out of their way to use. Some EV owners (4%) specified that DCFC stations were most important to them on long trips rather than day-to-day travel.

Issues Finding Charging Stations

Almost half of all EV owners (49%) reported experiencing issues finding charging stations in Massachusetts, although another 12% have not looked for charging stations away from home. Many EV owners noted that they experienced these issues finding a charging station while on longer trips, many of which were outside the National Grid's service territory, including driving to Western Massachusetts, Cape Cod, or out of state. The focus on longer trips mirrors concerns that the general population respondents expressed about perceived lack of charging stations within and outside of Massachusetts. Together, EV owner and general population comments suggest that range anxiety and perceptions about charging station availability are influenced by the availability of stations beyond National Grid's territory. Along with longer trips, EV owners also had issues finding charging stations around the Boston metro area.

In addition, a few EV owners noted that they have come across charging stations that do not work or are broken.

EV Ownership Experience

We asked EV owners to share their biggest surprises about owning or leasing an EV. Most reported how fun and easy their EV is to drive, specifically citing that it is smooth, powerful, and quiet. Many EV owners were also surprised at how low the operating and maintenance costs are.

[52] A network of charging stations installed and maintained by an EV manufacturer or dealer, such as Tesla's Supercharger network. Charging stations in these networks are typically located near destinations and along major transportation corridors (e.g. retail, highway rest stops, gas stations).

Overall, 90% of EV owners reported that they were either somewhat (38%) or very satisfied (52%) with the driving range of their EV. The average driving range reported by BEV owners was 216 miles. PHEV owners reported that the average driving range for their electric battery was 44 miles. However, sentiments that EV owners expressed in comments about range were split; some EV owners expressed that their range anxiety was decreasing, while some still felt concerned. Most EV owner comments about range focused on the variation in driving range depending on the outside temperature.

> *"[Range] drops a lot in the winter – especially in very cold weather. I knew it would drop a bit but my car will be down to 180 miles in fall weather and 120 miles per charge in very cold weather. For normal commutes, this isn't a big deal. Winter travel requires additional planning and makes longer trips impractical. Also, my car doesn't support very fast Level 3 charging – I knew about this going in, but it does limit the practical trip distance to about 300 miles between locations where I can get a full charge (summer) and 200 miles in the winter."*

Some EV owners noted that they have issues with non-EVs parked in spots designated for charging stations. This might signal future tensions related to parking spaces between EV owners, non-EV owners, and site hosts. This topic also came up during interviews with National Grid sales and implementation teams.

