# Massachusetts Phase I EV Charging Station Program Evaluation Report – Program Year 2

*prepared for*

## National Grid

ILLUME

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# 1 EXECUTIVE SUMMARY

This report presents the ERS Team's evaluation results and findings for Program Year 2 (PY2) 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 PY2 evaluation in this report covers program activity from January 1, 2020, through December 31, 2020. The ERS Team's evaluation activities for PY2 included the following:

- Review and analyze all program data and materials, including general program information and program tracking spreadsheets that monitor charging station progress and costs.
- Conduct site host interviews with 24 current or prospective site hosts. All 24 had installed or considered installing Level 2 stations; one also installed a DCFC station and one also considered but did not install a DCFC station.
- Analyze charging station utilization data provided by six EV supply equipment (EVSE) vendors covering 342 program-supported charging stations across 149 site host facilities (sites).
- Administer follow-up surveys with EV owners and site host community members to gather data on attitudes and behaviors regarding EV charging.
- Administer surveys with workplace charging site host employees to gather data on awareness and knowledge of EVs and EV charging and the impact of the program-installed charging stations on that awareness and knowledge.

From these evaluation activities, the ERS Team developed the following PY2 program findings, recommendations, and considerations, grouped into program achievements, challenges and barriers, and process improvement opportunities. These are summarized below.

## 1.1 Program Achievements

**Finding #1: The Charging Program has activated a cumulative total of 447 stations through December 31, 2020.** This represents 66% of the program target (or mid-point) goal of 680 stations[1]. Broken out by station type, the program activated 338 Level 2 stations and 1 DCFC station during PY2, and a cumulative total of 445 Level 2 stations and 2 DCFC stations through

[1] The Charging Program has a goal to activate a minimum of 510 stations, a target or mid-point goal of 680 activated stations, and an exemplary goal of 850 activated stations.

the end of PY2. The program also has a strong pipeline of committed projects and is on track to meet overall station activation goals, discussed in greater detail in Section 4.2.2.

**Finding #2: The Charging Program is very influential on site hosts' decisions to install EV charging stations, and site hosts depend on incentives to install stations.** Site hosts reported that they did not necessarily have a need to install stations but were heavily motivated by the amount of program funding available. Many of the customers interviewed in 2020 would not have pursued a station installation at the time they did without external funding covering most or all of the project cost. This is consistent with the 2019 finding that customers with multiple locations were prioritizing projects across utility territories and states based on the available incentives.

**Finding #3: The Charging Program continues to increase the number of publicly accessible charging stations in the Commonwealth and the number of stations in environmental justice (EJ) communities[2].** Approximately 74% of the activated stations are classified as publicly accessible, which was identified as a priority by the Massachusetts Department of Utilities (DPU) in its 17-13 Order.[3] As of December 31, 2020, 21% of the activated and in-flight Level 2 stations in the Charging Program qualify as EJ community stations meeting two or more EJ criteria, making them eligible for enhanced program funding, compared to a program target of 10%.

**Finding #4: The Charging Program continues to support multi-unit dwelling (MUD) site hosts to provide opportunities for home charging.** The overwhelming majority of EV owners have access to EV charging at home and almost 75% report charging their vehicles most frequently at home. These EV owners supplement home charging at a variety of other locations, but the majority of charging time occurs at home. Given this preference for home charging, a continued focus on MUD site hosts can enable future EV adoption for residents of those facilities. While MUD station development to-date has been slower than workplace and public stations, at the end of PY2 there were 23 activation stations and 47 committed stations.

- **Recommendation #1:** Continue to engage MUD site hosts to promote station development and EV ownership. At-home charging is often less accessible to people living in MUDs than in single-family residences. A robust MUD infrastructure would support EV ownership for residents who would have the ability to charge at home and

[2] In Massachusetts, a community is identified as an environmental justice (EJ) community if it meets any of the following three conditions: a block group's annual median household income is equal to or less than 65% of the statewide median; 25% or more of the residents identify as a race other than white; or 25% or more of the households have no one over the age of 14 who speaks English fluently. To be eligible for 100% funding of EVSE, EJ communities must meet at least two of these three criteria.
[3] MA D.P.U. 17-13 Order, September 10, 2018, page 30.

not rely upon workplace or other public charging facilities. The program can also target outreach towards developers of new MUD sites, in addition to existing MUD facilities, to promote adoption during the design phase of a project and potentially attract new EV drivers.

**Finding #5: National Grid's internal processes are effective and appropriate for the program design.** 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 program. The ERS Team identified many improvements in the data recorded in the PY2 tracking spreadsheet relative to the tracking spreadsheets provided in PY1, and the team found only minor data inconsistencies.

**Finding #6. Workplace charging is valued by employees who own EVs, has motivated employees to consider or purchase EVs, and has increased knowledge and awareness of EV charging**. The majority of EV commuters with access to workplace charging have used it and the majority of EV commuters that do not have workplace charging said they would use it if it was available**.** Among respondents at the large manufacturing facility that participated in the workplace charging site host survey, approximately two-thirds of respondents who do not own EVs indicated that the presence of charging stations at work affected their likelihood to purchase an EV, motivated them to learn about EVs, and contributed to their knowledge about how and where to charge an EV to some extent. Respondents from both the large manufacturing facility and city workplace surveys are significantly more likely than the general population to have seen charging stations. Further, most EV owners who purchased their EVs after their workplace installed charging stations (all 10 in the large manufacturing facility workplace survey and four of the five in the city workplace survey) reported that the availability of charging at work affected their decision to purchase an EV to some extent.

## 1.2 Program Challenges and Barriers

**Finding #7: The COVID-19 pandemic and its resulting disruption to normal business operations throughout Massachusetts has caused several key impacts on the Charging Program**, including:

- **Impacts on site host development**. Site hosts reported some impacts from the COVID-19 pandemic on station development, primarily delays in planning and implementation, halting development in several cases due to budget and resource constraints.
- **Reduction in charging activity.** The total per-station charging load recorded at all actively reporting stations funded through the Charging Program in April 2020 was 66% lower than pre-pandemic levels in February 2020, indicating that pandemic-related

shutdowns significantly impacted the driving and charging behavior of National Grid customers in Massachusetts. During the course of PY2020, charging at public and workplace sites decreased, while MUD charging increased as the pandemic lockdowns began. As of December 2020, charging at site host facilities is down approximately 48% compared to pre-pandemic levels, showing that the impacts of the COVID-19 pandemic continue to be felt in MA.

- **Change in driving habits**. The majority of EV owners and community survey respondents indicated that the COVID-19 pandemic affected their regular driving habits, reporting that they take fewer long overnight and day trips and commute less. While most drivers expect to resume typical driving habits within 12 months, there remains uncertainty regarding timing, and some drivers do not expect to resume pre-pandemic driving habits.

**Finding #8: Revenue from EV charging is not a primary driver for site hosts to install stations.** Site hosts reported interest in offering EV charging as a low-cost, environmentally friendly amenity to attract staff, visitors, and/or customers, and they do not anticipate revenue from EV charging to be significant. Customers that profit from in-person visits, such as hotels, gas stations, and convenience stores, were interested in stations to gain a competitive advantage in attracting EV drivers, but customers that are less competitive and/or less financially reliant on in-person visits (e.g., municipal organizations, offices) install stations as an environmental signal and/or as an amenity.

**Finding #9: The high installation and EVSE costs continue to be a barrier to DCFC installation.** While the Charging Program made progress in increasing the number of installed and activated DCFC stations in PY2 compared to PY1, as of December 31, 2020, there were only 6 active DCFC stations and applications submitted for 25 additional stations. Most customers we spoke to ruled out DCFC stations because their motivations to install a station did not justify their high installation costs. Customers were primarily motivated to install stations to offer an amenity, to appear "green" or forward thinking, or to support organizational sustainability goals. The value of these charging station benefits to the organization was generally not great enough to warrant a high expense project.

**Finding #10: When selecting a charging station away from home, EV owners cite charging speed as an important factor, but few report that they will go out of their way to use fast charging stations.** While DCFC charging becomes more important for long trips, the fact that most EV owners will not go out go out of their way for fast charging remains a barrier to DCFC station development. Note that the COVID-19 pandemic has likely impacted these reported habits.

- **Recommendation #2:** Pursue alternative ownership and financing models that mitigate the high upfront infrastructure costs faced by prospective DCFC site hosts. These could include arrangements where National Grid owns and operates stations, as well as on-bill repayment or other financing strategies to reduce upfront capital requirements. Site hosts expressed interest in learning more about these types of solutions during PY2 interviews. Additionally, alternative ownership structures could encourage more widespread adoption of future proofing electrical infrastructure to support future EV growth.
- **Consideration A:** Consider pursuing regulatory approval to increase the incentives available to DCFC stations to cover EVSE. This would directly target the high-cost barrier to DCFC stations and could enable more prospective site hosts to consider incorporating fast charging as an amenity.[4]

## 1.3 Process Improvement Opportunities

**Finding #11: The process for EVSE data management and tracking does not capture all Charging Program station usage data.** The Charging Program requires that EVSE vendors provide National Grid with charging data for all stations funded by the program. National Grid requires that site hosts provide usage data for each activated station for a period of five years from the installation date and specifies a required data format but does not have a process to verify that data for each station complies with the data standard. Mapping EVSE data to individual stations is a manual process, resulting in frequent inconsistencies between tracking and charging data. Despite coordinated efforts by National Grid, the EVSE providers, and the ERS Team, 29% of the charging utilization data received could not be mapped to activated stations. While the remaining 71% of mapped data does provide insights on station utilization (See Finding #14), the mapping challenges make it difficult to ensure that the Charging Program is receiving data from all activated stations. Additionally, inconsistency in vendor-provided data formats further complicates the analysis of charging station utilization across multiple vendors at scale.[5]

[4] While we are aware of other DCFC incentives available in Massachusetts, such as the MassEVIP DCFC Program, we still encourage National Grid to expand its DCFC incentives to ensure prospective site hosts have access to necessary capital to offset high upfront station costs.

[5] We acknowledge that this is a relatively new program, with both National Grid and the EVSE vendors learning about data-related challenges and opportunities. However, it is important to apply strong oversight to the data management process now so that current and future data can be leveraged for future program enhancements; this oversight can include improved tracking data management, closer upfront review of vendor charging data, and ongoing engagement with vendors to ensure continued data consistency.

- **Recommendation #3:** Standardize the station ID tracking process to accurately log the station IDs of program-funded stations as they are installed in an analysis-friendly format. Strengthening this tracking system, and working with EVSE suppliers, trade allies, and station developers to understand their practices for tracking and communicating station IDs, will ensure that station IDs are accurately provided to National Grid at the time stations are activated. This would enable National Grid to more confidently and efficiently link charging data to individual stations, ensuring full data coverage and streamlining analysis capabilities internally and for evaluators.
- **Recommendation #4:** Conduct upfront quality control for each EVSE vendor and station to ensure that the vendor-provided data meets program data requirements and is suitable for ongoing analysis. As the program scales and greater volumes of charging data are provided by a broadening vendor pool, the challenge of data compatibility and integration across multiple vendors will grow. Developing a "charging data evaluability checklist" or other formalized process and requiring approval of vendors' proposed data formats has proven effective in other data-driven evaluations the ERS Team has conducted and has resulted in the seamless transfer of years' worth of interval data.

**Finding #12: While National Grid is technology agnostic and promotes all approved EVSE providers, there is little supplier diversity in activated stations; one EVSE provider continues to provide the overwhelming majority of Charging Program stations and utilization.** While the number of vendors with activated stations in the program and reporting data increased in PY2, a single EVSE vendor's equipment is used at 89% of actively reporting stations and 89% of the kWh charged program-wide. Customers rely on EVSE suppliers and/or vendors to guide them through the process, and strong vendor relationships are important for successful program experiences.

- **Recommendation #5:** Continue to provide resources to participating and potential site hosts about eligible EVSE providers to encourage EVSE supplier diversity. National Grid and participating vendors are already actively providing site hosts with resources on EVs and EVSE, but additional information on all available EVSE technologies for all customers can help promote further participation and encourage the use of other vendors.

**Finding #13: The EV charging station market is still immature; some customers could have benefited from additional information about the program and support in making the decisions necessary to install EV charging stations**. While most customers appreciated the turnkey-type support provided by their vendors, some expressed difficulty in finding program information themselves. All ten customers who provided suggestions for improving the program noted that they were interested in more program-related information such as details on program processes, timelines, and additional information on EV charging. Five of those

customers specifically said that they did not know where to start, and could not find information about the program to use in their planning (for more details, see Program Satisfaction and Feedback in section 4.1.3).

- **Consideration B**: Enhance customer-facing program information and process steps to improve prospective site hosts' understanding of program mechanics and EV charging technology basics. Site hosts are not in the EV charging business and would like additional information about the program, EV charging station benefits, and EVSE vendors to improve their program experience.

**Finding #14: Insights from the charging station utilization analysis can help National Grid refine program offerings to increase utilization, raise EV awareness, and pilot advanced load management technologies.** The key observations and corresponding program considerations include:

- **Concentration of utilization among few workplace and public stations.** Station utilization is concentrated at a few workplace and public site hosts, with just four sites (13%) responsible for 70% of the workplace segment's kWh and 13 sites (12%) responsible for 70% of the public segment's kWh. We note that this trend may be the result of the pandemic and could evolve as EV adoption increases, and pandemic-related restrictions ease to allow site hosts and the broader public to resume more regular operations.
  - **Consideration C:** The concentration of utilization suggests an opportunity for National Grid to work with underutilized stations to ensure that they are providing targeted education and marketing to their prospective users to increase awareness of both EVs and the availability of installed charging stations. Finding #6 suggests that the presence and visibility of a workplace charging station has positive effects on EV awareness and adoption.[6]
- **On-peak impacts vary across segments.**[7] Charging stations in different segments have different on-peak impacts, depending on the type of facility and the type of charging they support. Two-thirds (67%) of kWh are charged on-peak for the program's only actively reporting DCFC station and 46% of kWh are charged on-peak for the most

[6] The ERS Team understands that general marketing and education activities to increase EV adoption are not eligible for funding under the current program. It is worth noting, however, that a future program in which those activities are eligible may be able to address lagging utilization at already-funded stations through such activities.

[7] Here the "peak period" (including the use of the phrases "on-peak" or "off-peak") refers to the 1–9 p.m. window defined by the SmartCharge Massachusetts Program, not the distribution system/coincident peak.

utilized public sites. On-peak coincidence for the most utilized stations in the workplace (33%) and MUD (39%) segments is lower, though these segments show significant load concentration around midday (workplace) and overnight (MUD).

- **Consideration D:** In developing future managed charging programs, given the variable peak impacts across different segments, National Grid should tailor solutions based on segment, the existing load shapes, and the type of charging to ensure the program balances grid value against the customer charging experience.

- **Opportunity for load-shifting at long-dwell charging sites.** Several segments support long-dwell charging, where EVs are parked for long stretches and present an opportunity to deploy smart EV charging load management solutions to manage EV charging load. These "vehicle-grid integration" (VGI) solutions could allow National Grid to manage power flow to plugged-in vehicles in response to grid conditions while accounting for customer constraints.