4.6.5 Demographics

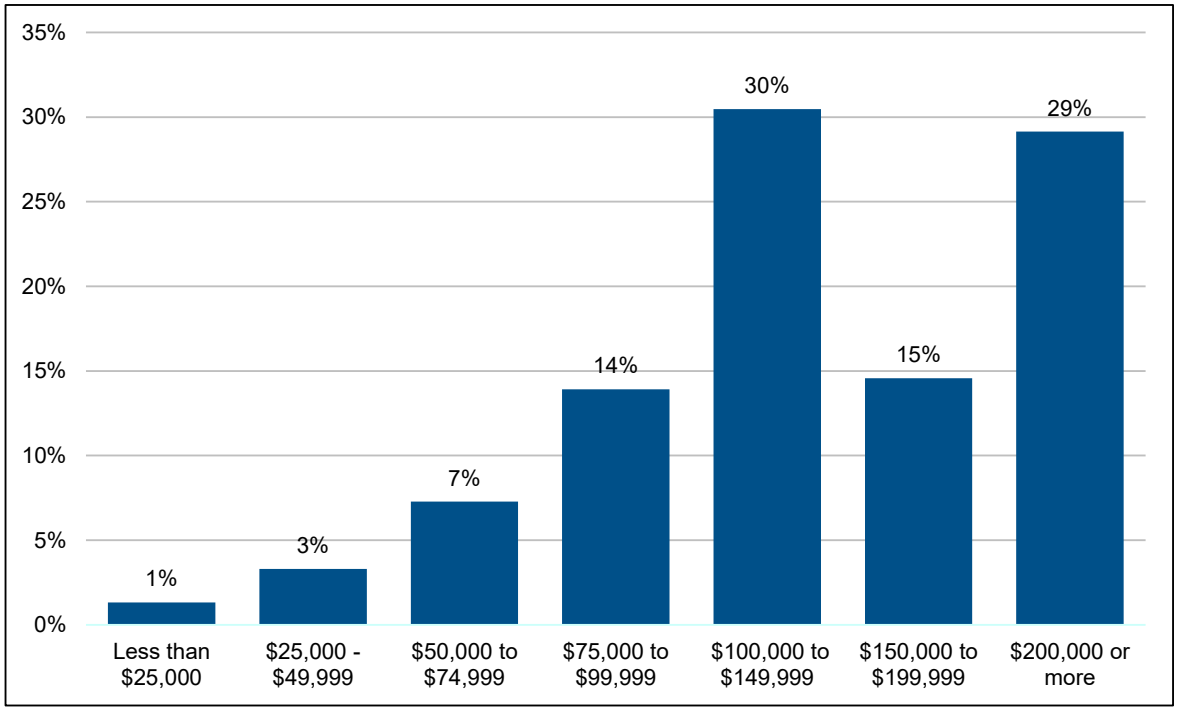
The vast majority of the EV owners own their homes (95%). Most (84%) EV owners live in a single-family detached home (more than the general population: 67%). Nearly half of EV owners' homes or buildings have rooftop solar (46%), far more than the general population (7%).

The average EV owner household has 2.5 people, and two-person households are the most common (47%). Over half of the households have at least one person over age 55 (60%), and just over one-quarter have children under age 18 (28%). The age distribution is similar to the general population sample.

About 74% of households have at least one adult working or attending school full-time out of the home, and 21% have an adult who works or attends school full-time from home. There is at least one retired adult in 28% of homes.

EV owners reported higher incomes than the general population sample. Among those who reported income, 12% had a household income less than $75,000 in 2018, while 74% reported incomes of $100,000 or more (compared with 39% among the general population sample). The majority of respondents had a bachelor's degree or higher (92%).

Figure 4-27. Household Income of EV Owner Respondents (n=151)



Almost three-quarters (73%) of the EV owner respondents identified as male, compared with 45% of the general population sample.

4.6.6 Upcoming Activities for PY2 and PY3

In PY2, 12 months after the baseline survey, the ERS Team will conduct a second online survey with EV owners. This follow-up survey will explore changes and, if the respondent resides in locations where charging stations are installed through National Grid's program, charging experience, including how the charging infrastructure has impacted how, when, and where EV owners charge their vehicles. There are no EV owner survey activities planned in PY3.

4.7 Baseline Participant Community Member Survey

The ERS Team randomly oversampled residential customers from three towns with recently installed public-access charging stations: Lowell, Haverhill, and Boxford. The oversampled customers were invited to take the same survey as the general population survey. The responses from the participant community oversample (n=24) were combined with responses from the general population survey from people who live or work in these communities (n=44) for baseline results (n=68).

The purpose of the participant community member survey is to establish a baseline for charging station awareness and perceptions in places where we know charging stations were installed.

The ERS Team will survey these communities again in 12 months to determine if there are changes in residents' awareness and perceptions of EVs and charging opportunities.

As of the November 14, 2019, program tracking data that ERS used for participant community selection, the City of Lowell had installed 15 stations using National Grid incentives, Haverhill had installed 4 stations, and Boxford had installed 3 stations.