  - **Consideration E:** National Grid should consider piloting VGI solutions at one or more long-dwell site hosts to evaluate the effectiveness and value of these approaches alongside any customer satisfaction impacts. Several large utilities around the country have piloted programs that leverage VGI solutions, including demand response and load optimization. A literature review would provide an overview of the effectiveness and customer experience impacts of these programs to inform any National Grid pilots.

  - **Consideration F:** National Grid should consider aligning outreach efforts for other distributed energy resources (DERs) alongside the Charging Program efforts. Co-locating DERs, such as solar and energy storage, with VGI-ready EV charging, provides an opportunity to increase renewable power generation and load flexibility and would allow National Grid to streamline efforts to expand multiple grid edge technologies.

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 2 (PY2), running from January 1, 2020, to December 31, 2020.

## 2.1 Electric Vehicle Charging Station Program Overview

National Grid's EV Charging Program seeks to increase the deployment of Level 2[8] and Direct Current Fast Charging (DCFC)[9] 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 regulatory filings 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 site host projects and determining the strategic direction of the program.

[8] 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.
[9] 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.

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.[10]

The PY2 evaluation objectives are to:

- Assess progress against charging station development goals.
- Measure technical impacts such as station utilization and development costs.
- Gather additional information from site hosts regarding the program.
- Gather additional information from EV owners and select communities regarding EV awareness, knowledge, attitudes, and behaviors regarding EVs and their charging infrastructure.
- Develop recommendations to enhance the Charging Program.

In PY3, the ERS Team will assess annual and overall progress against charging station development goals. 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.

[10] 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: EV owner, employee, and resident surveys**. The ERS 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 baseline survey of existing EV owners and for three communities that recently installed EV charging stations through the program. During PY2, the evaluators conducted follow-up EV owner and community surveys, as well as additional surveys of employees at workplaces installing charging stations.
3. **Task 3: Participant, prospective participant, and nonparticipant site host interviews**. The ERS Team completed in-depth interviews with site host decision-makers installing charging stations, considering participation, 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, and 24 site host interviews in PY2.
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 PY2 of this evaluation:

- **Program information review** – The ERS Team 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 program information, tracking spreadsheets, and other materials.
- **Site host interviews –** The ERS Team completed 5 interviews with prospective DCFC site hosts in PY1 (2019) and 24 additional interviews during PY2 (2020) with participating, prospective, and nonparticipating site hosts.
- **Customer surveys** – The ERS Team leveraged the survey instrument developed in PY1 to conduct follow-up interviews with EV owners and communities, as outlined below.

- **EV owner follow-up survey** – The ERS Team conducted a follow-up survey with EV owners to identify any changes to EV owner reported driving, charging, and vehicle purchasing behavior and experiences.
- **Site host community survey** – During PY1, the ERS Team worked with National Grid to identify three communities that had recently installed publicly accessible EV charging equipment: Lowell, Haverhill, and Boxford. The team selected these communities because of the number of recently installed and/or planned charging stations. The evaluation team surveyed customers in these towns during PY1 in November 2019 and during PY2 in October 2020 to determine if there were changes in residents' awareness and perceptions of EVs and charging opportunities over time.
- **Workplace surveys –** The ERS Team conducted site host employee surveys for two Charging Program site hosts, one with employees at a large manufacturing facility in eastern Massachusetts, and one with employees and sustainability council members of a large city that installed a suite of municipal charging stations.

- **Data analysis** – The ERS Team conducted data analysis to understand progress against program goals, assess charging station utilization and greenhouse gas (GHG) emission reduction 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, 2020.
  - **Station ID mapping.** The ERS Team mapped the station IDs contained in the provided charging data to individual records in the program tracking spreadsheet, working closely with National Grid staff and EVSE provider representatives. This mapping exercise was necessary to link the analyzed utilization data – which consists of charge session counts, charging kWh totals, load profiles, and other measures of charging activity – to program tracking records indicating each station's charger type, station use, segment, EJ status, location, and more. In this round of evaluation, the ERS and National Grid teams successfully mapped 71% of the charging data to be used in the analysis. The remaining 29% of charging data, which included EVSE station IDs from 73 stations, charging 161,634 kWh, could not be

successfully mapped to records in the project tracking spreadsheet and were excluded from the utilization analysis.[11]

- **Charging station data analysis**. The ERS Team analyzed charging session data from 342 charging stations – 341 Level 2 and 1 DCFC – from six different EVSE vendors in PY2. Data sets were provided to National Grid and included continuous program charging activity covering all program charging from January 1, 2019, through December 31, 2020.
  - 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, 92% of the charging station data passed all QC checks, suggesting that overall data quality is sound; note, however, that this is 92% of the 71% of data that was successfully mapped to a project in the tracker, resulting in an overall data usability rate of 65%.
  - 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 emissions reduction 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.

[11] The excluded charging data could not be successfully mapped to any projects from the program tracking spreadsheet. This suggests that a portion of the tracked station IDs are missing or inaccurate. It is also possible that some of the charging data the ERS Team received does not belong to a program-funded station, in which case it *should be* excluded from our analysis; however, it is not possible to determine whether this is the case without a full and accurate list of tracked station IDs.

# 4 RESULTS AND FINDINGS

This section contains the results and findings from the PY2 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: Site Host Interviews
- Section 4.2: Charging Program Data Analysis
- Section 4.3: Electric Vehicle Owner Follow-up Survey
- Section 4.4: Participant Community Follow-up Survey
- Section 4.5: Impacts of the COVID-19 Pandemic
- Section 4.6: Workplace Surveys

## 4.1 Site Host Interviews

Between 2019 and 2020, the ERS team completed a total of 29 site host interviews. In 2019, the ERS team completed five initial interviews with prospective DCFC site hosts and then completed 24 additional interviews between July and November 2020. The 24 interviews conducted in 2020 were predominately with Level 2 station customers but also included a couple of DCFC customers (for details about the interviewed customers' characteristics, see Section 1.2 Site Host Characteristics).[12] The following section focuses on the findings that emerged during the 2020 interviews with nonparticipating, prospective, and participating site hosts.

While this research task is referred to as the "site host interviews," throughout this section the term "customer" is used in lieu of "site host" since most people who were interviewed had not yet installed a station. Also, since there is overlap in the findings between customer types (e.g., nonparticipant, prospect, and participant), the findings are generally not disaggregated by customer-type unless it is relevant to note.

Because customers did not necessarily distinguish between EVSE suppliers and installation vendors, the term "vendor" is used throughout the report to refer broadly to the EVSE supplier and/or installation vendor with which customers worked.

[12] These 24 interviews were conducted during the COVID-19 pandemic.

### 4.1.1 Site Host Interview Findings

The ERS team's findings from the site host interviews are summarized here:

- The program is very influential on customers' decisions to install EV charging stations, and customers need incentives to get stations installed. Customers were generally opportunistic when engaging with National Grid's Charging Program – they did not necessarily have a *need* to install stations but were heavily motivated by the funding opportunity. Overall, regardless of organization type or station type, the availability and amount of external funding customers could receive for an EV charging station heavily influenced and motivated their pursuit to install stations. Many of the customers interviewed in 2020 would not have pursued a station installation at the time they did without external funding covering most or all of the project cost. This is consistent with the 2019 finding that customers with multiple locations were prioritizing projects across utility territories and states based on the available incentives.
- Customers rely on EVSE suppliers and/or installation vendors to guide them through the process of installing a charging station; establishing a strong vendor relationship is important for customers to have a smooth program experience. Vendors play an important role in moving EV charging station projects forward. Without a guide through the program and EV charging station decisions, customers may have trouble planning and completing the project. The need for such a guide might be especially important given the variety of roles held by the people in the customers' organization managing EV charging station projects. Most customers interviewed had a close relationship with at least one vendor who guided them through the station installation process. Vendors often informed customers about funding opportunities (both governmental and utility resources), scoped projects, completed funding applications, and managed station installation.
- The EV charging station market is still immature; some customers could have benefited from additional information about the program, support in making the decisions necessary to install EV charging stations, and general information to improve their understanding of EV charging stations. While most customers appreciated the turnkey-type support provided by their vendors, some expressed difficulty in finding program information themselves. All ten customers who provided suggestions for improving the program noted that they were interested in more program-related information such as details on program processes, timelines, and more information on EV charging. Five of those customers specifically said that they did not know where to start and could not find information about the program to use

in their planning. As one customer noted after failing to find the desired information on the website, it appeared to be a "hidden program."

- Profit is not a driver for installing chargers; rather, customers are more interested in the environmental benefit and stations as a service to their visitors and staff. Customers that profit from in-person visits, such as hotels, gas stations, and convenience stores, were interested in stations to gain a competitive advantage in attracting EV drivers, but customers that are less competitive and/or less financially reliant on in-person visits (e.g., municipal organizations, offices, etc.) install stations as an environmental signal and/or as an amenity. Several customers stated that they did not want to be in the EV charging business because they already had a business to manage. Accordingly, many customers were interested in EV charging station arrangements where a third party, such as National Grid or an EVSE supplier, owns and operates the stations on site.
- **High installation costs (including EVSE) continue to be a barrier for DCFC installation.** Most customers we spoke to ruled out DCFC stations because their motivations to install a station did not justify their high installation costs. Customers were primarily motivated to install stations to offer an amenity appear "green" or forward thinking, or to support organizational sustainability goals. The value of these charging station benefits to the organization was generally not great enough to warrant a high expense project. Accordingly, most customers interviewed were only interested in Level 2 stations because National Grid's program would cover most or all of the costs, whereas with DCFC stations they would need to finance a much larger expense. While there are companies that are solely focused on developing a network of DCFC stations that they own and operate, the slow adoption of DCFC stations may slow broader EV adoption.[13]

### 4.1.2 Site Host Characteristics

Across 2019 and 2020, the evaluation team completed 29 interviews. In 2019, we spoke to five customers – large retail businesses, gas stations, and convenience stores – that considered installing DCFC stations through National Grid's Charging Program. At the time of the interviews, two of the five customers had submitted applications for DCFC stations in Massachusetts. In 2020, we interviewed 24 customers (12 participants, eight prospects, and four

[13] DCFC stations are seen as key infrastructure to advance EV adoption; however, participant and prospective site hosts have little to no interest in installing DCFC stations due to the cost. The 2020 EV Driver Insights report by FleetCarma hypothesizes that as vehicle range increases and the availability of fast chargers increases, more consumers will fully transition to EVs (i.e., they will not own a back-up ICE vehicle). Source: 2020 EV Driver Insights, FleetCarma.

nonparticipants) classified based on their experience with the program at the time of the interviews.[14] We classified four customers who had not yet had their stations installed but were certain they would install stations soon and four customers who had recently begun installing their station(s) as participants. In the 2020 interviews, most customers had installed or considered Level 2 stations. There was one customer who had installed a DCFC station and another who was considering installing DCFC stations. Table 4-1 and Table 4-2 provide additional details about the customers interviewed in 2020.

**Table 4-1. Station Type by Participant Type in 2020**

| Customer Type | DCFC | Level 2 | Both |
|---|---|---|---|
| Participant | 1 | 11 | 0 |
| Prospect | 1 | 7 | 0 |
| Nonparticipant | 0 | 4 | 0 |
| **Total** | **1** | **22** | **0** |

**Table 4-2. 2020 Interviewees' Business Type by Participation Status**

| Business Type | Participants | Prospects | Nonparticipants |
|---|---|---|---|
| Municipal organizations | 4 | 2 | 1 |
| Non-profits | 1 | - | - |
| Retail/entertainment | 1 | - | - |
| Industrial office park | 1 | - | - |
| Religious institution | 1 | - | - |
| Business/property owner | 1 | - | - |
| Veterinary clinic | 1 | - | - |
| Manufacturing facility | 1 | - | - |
| Educational institution | 1 | 1 | 1 |
| Real estate management | - | 1 | - |
| Hotel management | - | 1 | - |
| Law office | - | 1 | - |
| Infrastructure developer[1] | - | 1 | - |
| Recreational site | - | 1 | 1 |
| Hospital | - | - | 1 |
| **Total** | **12** | **8** | **4** |

[1]This organization submitted applications on behalf of a national food chain and represented them during the interview.

[14] Participants are customers who have either committed to installing a charging station, are in the process of installing a station, or have completed the station installation. Prospects are customers who are considering installing stations, and may have submitted an application, but are not yet certain they will install one. Nonparticipants are customers who may have considered installing a station but decided not to proceed at this time.

Interviewees who were leading and managing the EV charging station projects held a variety of roles within their organizations. For example, we spoke to people who were business owners, general administrative staff, city planners, sustainability officers, a librarian, educators, and a volunteer. Generally, the people interviewed were not the ones who held relationships with National Grid sales representatives but were the key stakeholders for their EV charging station project.

### 4.1.3 Program Experience

The following section describes the ways in which the customers interviewed in 2020 learned about the program and the steps they took to participate in it, as well as their program satisfaction and suggestions for improvement.

#### *Program Awareness*

Customers most commonly had learned about the program from a vendor. Sometimes the vendor approached the customer about the program, other times the customer learned about it from a vendor with whom they had a preexisting relationship, and in two cases the customer reached out to contractors for information about EV charging stations and learned about the program through those interactions. Five customers discovered the program through their own research and knowledge to check utilities for incentive programs. Six customers learned about the program from National Grid outreach (four learned through their National Grid representative and two heard presentations about the program at conferences they attended). Two other customers did not recall how their organization had learned about the program; they were asked to learn about the program and manage the projects.

The people managing EV charging station projects might be less aware and knowledgeable of National Grid's resources and programs than contacts National Grid typically works with. As noted above, most of the people interviewed were not the ones who maintained their organization's relationship with National Grid. Accordingly, their awareness of National Grid's resources and programs might be more limited than organization contacts that have participated in other offerings.

#### *Program Satisfaction and Feedback*

Customers were satisfied with the program and its processes and did not think that there were any major barriers to becoming a site host. Customers tended to have very little interaction with National Grid staff and program materials; vendors were their primary contact throughout the process. Those that did interact with National Grid staff generally had positive feedback, such as:

*"The folks we worked with were great." – Municipal Organization, Prospect*

*"It felt like [National Grid] was on my side." – Business and Property Owner, Participant*

A majority of customers relied on their vendor to handle most aspects of the project, including developing the project scope and design, finding and completing the applications for funding, and managing the station installation. Accordingly, most customers thought the process was fairly smooth and easy since the vendor handled it.

*"[Our vendor was] really helpful about working with the town, getting the permits, doing inspections, working with National Grid or Eversource. So, it was just a pretty easy sort of turnkey operation with them." – Non-profit, Participant*

Ten customers identified some opportunities to improve the program (five participants, four prospects, and one nonparticipant). These customers were generally interested in more information about program processes, timelines, and information about EV charging stations to inform their decisions. Five of these customers highlighted that they did not know "where to start" since they did not think they were particularly knowledgeable about EVs, charging infrastructure, or vendors. Two customers also noted some dissatisfaction with National Grid's turnaround in reviewing their application.