Table 4-16. Installed and Committed Stations in Target Communities for Participant Community Sample (as of 11/14/2019 Program Tracking Data)

Community	Installed Stations[1] (through 11/14/2019)	Activation Date Range	Additional Committed Stations
Lowell	16 Municipal[2]	3/26/2019	10 Committed (8 UMass Lowell)
Haverhill	4 Municipal	5/31/2019	None
Boxford	3 Municipal	6/28/2019	3 Committed

[1] Most stations have two ports per station

[2] Includes all City parking lots or garages, school district, and city departments

We understand from sales staff interviews that each of these communities may have already had public-access charging stations prior to the installation of program-funded stations (and some are visible on PlugShare.com), so baseline awareness of local charging may be a factor of program and non-program stations. The key question that the baseline and 12-month-follow-up community surveys will address is whether, over time, changes in awareness and perceptions in communities with relatively more program-funded stations (within the program period) are greater than among the general population. While we expect some changes due to general market education, media, etc., we will be able to assess whether changes in communities with program station installations are greater than the general population.

4.7.1 Initial Evaluation Findings: Participant Community Surveys

The participant community surveys are designed as a baseline against which to assess changes or improvements in key success metrics, such as EV awareness and perceptions and EV charging station awareness and recall over time, as more customers encounter or learn about charging stations, or more are installed. As such, the initial findings do not provide a basis for conclusions or recommendations.

4.7.2 Respondent Overview

The ERS Team received 68 survey responses from residential customers who live or work in Lowell, Haverhill, or Boxford. About 91% of the participant community sample lives in one of these communities and 9% regularly commute to work or school in them, but do not live there. In total, about 31% of the sample regularly commutes to work in one of the three communities;

an additional 44% regularly commute to another city or town, and 25% do not regularly commute to work.

About 9% of the sample said they were employees or students with one of the three municipalities that has installed charging stations (e.g., employed by the Town of Boxford, City of Haverhill, or City of Lowell in any capacity). An additional 3% said they were employees or students at UMass Lowell, which already has at least one non-program charging station installed (according to PlugShare.com) and has eight stations committed through National Grid's Charging Program.

Vehicle ownership rates are similar to the general population – 88% own at least one vehicle, and 4% reported owning an EV.

4.7.3 Market Awareness and Perceptions of EVs

The purpose of the participant community surveys is to gather baseline information on EV awareness, perceptions, and purchase considerations, and assess how these metrics change after 12 months. At 12 months, these metrics will be compared to a) the baseline participant community survey results, and b), as needed, compared in a difference-in-difference analysis to determine if they have changed more than in the general population.

In Table 4-17, below, we present baseline metrics for the participant community surveys, and analogous results from the general population survey. While the general population metrics are shown as a reference, any differences at this point cannot be attributed to the National Grid Charging Program, due to inherent differences in the surveyed populations and the presence of non-program charging stations in and around these communities prior to the Charging Program. Even in the absence of any program charging stations, we would not expect EV metrics in these communities to match the general population, due to demographic, socioeconomic, work, and commuting differences.

Baseline EV awareness and several barriers/perceptions are similar between the general population and participant community members. Two barriers seem slightly higher among participant community members: feeling that they'd worry about running out of battery power with an EV, and that it would take a lot of time and effort to keep an EV charged. On the other hand, slightly more participant community members reported taking action to look for nearby charging stations or to research charging costs. The 12-month follow-up survey can assess how perceptions of these barriers change over time.

Table 4-17. Baseline EV Awareness, Perception, and Purchase Metrics for Participant Community Surveys and the General Population Survey