One customer who operates in multiple states did not know where to start with National Grid's program and suggested that National Grid manage more of the project scoping and vendor selection process rather than leaving it to the customer to figure out. This customer thought that National Grid's program was too time-consuming to get going because they needed to find all the vendors and then run the project, which they did not have time, resources, or knowledge to do. Despite having learned about the program a year ago, this customer only more recently submitted an application with National Grid after gaining experience installing charging stations elsewhere.

*"I didn't know enough to be the project manager of a National Grid [station project] …there's no reward and it becomes a full-time job." – Real Estate Management Business, Prospect*

The five customers who were not sure where to start also struggled to find information about the program to inform their project planning. For example, one customer looked for the program website but thought that it seemed like "a hidden program," which aligns with other customers' comments that they could not find enough details about the program steps, timeline, equipment, and cost. Among these five customers, only one – who had established a relationship with a vendor – progressed to station installation.

Notably, four of the seven municipal organizations interviewed were among those who expressed some dissatisfaction:

- One participant municipal organization wanted more support from an independent third party – "someone other than the person trying to sell me the equipment."
- One participant municipal organization wished that National Grid had more clearly defined and explained the participation steps and timeline – possibly through a webinar or through case studies of other municipal projects. They also thought that the time between completing the application and installation was too "strict" and did not allow them to complete their research to inform their decisions.
- A nonparticipant municipal organization identified three main "hurdles" that led to some dissatisfaction: Procurement, the legal terms and conditions, and uncertainty with National Grid's application review process. The procurement barrier was similar to the barrier of not knowing "where to start" or having enough resources to develop a scope of work for vendors to bid. For terms and conditions, they were uncomfortable with the liability clause in the program documentation. Lastly, planning the project was difficult since the application review process, turnaround time, and the incentive amount were not clearly explained. The ambiguity of this information created an additional barrier for them to start the procurement process because they did not want to proceed if the incentive was too low.
- Finally, one participant municipal organization felt that they had stumbled upon the program only because of their professional connections and experience with utility incentive programs. This customer expressed some frustration with the difficulty they had trying to find detailed program information explaining how to participate and completing the program application, noting that they had to "chase down" a lot of information to complete it. They suggest that National Grid should more clearly outline and present the program's processes and consider streamlining the application.

### 4.1.4 Motivations and Decision-Making

The following section describes customers' motivations to participate in the Charging Program, as well as the ways they made decisions about station type, quantity, location, and the fee structure for station use.

#### *Motivations to Install Stations*

Customers are most interested in installing EV chargers for competitive or environmental purposes. Specifically, customers were primarily motivated to install charging stations for the following reasons:

- The organization wanted to demonstrate care for the environment and show they were forward thinking – this tended to be a mix of the decisionmaker's beliefs and a marketing strategy.

- The organization wanted to offer charging as an amenity to its employees and/or visitors.
- The decision-maker had an EV that they wanted to be able to charge at work.

Motivations vary by type of organization. Businesses that profit from in-person visits (e.g., hotels, gas stations, convenience stores) consider EV charging stations as an opportunity to give themselves a competitive advantage and a tool to draw EV drivers to their business. For example, in addition to "being green" and providing an amenity, a hotel management business interviewed in 2020 noted that they wanted to install stations to accommodate the EV driver market. This customer did not expect to make money from people charging at their stations, but they did hope that the stations would ensure they could attract EV drivers to their hotel.

> *"There is that aspect to it, of us supporting that initiative of, I guess, "going green" for a lack of a better term… attracting guests is where I see that we would actually bring financial value to the properties. I don't see these stations as being a huge revenue generator…but [the main benefit is] attracting guests with EV vehicles that would otherwise be forced to stay at a different property that had their stations, if we did not." – Hotel Management Business, Prospect*

The revenue-related motivation to attract and/or retain customers was not common among the customers interviewed in 2020, but it is similar to the motivations of the gas stations and convenience stores interviewed in 2019 as prospective DCFC site hosts. During the 2019 interviews, we learned that gas stations and convenience stores sought ways to engage the growing EV driver market and draw them into their stores. The hotel, gas station, and convenience store customers we interviewed are in more competitive markets than other customers, so offering EV charging stations as a service for EV drivers has financial value to them by giving them a competitive edge in the market.

Organizations that are less competitive and/or less financially reliant on in-person visits (e.g., municipal organizations, offices, manufacturing sites, educational institutions) primarily install stations to help the environment and/or provide an amenity to their employees and/or visitors. This aligns with the motivations of the large retailers interviewed in 2019. The retailers were content with third-party ownership models and sought out "fully-funded DCFC opportunities that are zero impact to them – no cost or financial benefit."

> *"We thought it would be a good idea, both from a visual and knowing where the world is headed and saw a nice financial opportunity with National Grid to get a lot of these charging stations in place for relatively short money…but the original motivation for this came when [some staff] asked for the ability to have charging stations." – Retail/Entertainment Business, Participant*

The customers interviewed did not view direct revenue from the charging stations as a motivating factor for installing charging stations. The only instance where profit from users charging at stations was described as a motivation was during an interview with one infrastructure developer who had submitted applications on behalf of a national food chain. The vendor operates throughout the country with the goal of creating a network of DCFC stations that they own and operate on their clients' properties. Their business model is based on the idea that some customers want to support EV technology and have it on site, but they do not necessarily want to manage it, which is consistent with our interview findings (see section 1.5.3, National Grid Owned-Operated Stations).

#### *Selecting the Type of Station*

With the exception of two customers interviewed in 2020, all interviewees said they only considered installing Level 2 stations. When selecting the station type (DCFC vs. Level 2), customers primarily considered the available incentives. Secondary considerations included length of stay at the property and proximity to transportation corridors.

**Available incentives** were key factors when deciding to install a station because without incentives covering most or all of the associated costs customers thought it was cost prohibitive and likely would not have proceeded with their project. According to interviews completed throughout this study, incentive availability is especially important for customers to consider a DCFC station given that they are much more costly compared to Level 2 stations. When Level 2 customers were asked whether they had considered installing a DCFC station, most reported that there was little to no discussion of DCFC stations internally or with their vendor, mainly because the out-of-pocket cost for a DCFC station was too high even with currently available incentives.

**Length of stay at the property** relates to the length of time that employees, customers, or visitors typically park at the location. Length of stay helps identify which charging speed is sufficient in order to be useful for the people coming to the property. For example, although the 2020 hotel customer had similar motivations to install stations as the gas stations and convenience stores from 2019, the hotel customer did not see the value of installing DCFC stations on site since most of their users would presumably charge overnight during their stay, thereby making fast charging unnecessary. However, the gas stations and convenience stores only considered DCFC because they expected their users to make a "pit stop," which lends more to fast chargers.

**Proximity to transportation corridors** considers the project site's distance to a major roadway, such as a highway or interstate. The proximity consideration also helps identify whether there is a practical need for a DCFC station given the level of traffic. For example, a non-profit customer did not consider DCFC stations because they heard that such stations cost nearly

$100,000, and they did not think it would be "a good investment for utilities because [their site doesn't] have the type of traffic as you'd have along the turnpike."

The one DCFC participant interviewed in 2020 is an example of how these three pieces led to their decision to install one DCFC station. Originally, they were only considering Level 2 stations, until they learned that they were eligible for additional incentives that covered most of the cost of a DCFC station since they were in an environmental justice community. In addition, a DCFC station made sense to the property owner because the site is located near an interstate and contains a coffee shop; therefore, the property owner felt that the DCFC station would be utilized given these features of the site.

#### *Station Placement and Quantity*

Customers generally left decisions about station placement and quantity up to their vendor. Stations were typically located in parking spaces that were the least-cost-path from existing electrical equipment. Vendors sometimes suggested additional stations to customers with available parking in order to maximize the National Grid incentive. Only three customers in the 2020 interviews explicitly noted concerns about the EV stations impacting the number of parking spaces – most were not concerned about stations taking over parking spots.[15]

#### *Station Fee Structure*

As noted above, most customers were not motivated to install stations as a means to generate revenue and they generally did not have a cost-recovery plan for the full cost of the stations. Most customers only planned to charge station users a fee to recoup the electricity costs. Five customers did not plan to charge for station use and five others were still unsure. Again, the decision to breakeven or not charge at all was driven by customers' disinterest in turning the EV charging station(s) into a money-making venture. Customers "don't want to be in the EV charging business," but they do want to support the technology as a means to protect the environment and provide a service or amenity to their employees and visitors.

### 4.1.5 National Grid Interest Areas

In addition to understanding customers' program experience and decision-making to install stations, National Grid expressed interest in learning more about customer interest regarding future proofing, stations owned and operated by National Grid, and on-bill repayment, as well as the effects of the COVID-19 pandemic on the program.

[15] This contrasts findings from the 2019 prospective DCFC site host interviews where some customers, such as convenience and grocery stores, identified underutilized parking spaces as a barrier to installing stations since it could adversely affect their sales potential. These businesses thought that the volume of EV owners using those parking spaces and making purchases would be less than if those spaces were available to everyone.

### *Future Proofing Sites*

Since the Charging Program funds up to 100% of electrical infrastructure for approved projects, National Grid was interested in understanding whether customers were considering "future proofing sites" so that the electrical capacity could accommodate additional stations in the future. During the 2020 interviews, the ERS Team asked 21 customers about future proofing sites. Very few of these customers were intentionally future proofing sites. Future proofing sites had not occurred to most customers, so they did not have much of a perspective formulated on the topic or much interest. Some thought they could handle future stations based on the existing electrical infrastructure, but this was not deliberate.

There were seven customers who had or were considering future proofing their site. Of these, five had intentionally installed additional wiring for a future station, and one had explicitly cited National Grid's rebates as the motivation – he figured he "might as well do it now," while the rebates are available. The infrastructure developer representing a national food chain said that "as a rule of thumb," they lay enough electrical infrastructure to support double the stations that they initially install.

For a real estate management firm, future proofing with National Grid's incentives was very important. Most of their tenants are affiliated with the state and federal governments and they expect they will be required to electrify their fleets before others, so they want to get ahead of their future needs. This customer was also cognizant of possible future zoning changes that would require a certain number of stations on a property. The customer anticipated that they would need to come into compliance with such zoning requirements whenever they did a major renovation to their buildings, which they do every decade or so. Accordingly, they would rather install enough infrastructure now while there are incentives than pay full price at a later date. In other words, they see EV stations as inevitable and are planning long term to 1) accommodate their tenants' needs and 2) save themselves a few dollars down the road.

### *National Grid Owned and Operated Stations*

National Grid wanted to learn whether customers are interested in an arrangement where National Grid owned and operated EV charging stations at customer facilities, thereby removing the customers' need to finance and manage the stations. Of the 22 customers asked, most (n=18) were interested in learning more about such an arrangement, with several expressing that it would be ideal for them since they "just want this as an amenity and aren't interested in being in the EV station business."

> *"I think that would be a great setup if National Grid just ran it so that it was their charging stations on our property…that would make it very simple…financing and things like that,*

> *wouldn't be a concern… it keeps National Grid in the business that they're normally in of selling electricity and it keeps us in our business of just offering services to our community."*
>
> *– Municipal Organization, Prospective Site Host*

Four customers indicated that they were not interested in an arrangement where National Grid owned and operated stations on their property. Three of these customers cited concerns about access to land and "remaining in charge" of their facilities; the other one was an EV station vendor and such an arrangement would conflict with their business model.

#### *On-Bill Repayment*

National Grid also wanted to explore the possibility of offering On-Bill Repayment (OBR) for any customer costs that are not covered by the program incentives. This would allow customers to make monthly payments through their utility bill rather than financing the project another way. Of the 16 customers asked, most were interested in learning more about the arrangement. Several were already familiar with OBR because they had used it on past energy efficiency projects with National Grid.

Four customers were not particularly interested in OBR for varied reasons. One was not interested simply because the station's cost was wrapped up in a larger construction project and the rebate was covering most of the expense, one did not think they would do the project if they had anything remaining to pay, and another thought that an OBR arrangement might not fit with their accounting department's processes since they generally prefer to pay for expenses in the year they occur.

#### *Impacts of the COVID-19 Pandemic*

Among the 14 customers asked about the impacts of the COVID-19 pandemic on their project plans, many (10 out of 14) reported that the pandemic had little to no impact on their plans. Four customers said that the pandemic had significantly delayed their EV station projects, and three customers said the pandemic had "some" impact on their planning.

The customers whose projects halted due to the COVID-19 pandemic (two municipal organizations, one recreational site, and one educational institution) cited budget and resource constraints, as well as shifting priorities. Two explained (both municipal organizations) that projects had been halted out of concern for the health of their budgets and potential bad optics of spending scarce dollars on charging stations. The recreational site explained that their priorities had shifted – and therefore staff and financial resources also shifted – toward improving the safety of their facilities to minimize COVID-19 risk. The educational institution cited both budget and changing priorities as the reason they stopped their EV charging station project.

The three customers whose projects have been slightly impacted by the COVID-19 pandemic explained that it has mostly delayed their installation timeline. Two noted that they were being more mindful of their budgets since incoming revenue has slimmed during the pandemic and future income is a bit unpredictable. For all three, the effort to move the EV charging station project forward has also slowed because their facilities have not been used as much (or at all) during the pandemic; therefore, the "need" is less urgent since they likely would not be used at the moment.

## 4.2 Charging Program Data Analysis

This section presents the evaluation results of National Grid's Charging Program for PY2, which includes cumulative program results from January 1, 2019 through December 31, 2020. The high-level program findings are presented first, followed by additional detail regarding charging station and utilization results.

### 4.2.1 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 a cumulative total of 447 stations through December 31, 2020.** In PY2, the program activated 338 Level 2 Stations and 1 DCFC stations. The program target (or mid-point) goal is 680 stations.[16] Broken out by station type, the program overall has activated 445 Level 2 stations and 2 DCFC stations to date. Through PY2, the activated stations represent 66% of the program target goal, exceeding National Grid's internal goal of 35% for PY2.
- **The Charging Program continues to have a strong pipeline of projects** across multiple stages of the lead generation and project development lifecycle. In addition to the 447 activated stations through December 31, 2020, there were also a total of 558 stations in the pipeline.
- **Without targeted incentives, DCFC station installations face barriers to development.** The program has 2 activated DCFC stations, 6 stations in flight, 1 committed, and 22 stations with applications submitted as of December 31, 2020; this amounts to 31 DCFC stations (activated and in the pipeline). The barriers to DCFC station development, which include high costs, limited available capital and incentives, and complex decision-

[16] The Charging Program has a goal to activate a minimum of 510 stations, a target or mid-point goal of 680 activated stations, and an exemplary goal of 850 activated stations.

making requirements, were discussed in detail in the PY1 report and are addressed in Section 4.1.

- **The Charging Program is succeeding in incentivizing publicly accessible stations and stations within environmental justice (EJ) communities**. Approximately 74% of activated stations are classified as publicly accessible, representing about 65% of all charging kWh recorded through 2020. Of the 447 activated and in-flight stations as of December 31, 2020, 46% are located in EJ communities meeting at least one of the EJ criteria, and 21% are located in communities meeting two or more EJ criteria, making them eligible for enhanced program funding, compared to a goal of 10% of Level 2 stations developed in EJ communities.[17]
- **Program project tracking has improved since PY1.** The program uses a Microsoft Excel spreadsheet 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 recognized improvements in tracking in PY2 compared to PY1.
- **Most charging takes place at public and workplace Level 2 stations.** Of the total of 393,520 kWh charged through PY2, 98% (386,865 kWh) occurred at Level 2 stations. Approximately 65% (252,252 kWh) of all Level 2 charging has occurred at public stations, 33% (128,652 kWh) has occurred at workplace stations, and 1.5% (5,962 kWh) comes from MUD stations. Normalized by station, workplace stations charged 1,629 kWh per station while public stations charged 1,042 kWh per station and MUD charged 298 kWh per station.
- **The COVID-19 pandemic had a significant impact on charging at activated stations.** The total per-station charging load in April 2020 was 66% lower than pre-pandemic levels (February 2020). Public charging, the most active segment, saw an approximately 67% reduction in charging as a result of the pandemic, while workplace charging dropped 66%. MUD charging spiked as the pandemic began, though it is not possible to directly link this observed behavior to the COVID-19 pandemic due to a lack of sufficient pre-pandemic data availability for this station use category. As of December 2020, charging at site host facilities is down approximately 48% compared to pre-pandemic levels, showing that the impacts of the COVID-19 pandemic continue to be felt in Massachusetts.
- **One EVSE supplier is responsible for 89% of actively reporting stations as well as 89% of the kWh charged program-wide through PY2.** While National Grid is technology-agnostic and promotes all approved EVSE providers, there is little supplier

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

diversity in activated stations to date. It is worth nothing that the number of vendors reporting data increased in PY2 relative to PY1.

- **Station utilization is concentrated at a few workplace and public site hosts,** with just four sites (13%) responsible for 70% of the workplace segment's kWh and 13 sites (12%) responsible for 70% of the public segment's kWh. This may be related to the COVID-19 pandemic and the ERS Team will continue to monitor this trend.
- **On-peak impacts vary across segments,** depending on the type of facility and the type of charging.[18] Two-thirds (67%) of kWh are charged on-peak for the program's only actively reporting DCFC station and 46% of kWh are charged on-peak for the most utilized public sites. On-peak coincidence for the most utilized stations in the workplace (33%) and MUD (39%) segments is lower, though these segments show significant load concentration around midday (workplace) and overnight (MUD).
- **Opportunity for load-shifting at long-dwell charging sites.** Several segments support long-dwell charging, where EVs are parked for long stretches; this presents an opportunity to deploy "vehicle-grid integration" (VGI) solutions to intelligently manage charging load in response to grid conditions while accounting for customer constraints.

### 4.2.2 Charging Station Development Results

**In PY2, National Grid made great progress toward the installations of Level 2 stations, most notably in public areas (77% of activated Level 2 stations) and workplaces (17% of activated Level 2 stations). During PY2, there were 338 Level 2 stations and 1 DCFC station activated through the Charging Program. To date, the program has activated a cumulative total of 447 stations, which represents 66% of the program target (or mid-point) goal of 680 stations (see Table 4-3 and**

Table 4-4Table 4-1).[19]

**Table 4-3. Charging Program Activated Stations by Program Year**

| Program Activation Station Goal (midpoint) | PY1 Activated Station Count | PY2 Activated Station Count | Total Activated Stations through PY2 | Progress Toward Goal (%) |
|---|---|---|---|---|
| 680 | 108 | 339 | 447 | 66% |

[18] All references to the "peak period" (including the use of the phrases "on-peak" or "off-peak") in this section refer to the 1–9 p.m. window defined by the SmartCharge Massachusetts Program, not the distribution system/coincident peak.
[19] M.D.P.U. No. 1441. Page 2.

**Table 4-4. Charging Program Activated Stations by Program Year**

| Charging Level | PY1 Activated Station Count | PY2 Activated Station Count | Total Activated Stations through PY2 |
|---|---|---|---|
| Level 2 | 107 | 338 | 445 |
| DCFC | 1 | 1 | 2 |
| **Total** | **108** | **339** | **447** |

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 "activated" or "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 status of "under construction."
  - **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 "application approved" or "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 "application 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 "project opportunity" or "in development."

There are additional statuses in the tracking data representing projects that are not actively moving forward, including "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 set an internal goal that at the end of PY2 that 35% (238 stations) of the program target mid-point goal of 680 stations would be either committed, in-flight, or activated. National Grid has exceeded this 35% commitment goal with 116% (788 stations) committed, in-flight, or

activated through PY2; broken out by station type, there are a total of 779 Level 2 Stations and 9 DCFC stations.

**Table 4-5. Charging Program Project Pipeline as of 12/31/20**

| **Roll-Up Status** (Ordered from most to least developed) | Site Count | Station Count |
|---|---|---|
| Activated | 189 | 447 |
| In-flight | 22 | 94 |
| Committed | 76 | 247 |
| Application Submitted | 74 | 191 |
| Lead Generation | 8 | 26 |
| **Total** | **369** | **1,005** |

While the program has experienced significant progress in PY2 for public and workplace stations, progress continues to be slower for MUD stations and DCFC stations. There are a total of 25 Level 2 stations at MUD sites in the lead generation and application submitted stages, and 22 DCFC stations with applications submitted, suggesting some uptick in progress in these segments. National Grid continues to actively engage an installation vendor to target MUD customers and help promote these stations as an amenity to their site. The program can also focus on targeting outreach towards developers of new MUD sites to promote adoption during the design phase of a new project, in addition to existing customers.

Table 4-6 presents the program progress for PY2 for both Level 2 and DCFC stations, measured in the number of charging stations. Note that MUD sites are not identified as locations intended for DCFC station deployment and are thus excluded.

**Table 4-6. Charging Program Progress – Station Counts – Through PY2**

| Station Use | Lead Generation | Application Submitted | Committed | In Flight | Activated |
|---|---|---|---|---|---|
| **Level 2** | | | | | |
| MUD | 8 | 17 | 47 | 0 | 23 |
| Public | 0 | 100 | 182 | 84 | 328 |
| Workplace | 18 | 52 | 17 | 4 | 94 |
| **Total Level 2** | **26** | **169** | **246** | **88** | **445** |
| **DCFC** | | | | | |
| Public | 0 | 18 | 1 | 6 | 1 |
| Workplace | 0 | 4 | 0 | 0 | 1 |
| **Total DCFC** | **0** | **22** | **1** | **6** | **2** |
| **Total** | **26** | **191** | **247** | **94** | **447** |

Figure 4-1 and Figure 4-2, below, show the growth of EV stations across the first two years of the Charging Program, overlaid with National Grid's electric service territory. The PY2 growth of activated stations is clear from these maps, as many stations that were committed or in-flight at the end of PY1 are now activated (in red on the graph).

**Figure 4-1. Level 2 and DCFC Stations in Massachusetts – as of 12/31/19**

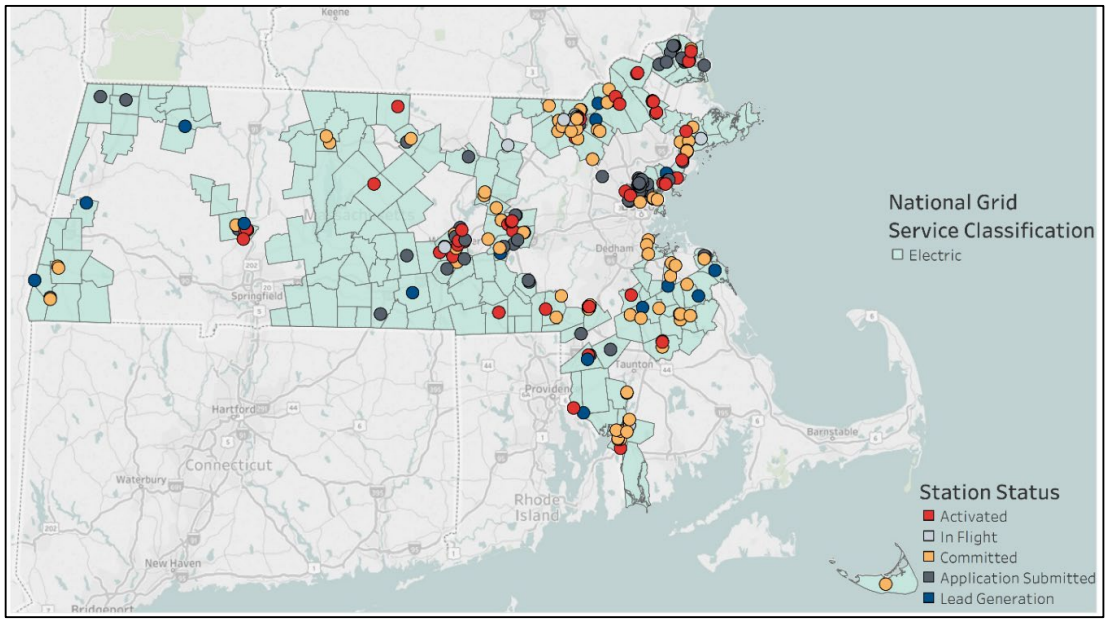
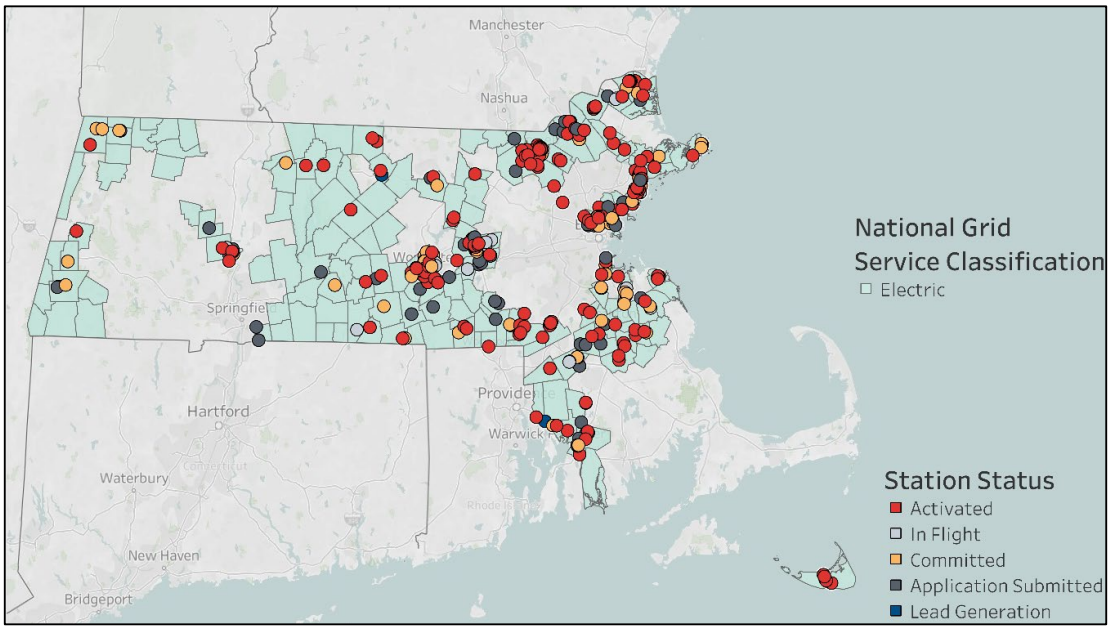



**Figure 4-2. Level 2 and DCFC Stations in Massachusetts – as of 12/31/20**



***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.

The ERS Team analyzed the infrastructure and EVSE costs for PY2 to summarize the "invoiced costs," which include all costs listed in project invoices, and the "paid costs," which reflect only the portion of the invoiced costs that are eligible for rebates through the program. Note that in PY2, the ERS Team analyzed updated cost values from the implementation team; the "invoiced" and "paid" costs analyzed are updated during the time of payment to reflect the actual amount, rather than an estimate that was reported in PY1. Total paid and invoiced costs are presented in Table 4-8 and Table 4-10 respectively, while Table 4-9 and Table **4-11** present average per-station paid and invoiced costs. This analysis is based on the 447 activated stations included in National Grid's program tracking spreadsheet.

The 445 Level 2 stations reporting data span three segments: MUD, publicly accessible, and workplace stations. The average total per-station invoiced cost (including installation and EVSE costs) was $20,831.39, and the infrastructure costs represented 62% of overall project costs. Table 4-7 below, compares the anticipated program costs to the actual costs to-date through PY2; the costs incurred are lower than the projection, reflecting the lack of activated DCFC stations.[20]

**Table 4-7. Program Filing Cost Comparison to Program Costs Spent to-Date**

| | Anticipated Total Costs from DPU Filing (PY1 – PY3) | Actual Program Costs through PY2 |
|---|---|---|
| Total program costs | $12,731,482.49 | $7,031,150.35 |
| Number of stations | 680 | 447 |
| Total Costs per station | $18,722.77 | $15,729.64 |

The six DCFC stations reporting data span over two segments: publicly accessible and workplace stations. The average reported project cost (including installation and EVSE costs) of

[20] 17-13 Exhibit KAB/BJC-4, page 4, line 20-22

$88,708; the infrastructure portion of this station cost, which was eligible for National Grid rebates, was $53,978. EVSE costs for DCFC stations are not eligible for rebates under the Charging Program.