Survey Question	Baseline (2019)		12-month Follow-Up (2020)**	
	General Population (n=642)	Participant Community (n=68)	General Population	Participant Community
EV Awareness				
Able to name at least one make/model	72%	66%		
Aware of Electric Vehicles[1]	69%	69%		
EV Barriers (Among EV Aware Non-Owners)[2]				
If I had an electric vehicle, I'd always worry about where to charge it.	62%	64%		
If I had an electric vehicle, I'd constantly worry about running out of battery power.	61%	76%		
It would take a lot of time and effort to keep an electric vehicle charged.	32%	42%		
I am confident that I could figure out how and where to charge an electric vehicle.	64%	60%		
Actions Taken Toward EV Purchase (Among EV Aware Non-Owners)				
Test drove a friend or family member's EV	9%	9%		
Test drove at a dealership	3%	0%		
Looked for nearby charging stations	14%	25%		
Researched charging costs	4%	9%		
EV Purchase Consideration				
Considering PHEV or BEV for next purchase (*among those purchasing/leasing in two years*)	23%	24%		
EV Ownership				
Self-reported EV Ownership	2%	4%		

** These columns will be filled in after 12 months.

[1] Anyone who reported at least "I know a little about this" to one of four aspects of EVs (driving range, makes/models, how or where to charge, and different between BEVs and PHEVs) is classified as "Aware"

[2] Percentages shown are respondents who agree or strongly agree to each statement.

The ERS Team calculated the percentage of personal EV registrations in Massachusetts registered to drivers in the participant communities compared with the rest of National Grid's service territory. As of 2019 Q2, about 4,888 personal EVs were registered to zip codes in National Grid's electric or combination-fuel service territory (43% of the statewide total).[53] Of these, 244 vehicles (2.1%) were registered to homes in Lowell, Haverhill, or Boxford. If updated registration data are available after 12 months, we can assess whether the share of EVs within National Grid's territory and these communities has shifted.

[53] Source: Analysis by ERS Team of IHS Markit Massachusetts EV Registration Data from Q2 2019. Data restricted to personal vehicles.

4.7.4 Charging Station Awareness and Perceptions

Table 4-18, below, presents charging station baseline metrics for the participant community surveys, and analogous results from the general population survey. Per above, any differences at this point cannot be attributed to the National Grid Charging Program, due to inherent differences in the surveyed populations, and the presence of non-program charging stations in and around these communities prior to the Charging Program.

Baseline charging station awareness and recall of nearby charging stations (to home or work) are very similar between the general population and participant community members. Respondent knowledge of how to pay at a charging station is also similar (60% don't know). However, the places that respondents recall seeing charging stations show some differences, with higher recall of stations in paid public parking among participant community members and higher recall of retail and grocery stations among the general population. Since there were pre-existing differences in the availability and distribution of charging stations in these communities and throughout National Grid's service territory, the test will be whether and how some of these metrics shift in participating communities versus the general population after 12 months.

We also asked respondents whether they had seen a charging station at each of the program-funded installation locations in their town with an installed station. About 13% of respondents reported seeing one of the program-funded stations at a location in their town.

Table 4-18. Charging Station Awareness, Perception, and Purchase Metrics for Participant Community Surveys and the General Population Survey

	Baseline (2019)		12-month Follow-Up (2020)**	
	General Population (n=642)	Participant Community (n=68)	General Population	Participant Community
Charging Station Awareness				
Have seen charging stations in MA (among non-owners)	72%	71%		
Have seen charging stations within 10 minutes of home	20%	19%		
Have seen charging stations within 10 minutes of work (among commuters)	23%	25%		
Have seen charging station AT workplace (among commuters)	10%	14%		
Charging Station Location Recall (Among those who have seen stations in MA)				
Retail store (including restaurants, convenience stores, pharmacies, malls)	40%	20%		
Paid Public Parking [a]	28%	47%		
Travel plaza or highway rest stop	24%	14%		
Municipal or government parking (e.g., town hall, library or municipal parking lot)[1]	22%	29%		
Grocery Store	16%	8%		
School, college or university	12%	18%		
Charging Station Recall in Participant Communities				
Have seen one of the program-funded charging stations in their community	N/A	13%		
Have NOT seen a program-funded charging station in their community	N/A	87%		
Understanding of How to Pay to Charge (Among those aware of stations)				
% who *don't know* how you pay	60%	60%		
% who think charging is paid	21%	27%		
% who think charging is free	7%	7%		
% who think it depends	12%	7%		

** These columns will be filled in after 12 months.

[1] It is possible that respondents could categorize public stations they see at municipal lots or garage as public parking or municipal parking, hence both are included in this table.