**Table 4-8. Charging Program Paid Costs (Total) – Through PY2**

| Charging Level | Segment | Number of Stations | Total Rebate Costs Paid by National Grid | | | |
|---|---|---|---|---|---|---|
| | | | Company-Owned Infrastructure Costs (Total) | Electrical Infrastructure Rebates (Total) | EVSE Rebates (Total) | Charging Program Costs (Total) |
| Level 2 | MUD | 23 | $1,292 | $193,418 | $144,151 | $337,569 |
| | Public | 328 | $106,984 | $3,338,384 | $1,947,923 | $5,286,307 |
| | Workplace | 94 | $0 | $956,623 | $373,018 | $1,329,641 |
| **Total Level 2** | | **445** | **$108,276** | **$4,488,424** | **$2,465,092** | **$6,953,516** |
| DCFC | Public | 1 | $12,136 | $46,825 | $0 | $46,825 |
| | Workplace | 1 | $93,824 | $55,000 | $4,000 | $59,000 |
| **Total DCFC** | | **2** | **$105,960** | **$101,825** | **$4,000** | **$105,825** |
| **All** | | **447** | **$214,236** | **$4,590,249** | **$2,469,092** | **$7,059,341** |

**Table 4-9. Charging Program Paid Costs (Per Station) – Through PY2**

| Charging Level | Segment | Number of Stations | Per Station Paid Rebate Costs | | |
|---|---|---|---|---|---|
| | | | Electrical Infrastructure Rebates (Per Station) | EVSE Rebates (Per Station) | Charging Program Rebates (Per Station) |
| Level 2 | MUD | 23 | $8,409 | $6,267 | $14,677 |
| | Public | 328 | $10,178 | $5,939 | $16,117 |
| | Workplace | 94 | $10,177 | $3,968 | $14,145 |
| **Total Level 2** | | **445** | **$10,086.35** | **$5,539.53** | **$15,625.88** |
| DCFC | Public | 1 | $46,825 | $0 | $46,825 |
| | Workplace | 1 | $55,000 | $4,000 | $59,000 |
| **Total DCFC** | | **2** | **$50,912.50** | **$2,000.00** | **$52,912.50** |

**Table 4-10. Charging Program Invoiced Project Costs (Total) – Through PY2**

| Charging Level | Segment | Number of Stations | Total Invoiced Costs | | | |
|---|---|---|---|---|---|---|
| | | | Company-Owned Infrastructure Costs (Total) | Invoiced Electrical Infrastructure Costs (Total) | Invoiced EVSE Cost (Total) | Invoiced Charging Program Costs (Total) |
| Level 2 | MUD | 23 | $1,292 | $203,228 | $217,046 | $420,274 |
| | Public | 328 | $106,984 | $3,755,583 | $3,135,482 | $6,891,065 |
| | Workplace | 94 | $0 | $1,026,901 | $962,845 | $1,989,746 |
| **Total Level 2** | | **445** | **$108,276** | **$4,985,712** | **$4,315,373** | **$9,301,085** |
| DCFC | Public | 1 | $12,136 | $48,625 | $37,493 | $86,118 |
| | Workplace | 1 | $93,824 | $124,750 | $56,339 | $181,089 |
| **Total DCFC** | | **2** | **$105,960** | **$173,375** | **$93,831** | **$267,207** |
| **All** | | **447** | **$214,236** | **$5,159,087** | **$4,409,204** | **$9,568,290** |

**Table 4-11. Charging Program Invoiced Project Costs (Per Station) – Through PY2**

| Charging Level | Segment | Number of Stations | Per Station Invoiced (project) Costs | | |
|---|---|---|---|---|---|
| | | | Reported Electrical Infrastructure Cost (Per Station) | Reported EVSE Cost (Per Station) | Reported Charging Program Costs (Per Station) |
| Level 2 | MUD | 23 | $8,836 | $9,437 | $18,273 |
| | Public | 328 | $11,450 | $9,559 | $21,009 |
| | Workplace | 94 | $10,924 | $10,243 | $21,168 |
| **Total Level 2** | | **445** | **$11,203.85** | **$9,697.47** | **$20,901.31** |
| DCFC | Public | 1 | $48,625 | $37,493 | $86,118 |
| | Workplace | 1 | $124,750 | $56,339 | $181,089 |
| **Total DCFC** | | **2** | **$86,687.50** | **$46,915.68** | **$133,603.18** |

***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 are defined as locations that meet at least one of the criteria below. To be eligible for enhanced funding opportunities through the Charging Program, locations must 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.[21] This analysis separately verified the tracked EJ community statuses in the Project Tracking spreadsheet and identified slight differences from National Grid's tracking, shown below in Table 4-12.

This analysis identified that 96 activated and 15 in-flight stations (34 activated and 4 in-flight sites) are located in an EJ community. As of December 31, 2020, 18% of the sites – and 21% of the stations – are eligible for enhanced funding since they meet at least two of the EJ criteria.[22] In

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

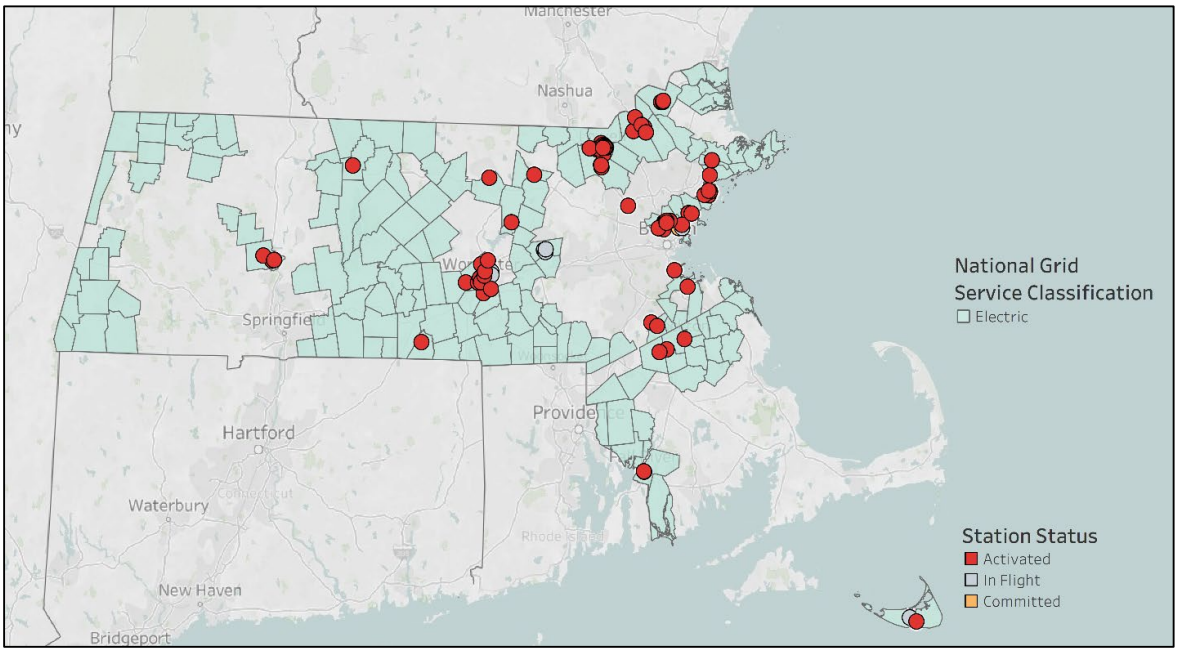
total, 42% of the program's activated and in-flight sites (and 47% of stations) are located in communities that meet *at least one* of the EJ criteria. This exceeds National Grid's program goal of developing 10% of Level 2 sites in EJ communities. Note that this analysis only covered activated and in-flight stations, which are more have complete address information (to facilitate the EJ map-based verification process) and are the most developed projects.

**Table 4-12. 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 | 321 | 289 | 54% | 128 | 121 | 58% |
| One criterion | 103 | 140 | 26% | 43 | 51 | 24% |
| 2+ criteria | 117 | 111 | 21% | 40 | 38 | 18% |
| **Total** | **541** | **540** | **100%** | **211** | **210** | **100%** |

Figure 4-3 presents the geographic distribution of charging stations in EJ communities. The stations mapped meet *at least one* of the criteria defined above. Most of the EJ community charging stations within National Grid territory are concentrated in a handful of localities, including Lawrence, Worcester, Lowell, and communities north of Boston.

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



### 4.2.3 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 341 Level 2 stations and 1 DCFC station (660 ports in total) in PY2 to help National Grid understand station utilization in Massachusetts[23]. The actively-reporting stations were all activated between January 2019 and December 2020; charging data were available from January 2019 through December 2020.

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 improve the awareness of EVs and the availability of charging infrastructure for drivers who currently drive gas-powered vehicles while providing reassurance for EV drivers with range anxiety. Tracking station utilization provides insight into how often, how long, and when charging stations are used; this information can then 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*

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)

Six vendors provided charging data for the PY2 evaluation. The ERS Team observed that the quality and type of data provided varied across vendors, though all vendors that delivered data provided all of the fields listed above. Several vendors provided additional data, including fees assessed for EV charging, 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 these vendors' stations to gain an understanding of how many drivers and localities are

[23] Note that the total of 342 stations reporting data is less than the 447 stations with an "activated" status in the program tracking spreadsheet. This is because not all "activated" stations had reported charging data by the end of PY2.

impacted by a given charging station. This analysis can be included in PY3 if National Grid is interested in conducting additional charging station data analysis.

**Data quality and mapping challenges.** Mapping the station IDs contained in the provided charging data to individual records in the program tracking spreadsheet is a critical, but still manual, process. This process is necessary to link the analyzed utilization data – which consists of charge session counts, charging kWh totals, load profiles, and measures of charging activity per week or month – to a program tracking record indicating the station's charger type, station use, segment, EJ status, location, and more. This mapping provides critical context to our analysis, allowing us to draw valuable conclusions beyond calculating the simple volume and timing of EV charging. The manual nature of this process, however, results in frequent inconsistencies between tracking and charging data and makes it difficult to efficiently derive insights from the charging data. Issues encountered in PY2 included typos in the tracked IDs, swapped or updated IDs not being accurately communicated to National Grid by EVSE suppliers, and the tracked IDs not aligning with the ID formats contained in the charging data. This results in challenges ensuring that the Charging Program is receiving data from all activated stations. The ERS Team worked closely with National Grid and the EVSE suppliers to resolve station ID mapping issues. In this round of evaluation, station IDs from 73 stations could not be successfully mapped to a record in the project tracking spreadsheet; the utilization of these chargers totals 161,634 kWh and is not included in any of the analysis below. Including the 161,634 kWh from chargers whose IDs could not be mapped to a project in the tracker, a total of 555,154 kWh was charged through PY2, of which 29% was excluded from the analysis. ERS also recognizes that EVSE charging data is typically not available for several weeks following a station's final installation.

### *Utilization Results*

Table 4-13 provides an overview of the charging data analyzed in PY2. Overall, 99% of charging sessions and 98% of the total charged energy (kWh) came from Level 2 stations. Note that this utilization analysis does not include all "activated" stations in the Project Tracking spreadsheet; charging data was only provided for 342 stations in PY2 (overall, a total of 447 stations have been activated), and the analysis is therefore limited to only those stations for which data sets were available; we anticipate that charging data from the activated but not yet actively reporting stations will be available in PY3 and understand that there is a time lag between a station's activation and when data from it is 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.

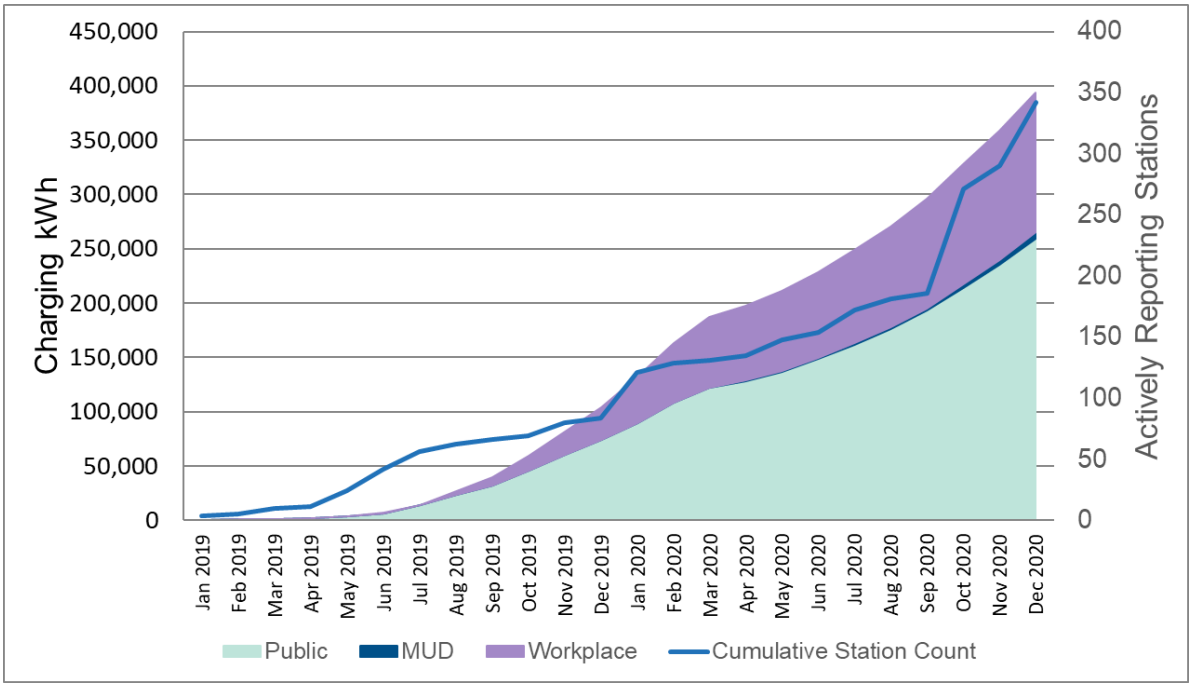
**Table 4-13. PY2 Charging Station Utilization Data Overview**

| Data | Level 2 | DCFC | Total |
|---|---|---|---|
| Number of stations | 341 | 1 | 342 |
| Number of ports | 659 | 1 | 660 |
| Number of charging sessions | 30,960 | 348 | 31,308 |
| Charging energy consumed (kWh) | 386,865 | 6,655 | 393,520 |
| GHG savings (kg) | 236,063 | 4,061 | 240,124 |
| Average charging energy per station (kWh) | 1,135 | 6,655 | 1,151 |
| Average charging energy per session (kWh) | 12 | 19 | 13 |

The 342 charging stations that reported data in PY2 are located at a total of 149 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 stations/ports, we have considered co-located stations as a single station-location; this approach also streamlines the utilization analysis. A full summary of charging station utilization across all activated projects is included in Appendix B.

**Station development and charging kWh.** As noted above, the program is making steady progress toward its goals, as described in Table 4-3 and Table 4-5. Of the 447 stations activated by the end of PY2, 342 of them reported charging data. While the amount of charging (kWh) initially lagged the growth in the number of active charging stations, it began to increase rapidly starting in fall 2019 before slowing slightly in March and April 2020, as shutdowns and schedule disruptions stemming from the COVID-19 pandemic reduced the amount of workplace and public charging being done in Massachusetts. Charging station load growth resumed its pre-pandemic growth rate in summer and fall 2020, as seen in Figure 4-4, below. Note that the pace of station activations also slowed slightly in spring and summer 2020, with 85 EV chargers beginning to report data in October 2020. It is possible that installations initially slowed due to work stoppages or related disruptions due to the COVID-19 pandemic at site host facilities.

**Figure 4-4. Growth in Reporting Station Count and Charging Activity Over thru PY2**




**Station utilization by station use.** At the close of PY2, 99% of the 342 stations reporting charging data were classified as Level 2 in the Project Tracking spreadsheet; 71% of the Level 2 stations were classified as public stations, 23% were classified as workplace stations, and 6% were classified as MUD stations. Approximately 65% (252,252 kWh) of all charging has occurred at public stations and 33% (128,652 kWh) has occurred at workplace stations. Only 1.5% of charging (5,962 kWh) comes from MUD stations; it should be noted, however, that the first MUD charging stations were not activated until mid-January 2020 and only 20 have been activated to date.

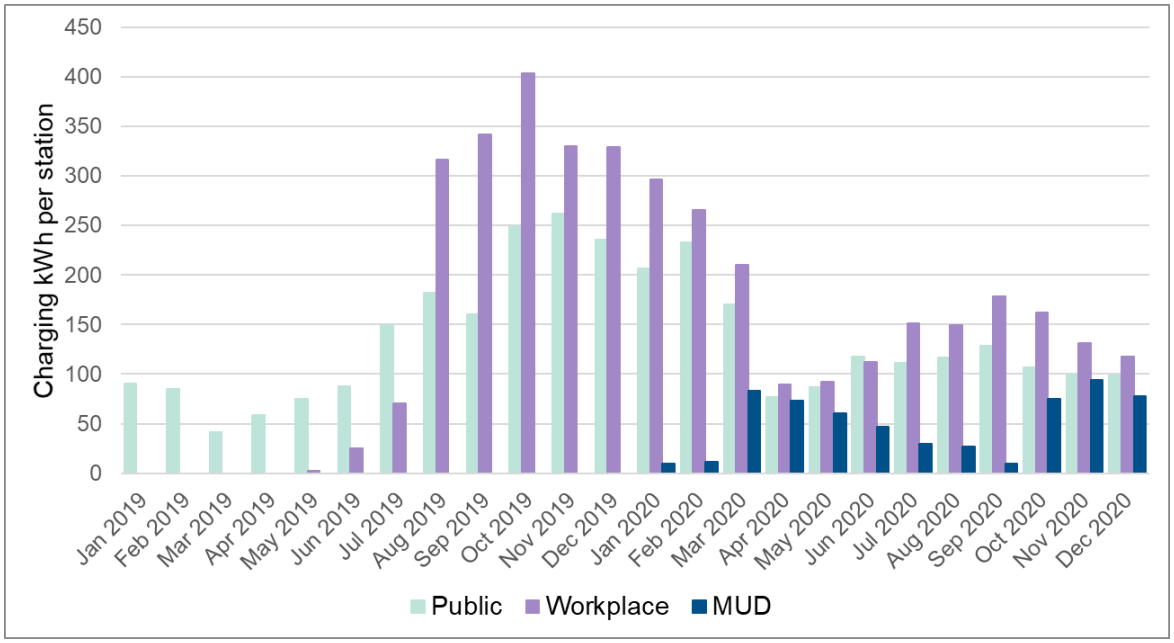
Table 4-14 provides an overview of the utilization data by station use and charging level. Note that MUD and workplace charging stations see the most kWh per session, which aligns with expectations, since these stations tend to support long-duration charging. Public stations, on the other hand, are more likely to be used for "convenience charging" and help to address range anxiety by allowing for short duration charging while drivers are away from home.

**Table 4-14. Charging Station Utilization by Station Use (Level 2 and DCFC)**

| Charging Level | Station Use | Station Count | Charge Session Count | Sessions per Station | Total kWh | kWh per Session | kWh per Station |
|---|---|---|---|---|---|---|---|
| Level 2 | Public | 242 | 23,036 | 95 | 252,252 | 11 | 1,042 |
| | MUD | 20 | 362 | 18 | 5,962 | 16 | 298 |
| | Workplace | 79 | 7,562 | 96 | 128,652 | 17 | 1,629 |
| **Level 2** | | **341** | **30,960** | **91** | **386,865** | **12** | **1,135** |
| DCFC | Public | 1 | 348 | 348 | 6,655 | 19 | 6,655 |
| **Total** | | **342** | **31,308** | **92** | **393,520** | **13** | **1,151** |

Figure 4-5, below, shows the monthly per-station utilization of the activated charging stations by station use. Note the drop-off in charging at the start of the COVID-19 pandemic in March and April 2020, which is followed by a bounce back, starting in June, as lockdown regulations began to be lifted and EV drivers returned to workplace and public charging stations. The per-station utilization of workplace and public stations had a post-COVID peak in September 2020 followed by another, less abrupt, drop-off into winter 2020, which suggests that EV drivers may have returned to working from home more as temperatures dropped and the COVID pandemic-related case counts climbed. Interestingly, the utilization of the program's activated MUD stations follows an inverse trajectory, bottoming out in September 2020 and returning to March 2020 levels in November and December 2020. The extent to which these trends may be related is not known.

**Figure 4-5. Normalized Charging Station Utilization by Month and Use – kWh per Activated Station**




By the numbers, it is clear that the COVID-19 pandemic had a significant impact on charging station utilization by comparing utilization levels in April 2020 (the first full month of pandemic impacts) to February 2020 (the last pre-pandemic month). The station uses tracked by the program were impacted as follows:

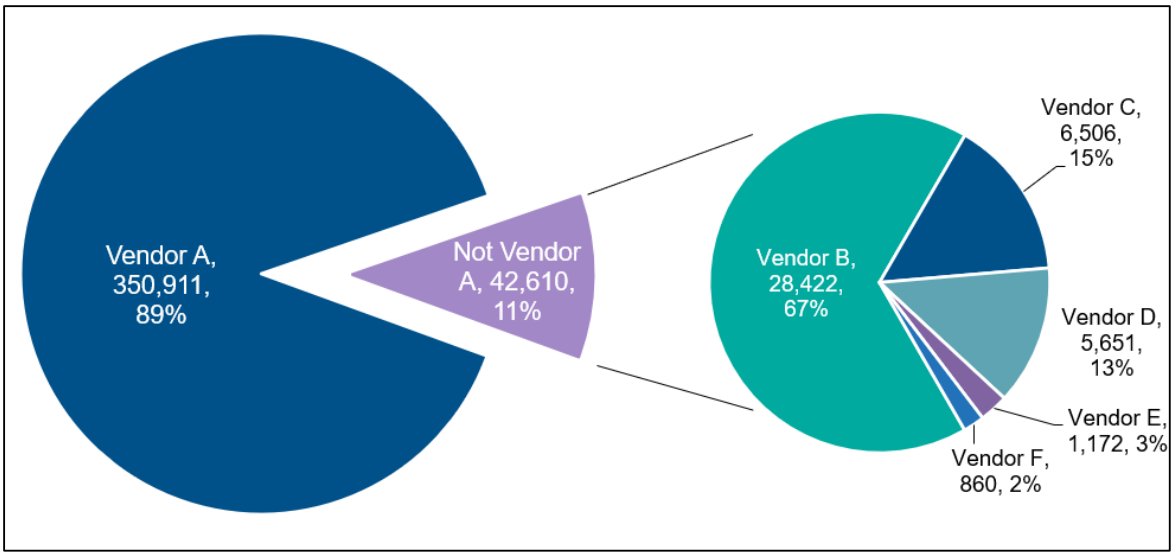
- Workplace charging use in April 2020 was just 33% of the usage in February 2020. As of December 2020, usage in this space is just 42% of February 2020 levels.
- Public charging use in April 2020 was just 34% of February 2020 usage. Usage as of December 2020 also represents just 42% of February 2020 levels.
- Because the first MUD stations were activated in mid-January 2020 it is difficult to draw clear conclusions about the pandemic's impact on these stations, as there is simply insufficient data available to understand how these stations would have been used prior to the pandemic. For example, while the April 2020 usage at MUD stations was 618% of February 2020 levels, it is not possible to quantify what portion of this large increase in usage is due to people choosing to charge at MUD stations over public and workplace stations as a result of COVID-related lockdowns versus the new chargers simply becoming available for widespread usage after installation activities wrapped up. It is possible there was pent-up demand for EV charging at MUD facilities from residents who were previously forced to rely on non-MUD stations to refuel. Other factors may also be at play for these stations.

**Station utilization by EVSE supplier.** Six vendors provided charging data for their activated stations for this analysis. One of the vendors (Vendor A) is responsible for nearly 90% of both the activated station deployments and the charging activity recorded through the end of PY2. Table 4-15 summarizes the breakdown of program activity by vendor. Figure 4-6 highlights the breakdown visually.

**Table 4-15. Utilization and Activated Stations by Vendor**

| Mapped Vendor Name | Charged kWh | Percent of Total kWh | Activated Stations | Percent of Stations |
|---|---|---|---|---|
| Vendor A | 350,911 | 89% | 305 | 89% |
| Vendor B | 5,651 | 1% | 4 | 1% |
| Vendor C | 28,422 | 7% | 10 | 3% |
| Vendor D | 1,172 | 0% | 8 | 2% |
| Vendor E | 860 | 0% | 13 | 4% |
| Vendor F | 6,506 | 2% | 2 | 1% |
| **Total** | **393,520** | **100%** | **342** | **100%** |

**Figure 4-6. Charging kWh by Vendor**




**GHG emissions reduction impacts.** As part of the utilization analysis, the ERS Team assessed the GHG emissions reduction 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 attempt to attribute GHG emissions 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.
- One aim of the program is to support increased EV adoption through the development of a publicly available EV charging network. As EV adoption increases, we expect to see an associated increase in grid load and GHG emissions. The ERS Team did not assess any incremental EV adoption impacts the program may have had.
  - In the absence of the program, it is possible that some fraction of the charging now occurring at program-funded stations would have occurred elsewhere, such as at privately developed public stations, EV drivers' home chargers[24], or stations funded by other utilities. This portion of charging may not be new to the grid but is now associated with National Grid activities relative to the baseline condition (fewer charging stations and less program-enabled charging).
- To measure any GHG emissions savings associated with the program, it is necessary to consider the amount of program-enabled charging relative to a baseline scenario in which all driving is done with ICEVs. The ERS Team's analysis is based on this approach.
- This analysis considered $CO_2$ impacts alone and did not consider other criteria pollutants, such as $SO_x$ and $NO_x$.

Table B-1 in Appendix B contains the station-level GHG emissions reduction analysis results. In total, the GHG emissions reduction through PY2 is 240,124 kg.

**Most utilized charging stations.** Additionally, the ERS Team conducted an analysis of the most utilized charging stations by looking at the 10 Level 2 sites with the most charging through the end of PY2 as well as the most utilized stations in the public and workplace segments. This analysis allowed us to identify commonalities between high-utilization installations as well as quantify the concentration of utilization in these segments.

It should be noted that this analysis was conducted against the backdrop of several complicating variables – including relatively low and unevenly distributed EV adoption in National Grid's Massachusetts territory as well as the COVID-19 pandemic, which impacted driving and charging behavior for a portion of the data collection period. The extent to which

[24] The ERS Team conducted EV Owner surveys in PY1 and PY2 that showed that the majority of charging takes place at home.

these trends may persist into the future is unclear. The ERS Team will continue to monitor utilization concentration over time to assess how this trend evolves.

Table 4-16 highlights the utilization metrics of the 10 most utilized stations across all segments. A review of these sites shows that five of them are located in municipal parking lots or garages, three are located at hospitals (two classified as workplace, one as public), one serves an office park/manufacturing facility, and another serves a commercial operation, potentially being used to refuel one or more electric fleet vehicles serving that operation. This diversity of facility types shows that chargers deployed at distinct facility types can achieve high utilization by serving a facility's, or its customer's, unique demands. For example, EV drivers charging at the municipal locations may have the opportunity to charge for several hours while they work or shop in town; the hospital and manufacturing charging stations may be accessed by both employees and guests; and the commercial operation may primarily serve one or more fleet vehicles that are charged on a consistent basis. The high utilization of the municipal lot/garage chargers also 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.

**Table 4-16. Charging Station Utilization of Top 10 Charging Sites Through PY2**

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week |
|---|---|---|---|---|---|---|---|---|
| EVSE 38 | Workplace | Level 2 | 4 | 2,024 | 28,333 | 14 | 27 | 380 |
| EVSE 33 | Workplace | Level 2 | 4 | 1,550 | 27,271 | 18 | 18 | 323 |
| EVSE 6 | Public | Level 2 | 1 | 1,167 | 24,105 | 21 | 13 | 262 |
| EVSE 12 | Public | Level 2 | 4 | 1,817 | 23,435 | 13 | 17 | 225 |
| EVSE 22 | Public | Level 2 | 1 | 1,557 | 19,763 | 13 | 21 | 273 |
| EVSE 191 | Workplace | Level 2 | 2 | 1,015 | 18,688 | 18 | 17 | 321 |
| EVSE 26 | Public | Level 2 | 1 | 1,206 | 17,873 | 15 | 14 | 200 |
| EVSE 209 | Workplace | Level 2 | 1 | 660 | 16,415 | 25 | 13 | 335 |
| EVSE 36 | Public | Level 2 | 2 | 1,611 | 15,962 | 10 | 19 | 190 |
| EVSE 29 | Public | Level 2 | 2 | 1,168 | 14,062 | 12 | 15 | 180 |

A review of these sites shows that five of them are located in municipal parking lots or garages, three are located at hospitals (two classified as workplace, one as public), one serves an office park/manufacturing facility, and another serves a commercial operation, potentially being used to refuel one or more electric fleet vehicles serving that operation. This diversity of facility types shows that chargers deployed at distinct facility types can achieve high utilization by serving a

facility's, or its customer's, unique demands. For example, EV drivers charging at the municipal locations may have the opportunity to charge for several hours while they work or shop in town; the hospital and manufacturing charging stations may be accessed by both employees and guests; and the commercial operation may primarily serve one or more fleet vehicles that are charged on a consistent basis. The high utilization of the municipal lot/garage chargers also 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.

Ranking stations by utilization level and segment allows us to assess the concentration of station utilization to determine whether a small number of stations drive the utilization figures for a given segment or whether utilization is more evenly spread across a large number of stations. For example, the four most utilized workplace charging sites are responsible for 70% of all charging in the segment (13%, 4 out of 31 total sites). Similarly, in the public segment, the 13 most utilized sites are responsible for 70% of all charging (12%, 13 out of 107 total sites). This analysis indicates that a relatively small number of sites drive utilization in both segments, though this trend may evolve as EV adoption increases in Massachusetts and pandemic-related restrictions ease.

Figure 4-7 and Figure 4-8 also show the extent of the concentration of station utilization across the workplace and public segments, respectively. They show the site-level station utilization, ranked by kWh charged per week, and include only sites with at least 10 kWh charged per week.