4.7.5 Upcoming Activities for PY2 and PY3

After 12 months, the ERS Team will conduct a second survey among residents of the targeted communities (coinciding with the follow-up general population survey), using a similar instrument administered in the first wave, and focusing on potential changes in awareness, attitudes, and intentions. Additionally, the ERS Team will conduct another similar survey, but with workplace-specific issues and questions among employees of companies who have recently installed charging stations during PY2. This survey will assess attitudes, awareness, knowledge, and EV behaviors such as intent to purchase. The team will reassess the value and

feasibility of follow-up surveys after the initial wave of surveys. There are no community or workplace survey activities planned in PY3.

Appendix A – Methodology for Calculating CO_2 Savings

This appendix presents the methodology for calculating CO_2 savings for the charging session data reported by the EVSE suppliers. The figure below shows the formula used to calculate CO_2 savings, and the table shows formula assumptions and their sources.

Figure A-1. Formula for Calculating GHG Impact (CO_2) for Charging Program

$$Gasoline\ miles = electric\ miles = \ EV\ efficiency\ x\ Charging\ kWh$$

$$CO_2\ savings = \left(\frac{Gas\ miles}{Average\ mpg}\ x\ Gas\ carbon\ intensity\right) - \ (Charging\ kWh\ x\ Grid\ carbon\ intensity)$$

Table A-1. GHG Impact Assumptions and Sources

Metric	Value	Units	Source
Gas miles	N/A	Miles	Calculated
Electric miles	N/A	Miles	Calculated
EV efficiency	3.5	Miles per kWh	National Grid
CO2 savings	N/A	kg of CO2	Calculated
Gas carbon intensity	8.67	kg CO2 per gallon of gasoline	National Grid
Grid carbon intensity	0.31	kg CO2 per kWh	ISO-NE Electric Generator Air Emissions Report, 2017
Average mpg	33	Miles per gallon	National Grid
Charging kWh	N/A	kWh	Charging station vendor data

Appendix B: Supplementary General Population Survey Results

The survey asked non-EV owners to list the first three makes and models of EVs that came to mind. About 72% of respondents provided at least one make or model as a response. The table below shows the top manufacturers and models that respondents mentioned.

Table B-1. Makes and Models of EVs Mentioned by Non-EV Owners

Manufacturer	Percentage of Non-EV Owners Mentioning Make or the BEV/PHEV or Hybrid Model[1]	Among those mentioning make or model…	
		Mention BEV, PHEV or Hybrid Model by Name	Mention Make *But Not* the BEV, PHEV, or Hybrid Model
Tesla	71% (Any Tesla mention)	8% (Model __ or Tesla Model __)	92% (Tesla but not Model)
Toyota	57% (Any Toyota or Prius mention)	82% (Prius or Toyota Prius)	18% (Toyota but not Prius)
Chevy	32% (Any Chevy, Bolt or Volt mention)	92% (Bolt/Volt or Chevy Bolt/Volt)	8% (Chevy but not Bolt or Volt)
Nissan	21% (Any Nissan or Leaf mention)	84% (Leaf or Nissan Leaf)	16% (Nissan but not Leaf)
Honda	8% (Any Honda mention)	*Not assessed*	*Not assessed*
Ford	7% (Any Ford mention)	*Not assessed*	*Not assessed*
BMW	4% (Any BMW mention)	*Not assessed*	*Not assessed*
Volkswagen	2% (Any VW mention)	*Not assessed*	*Not assessed*

[1] Among all non-EV owners who provided a make or model mentioned. Per above, 27% of non-EV owners did not try to mention an EV make or model.