**Figure 4-7. Workplace Segment Utilization Ranked by kWh Charged per Week**

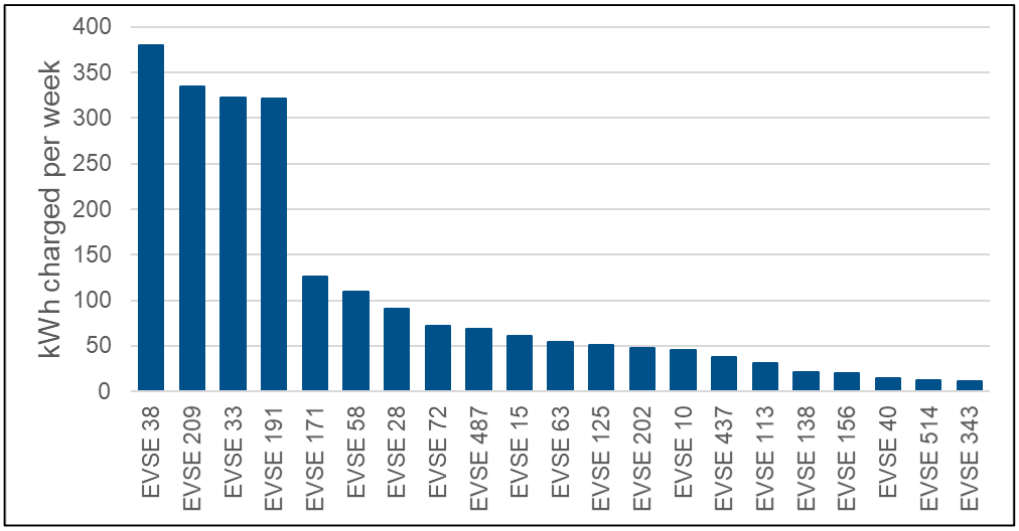
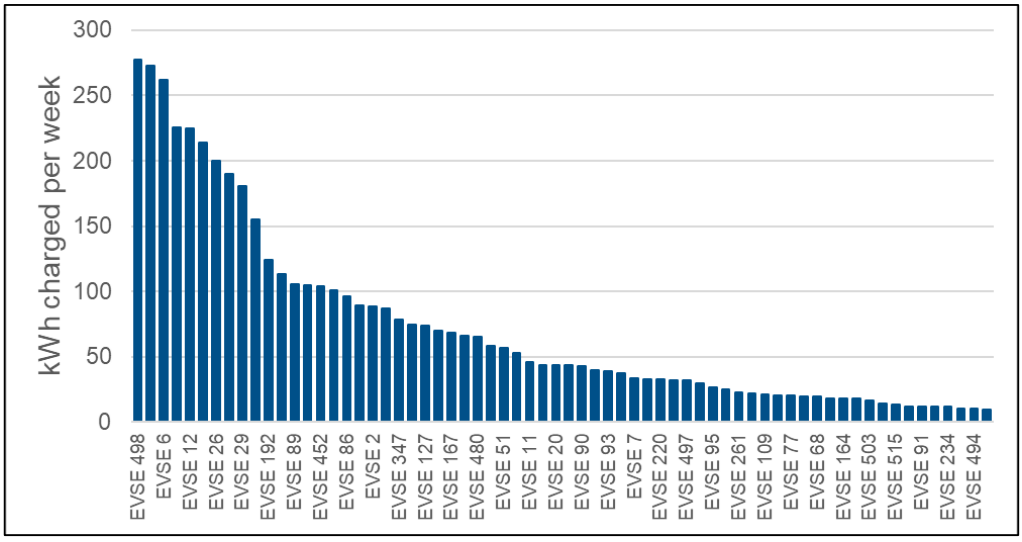



**Figure 4-8. Public Segment Utilization Ranked by kWh Charged per Week**




For the workplace segment, weekly utilization clearly drops off significantly beyond the four most utilized sites. The public segment shows a smoother decline, a greater number of stations achieving fairly high utilization, and a long "tail" composed of sites that are not yet seeing high utilization. Several factors play into a charging site's utilization, and these factors will differ across segments.

- EV ownership is unevenly distributed today. As such, the most utilized workplace charging sites may serve several EVs, while the least utilized sites may primarily serve a single employee's EV or be installed as an amenity to encourage EV adoption. Given this

uneven landscape, National Grid should consider strategies designed to help site hosts maximize the value of their charging stations, perhaps including the development of education and outreach materials for site hosts to share with their employees, customers, or tenants or a "how to" guide for site hosts interested in running their own Ride and Drive event to further increase EV awareness in their area.

  - The workplace surveys fielded in PY2 showed that the availability of charging stations at workplaces has motivated employees to consider or purchase EVs and has increased knowledge and awareness of EV charging, suggesting that site host-led activities could be successful.

- These site host-led activities could further increase EV awareness and adoption, thus increasing the size of the population served by those charging stations.[25]While not a direct strategy for increasing charging station utilization, additional outreach could be targeted to all site hosts to assess the hosts' willingness to learn about other distributed energy resources (DERs) that could increase renewable power generation, improve load flexibility, and reduce coincident on-peak demand, such as solar power and energy storage. EV charging pairs well with these DERs, and having the technologies in place would allow them to work in tandem to support future grid optimization efforts at National Grid.

### *Station Utilization by Station Use, Segment, and EJ Status*

Through PY2, 71% of the 342 stations reporting charging data were classified as "public" in the Project Tracking spreadsheet, with 23% classified as "workplace" charging stations and 6% classified as "MUD" charging stations. Program staff indicated – and tracking data shows – that the program has received significant interest from municipalities and other public entities for Level 2 stations, which is reflected in the amount of charging that has taken place at public charging stations. Table 4-17 provides an overview of the utilization data by segment; note that only segments with over 1,000 kWh of aggregate charging load were included in this table.

**Table 4-17. Charging Station Utilization Breakdown by Station Use and Segment through PY2 (Level 2 and DCFC)**

| Station Use | Station Segment | Station Count | Charge Session Count | Sessions per Station | Total kWh Through PY2 | kWh per Session | kWh per Station |
|---|---|---|---|---|---|---|---|
| Public | Hospital – Level 2 | 30 | 2,779 | 93 | 30,971 | 11 | 1,032 |

[25] The ERS Team understands that marketing and education activities are not eligible for funding under the current program. It is worth noting, however, that a future program in which those activities are eligible may be able to address lagging utilization at already-funded stations through such activities.

| Station Use | Station Segment | Station Count | Charge Session Count | Sessions per Station | Total kWh Through PY2 | kWh per Session | kWh per Station |
|---|---|---|---|---|---|---|---|
| Public | Hospital – DCFC | 1 | 348 | 348 | 6,655 | 19 | 6,655 |
| Public | Industrial | 3 | 62 | 21 | 1,141 | 18 | 380 |
| Public | MUD | 4 | 108 | 27 | 2,464 | 23 | 616 |
| Public | Municipal | 88 | 13,665 | 155 | 160,666 | 12 | 1,826 |
| Public | Office | 44 | 602 | 14 | 12,132 | 20 | 276 |
| Public | Parking | 6 | 211 | 35 | 3,467 | 16 | 578 |
| Public | Recreational/sports | 10 | 539 | 54 | 3,829 | 7 | 383 |
| Public | Retail | 7 | 3,349 | 478 | 15,989 | 5 | 2,284 |
| Public | School/University Parking | 40 | 1,661 | 42 | 21,156 | 13 | 529 |
| **Total Public[a]** | | **233** | **23,324** | **100** | **258,470** | **11** | **1,109** |
| MUD | MUD | 14 | 224 | 16 | 3,263 | 15 | 233 |
| MUD | Parking | 6 | 138 | 23 | 2,699 | 20 | 450 |
| **Total MUD** | | **20** | **362** | **18** | **5,962** | **16** | **298** |
| Workplace | Hospital | 1 | 660 | 660 | 16,415 | 25 | 16,415 |
| Workplace | Industrial | 33 | 3,019 | 91 | 47,450 | 16 | 1,438 |
| Workplace | Municipal | 4 | 270 | 68 | 5,595 | 21 | 1,399 |
| Workplace | Office | 22 | 1,254 | 57 | 22,926 | 18 | 1,042 |
| Workplace | School/University Parking | 17 | 2,348 | 138 | 36,185 | 15 | 2,129 |
| **Total Workplace[b]** | | **77** | **7,551** | **98** | **128,572** | **17** | **1,670** |
| **Total** | | **330** | **31,237** | **95** | **393,004** | **13** | **1,191** |

[a] A total of 10 "public" stations across three segments are not represented in this table due to low utilization to date: Automotive (2 stations, 336 kWh), Car Dealership (3 stations, 0 kWh), Hotel (4 stations, 66 kWh), and Laundromat (1 station, 35 kWh).

[b] A total of 2 "workplace" stations across two segments are not represented in this table due to low utilization to date: Automotive (1 station, 79 kWh to date) and Car Dealership (1 station, 1 kWh).

Several trends are observable based on the data in Table 4-17. These include:

- The five most utilized segments are:
  - Municipal (public), with over 160,000 kWh. This represents over 40% of the entire program charging activity.
  - Industrial (workplace), with 47,450 kWh charged.
  - Hospital (public), with 37,625 kWh charged.
  - School/University Parking (workplace), with 36,185 kWh charged.
  - Office (workplace), with nearly 23,000 kWh charged.
- The two segments with the largest per-session charging utilization are Hospital (workplace) at 25 kWh/session and MUD (public) at 23 kWh/session. Municipal

(workplace) and Office (public) also support long-duration charging sessions, with 21 and 20 kWh/session respectively.

- There is a wide array of per-session charging utilization rates for public charging stations, ranging from 5 kWh/session for Retail to 23 kWh for MUD stations. This range of variation highlights the different types of charging customers require and shows how different facility types may be better suited to provide one type of charging over another. For instance, people likely access Retail locations for shorter "convenience" refueling sessions, while they rely on chargers at MUD facilities to charge overnight.
- Based on the per-session utilization metrics, it is clear that several segments support long-dwell charging, where EVs are parked for long stretches. This opens up the possibility for EV charging load management solutions to be deployed at these facilities to support real-time grid optimization and demand response efforts. Solutions like these, known as "vehicle grid integration" (VGI) solutions, would allow National Grid to throttle or increase instantaneous power flow to plugged-in vehicles in response to grid conditions, with constraints based on driver preferences and other parameters, such as a vehicle's state of charge (SOC). For long-dwell charging, most EV drivers do not care when their EV is charging, so long as it has the expected SOC or range when they need to drive next. We recommend that National Grid consider piloting VGI solutions at one or more long-dwell site hosts to evaluate the effectiveness and value of these approaches alongside any customer satisfaction impacts.

The ERS Team also assessed station utilization through the lens of station use and environmental justice community status. A total of 72 actively reporting stations are located in communities meeting two or more EJ criteria and are thus classified as EJ per the program's definition. The results of this analysis are shown in Table 4-18, below; note that one station's EJ status could not be verified, leading to a total of 341 stations included in this analysis.

**Table 4-18. Charging Station Utilization Breakdown by Station Use and EJ Status through PY2 (Level 2 and DCFC)**

| Station Use | EJ Status | Station Count[a] | Percent of Stations (by Station Use) | Charge Session Count | Total kWh Through PY2 | Percent kWh (by Station Use) |
|---|---|---|---|---|---|---|
| Public | No | 124 | 51% | 12,216 | 116,099 | 45% |
| | One criterion | 61 | 25% | 7,455 | 101,816 | 39% |
| | 2+ criteria | 57 | 24% | 3,708 | 40,925 | 16% |
| **Total Public** | | **242** | **100%** | **23,379** | **258,840** | **100%** |
| MUD | No | 5 | 25% | 122 | 1,765 | 30% |
| | One criterion | 11 | 55% | 239 | 4,153 | 70% |
| | 2+ criteria | 4 | 20% | 1 | 43 | 1% |

| Station Use | EJ Status | Station Count[a] | Percent of Stations (by Station Use) | Charge Session Count | Total kWh Through PY2 | Percent kWh (by Station Use) |
|---|---|---|---|---|---|---|
| **Total MUD** | | **20** | **100%** | **362** | **5,962** | **100%** |
| Workplace | No | 49 | 62% | 1,684 | 30,938 | 24% |
| | One criterion | 19 | 24% | 5,480 | 93,565 | 73% |
| | 2+ criteria | 11 | 14% | 398 | 4,150 | 3% |
| **Total Workplace** | | **79** | **100%** | **7,562** | **128,652** | **100%** |
| **Total** | | **341** | | **31,303** | **393,454** | |

[a] Note that one station's EJ status could not be verified, leading to a total of 341 stations here instead of 342.

In total, 38% of charging has taken place at stations in communities that do not meet any EJ criteria, 51% has taken place in communities meeting one EJ criterion, and 11% has taken place in communities meeting two or more EJ criteria. For each of the station use categories, the least amount of charging has taken place in communities that meet two or more EJ criteria – the program's definition of an EJ community. However, as stated earlier in this report, assessing utilization based solely on the number of charging sessions or the total kWh charged may not always indicate a "successful" charger installation; seemingly underutilized stations still contribute to a robust EV charging network, can increase the visibility of EVs and zero-emission refueling infrastructure, and may address range anxiety for drivers who need to access them, however sparingly.

### *Charging Load Profiles Discussion*

As part of the PY2 analysis, the ERS Team developed both 24-hour average charging load profiles (kW) and hourly energy consumption profiles (kWh) for each of the actively reporting charging stations, capturing all days since the station's first recorded charge session (through December 31, 2020). Only data that passed QC was included in the analysis.

The team analyzed load profiles of select, highly utilized charging stations across diverse segments to determine the extent to which EV charging at these stations coincided with the 1 p.m. to 9 p.m. window, to identify differences in weekday vs. weekend charging, and to highlight key charging behavior differences across facility types. The 1–9 p.m. window is not a defined peak period under any National Grid electric rate; it was selected to align with the peak period definition for National Grid's SmartCharge Massachusetts Program, a managed charging program designed to shift EV charging off-peak.[26] Selected profiles were chosen to

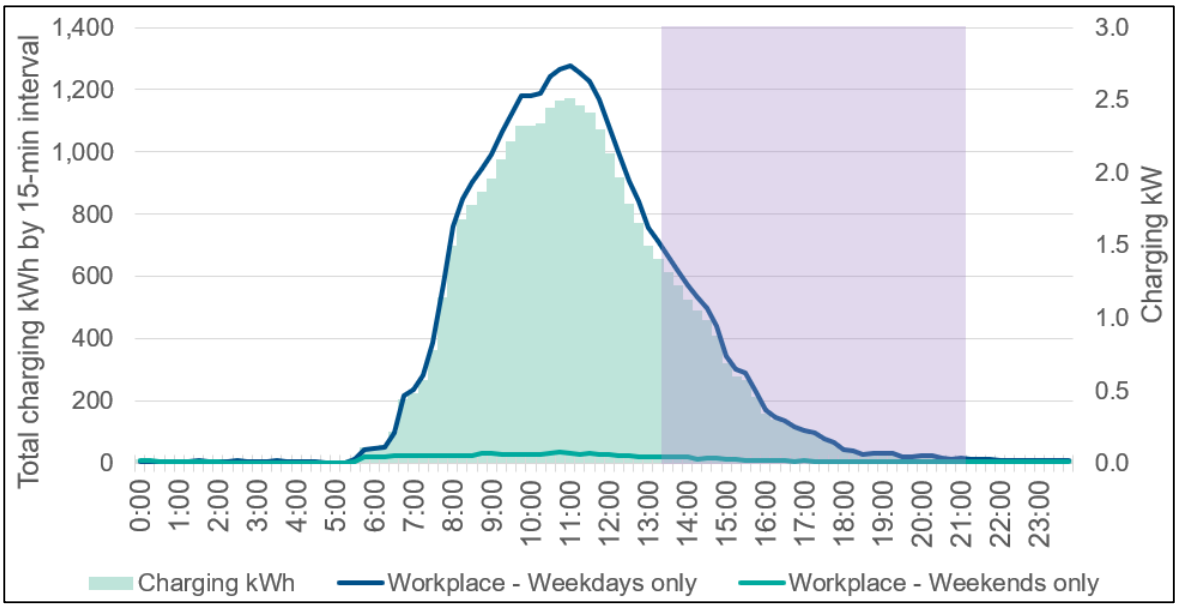
[26] All references to the "peak period" (including the use of the phrases "on-peak" or "off-peak") in this subsection refer to this 1–9 p.m. window defined by the SmartCharge Massachusetts Program.

facilitate a discussion on how site-specific conditions impact a charging station's utilization and load shape, since the same conditions may not apply to all facilities within the same segment. The profiles included in this discussion[27] include all data that passed QC for a given station's data reporting period (from the first recorded charge session through the end of PY2). Also included in this section is a summary, by segment, of the on-peak coincidence for each segment's most-utilized stations.

For each of the figures below, the navy blue and teal lines represent the weekday and weekend average charging load; the light green shading represents the total kWh charged in each 15-min interval for the entirety of the station's reporting period (PY1 and PY2); and the light purple box indicates the on-peak period hours of 1 p.m. to 9 p.m. For charging locations with multiple stations/ports, the average load profile (kW) and kWh totals include charging data from all stations/ports that provided data.

**Workplace charging station.** The load profile presented in Figure 4-9, below, is for a workplace charging station consisting of four Level 2 chargers (eight ports) located at a hospital facility. Through PY2, 23% of the kWh charged at this station occurred on-peak. The average weekday on-peak demand is 0.5 kW, and the average weekend on-peak demand is 0.0 kW. This station's first charge was recorded on May 21, 2019.

**Figure 4-9. 24-Hour Charging Load Profile – EVSE 33 (Workplace)**

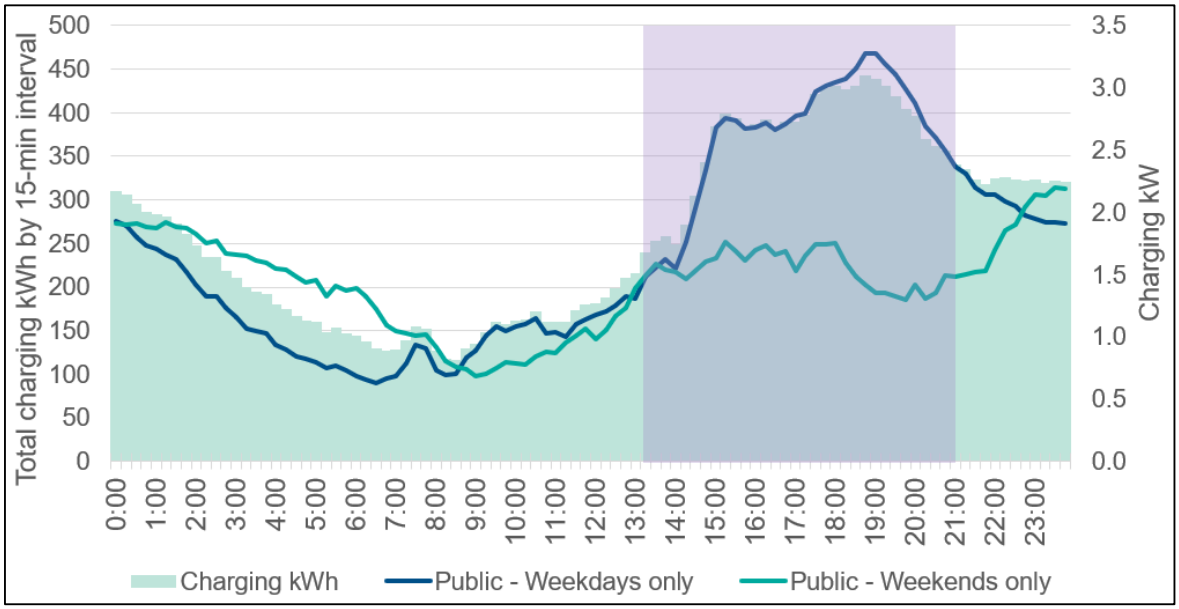



[27] Note that we have also developed monthly load shapes, segmented by weekdays, weekends, and "all days," for all of the actively reporting stations and will share that data in spreadsheet form along with the final version of this report.

On weekdays, the charging load at this station begins to climb in the morning, between 6 a.m. and 7 a.m. The load climbs throughout the morning, peaking around 2.75 kW between 10 a.m. and 11 a.m. before falling throughout the afternoon to less than 0.5 kW around 4 p.m. There is very little evening and no overnight charging. As would be expected for a workplace facility like this one, there is very little weekend charging.

**Public charging station.** The load profile presented in Figure 4-10, below, is for a public charging station consisting of one Level 2 charger (two ports) located at a municipal parking facility. Through PY2, 47% of the kWh charged at this station occurred on-peak. The average weekday on-peak demand is 2.6 kW, and the average weekend on-peak demand is 1.5 kW. This station's first charge was recorded on March 29, 2019.

**Figure 4-10. 24-Hour Charging Load Profile – EVSE 6 (Public)**

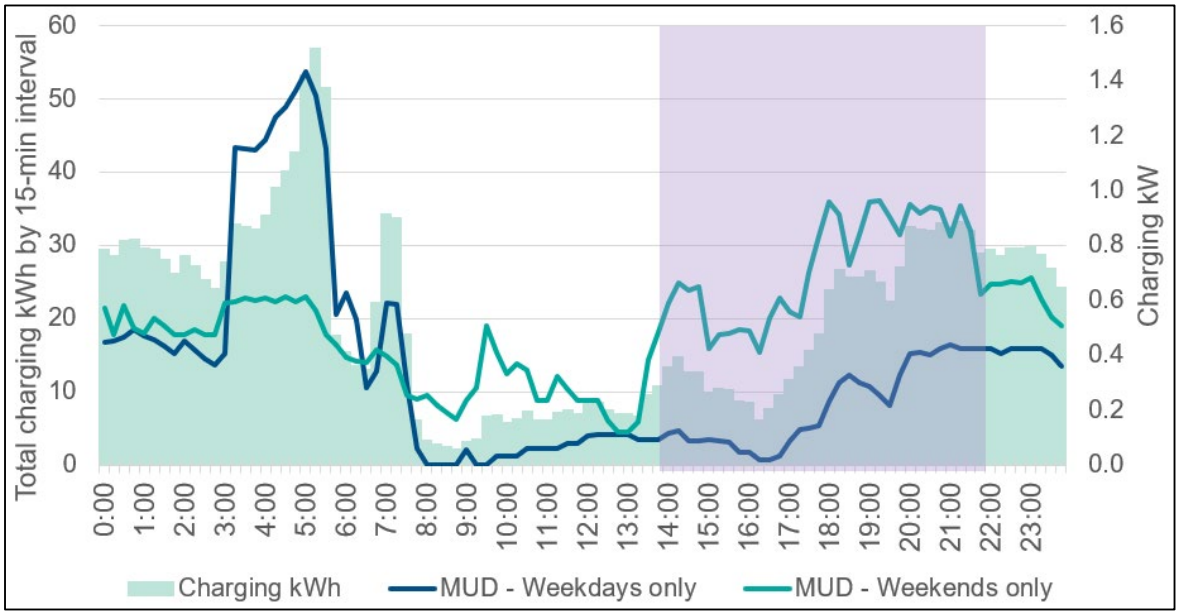



On weekdays, the charging load at this station begins to climb in the afternoon and peaks around 7 p.m. at 3.3 kW. The load tapers off in the evening, settling at approximately 1.9 kW through midnight, falling further overnight before starting to increase again between 7 a.m. and 8 a.m. Unlike the workplace example, this public charging facility shows consistent overnight charging.

On weekends, the charging load climbs steadily from 9 a.m. until roughly 3 p.m. before tapering off and then ramping up again after 10 p.m. Similar to the weekday charging load profile, this charger supports consistent overnight weekend charging.

**MUD charging station.** The load profile presented in Figure 4-11, below, is for a MUD charging station consisting of three Level 2 chargers (six ports). Through PY2, 28% of the kWh charged at this station occurred on-peak. The average weekday on-peak demand is 0.2 kW, and the average weekend on-peak demand is 0.7 kW. This station's first charge was recorded on October 3, 2020.

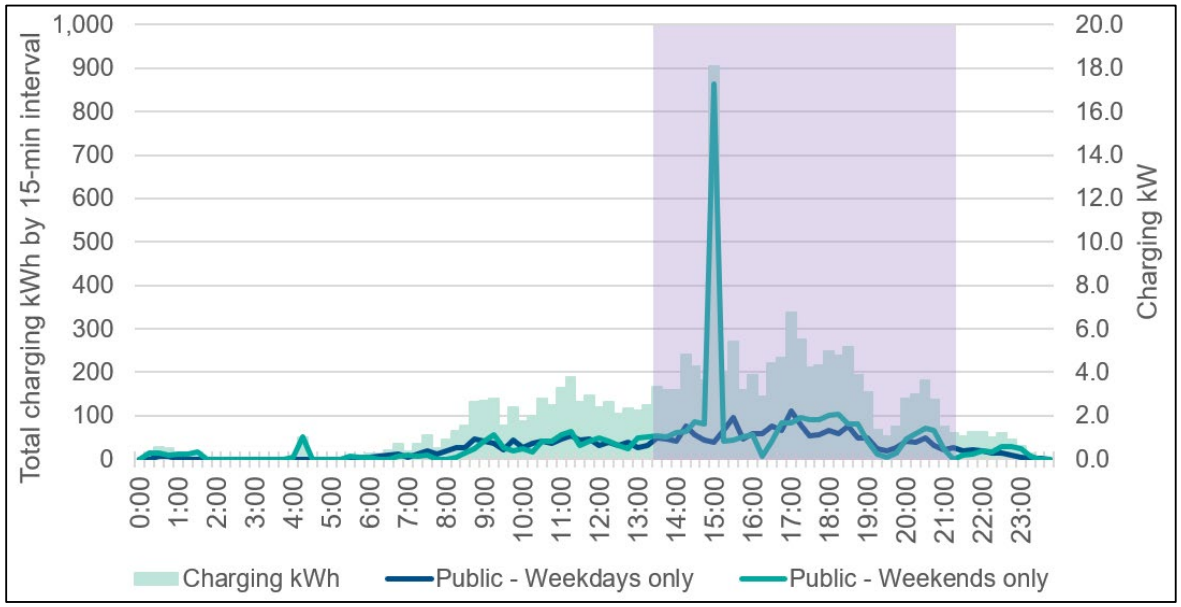
**Figure 4-11. 24-Hour Charging Load Profile – EVSE 545 (MUD)**




The majority of charging at this station takes place overnight. There is very little weekday charging between 8 a.m. and 12 p.m., though there is more weekend charging during this window. Charging load increases in the afternoon and evening on both weekdays and weekends. Given the large spikes in weekday charging load between 3 a.m. and 6 a.m. and again at 7 a.m., it is likely that one or more EV drivers makes consistent use of these chargers and have perhaps set charging schedules in-vehicle or at the charger interface. The fact that these charging spikes are only observed in the weekday profile suggests they may be related to the drivers' commute to work and that these drivers charge differently on the weekend.

**DCFC charging station.** The load profile presented in Figure 4-12, below, is for the program's lone actively reporting DCFC charging station (one port). Through PY2, 67% of the kWh charged at this station occurred on-peak. The average weekday on-peak demand is 1.1 kW, and the average weekend on-peak demand is 1.7 kW. This station's first charge was recorded on July 23, 2019.

**Figure 4-12. 24-Hour Charging Load Profile – EVSE 2 (DCFC)**




The charging station depicted in Figure 4-12 is publicly accessible and is located at a small office park off Interstate 495 in northern Massachusetts; it is classified as a public site and is located in an EJ community. The station experiences intermittent utilization throughout the day, as demonstrated by its spiky shape, and is used sporadically overnight, as would be expected for a public charger. Note that the majority of the charging takes place during the day, with two-thirds of energy consumption occurring on-peak, and that a single weekend charging session around 3 p.m. distinguishes the weekend load shape. This behavior makes sense for a DCFC station, which is more likely to be used sporadically – to complete long trips and/or to provide "emergency" or convenience charging – than to be used consistently by the same drivers.

Table 4-19, below, summarizes the on-peak coincidence for the most-utilized stations in each segment, separated by Level 2 and DCFC stations.

**Table 4-19. On-peak[1] Coincidence by Segment**

| Segment | Number of sites classified as "most-utilized" | Percent of kWh Charged On-Peak |
|---|---|---|
| Workplace Level 2 | 4 | 33% |
| Public Level 2 | 13 | 46% |
| MUD Level 2 | 3 | 39% |
| Public DCFC | 1 | 67% |

[1] Note that the on-peak period of 1–9 p.m. considered here was chosen to align with National Grid's SmartCharge Massachusetts managed EV charging program and not with the distribution system/coincident peak period.

This analysis shows that, for the workplace and MUD segments, the majority of charging occurs *off-peak,* while approximately half of charging is on-peak for the public segment and most charging is on-peak for the DCFC station. It is important to note, however, that even if the majority of a station's or segment's charging occurs off-peak, there may be significant load concentration in certain off-peak hours that could potentially lead to new or more difficult to manage peak loads in a future high-EV adoption scenario. For example, widespread overnight MUD charging, or significant morning and midday workplace charging, could alter future local grid dynamics. Proactively exploring flexible approaches to load management while gauging site host interest in installing other DERs, such as solar and storage, will help to ensure National Grid can absorb and manage new EV charging load in the future.

### 4.2.4 Upcoming Activities for PY3

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

## 4.3 EV Owner Follow-up Survey

This section presents the results of the follow-up EV owner survey conducted in October 2020 during the COVID-19 pandemic. The evaluation team conducted the baseline survey in November 2019 prior to the pandemic. Both surveys targeted customers who live or work in National Grid's electric or combination-fuel service territory and drive an EV as their primary vehicle[28] ("EV owners"). The follow-up survey conducted in 2020 received 121 responses, and the baseline survey conducted in 2019 received 182 survey responses. About 49% of EV owners

[28] All respondents who drove an EV (Battery Electric Vehicle or Plug-in Hybrid Electric Vehicle) 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.

in the 2020 survey are electric-only National Grid customers, 46% are combination-fuel, and 5% are natural gas customers, which is similar to 2019.

For questions related to work and commuting, use of public charging stations, and any issues finding charging stations in Massachusetts we make year-over-year comparisons, noting any statistically significant differences. For questions related to vehicle experience, type, home charging, the importance of direct-current fast charging (DCFC), future EV purchase consideration, and demographics, we characterize EV owners by pooling responses from both the baseline and follow-up surveys.

The evaluation team took this approach because:

- The mix of BEV and PHEV is very different in the two surveys, BEV owners made up a higher percentage of the baseline survey whereas PHEV owners made up a higher percentage of the follow up survey.
  - This is a result of the multi-pronged outreach strategy, using a third-party list of EV owners that was not representative of state registrations and relying on affinity organizations to distribute the survey link to reach underrepresented makes and models.
- Neither sample on its own paints a complete picture of the EV Owners markets, so pooling responses from the baseline and follow up survey provides a more balanced and "smooth" representation of EV owner characteristics and perspectives across pre-pandemic and pandemic times.

While the COVID-19 pandemic affected commuting, driving, and charging habits, we make these comparisons because they are important to the program. However, it is important to note that any changes could reflect the effects of the pandemic more than increased charging infrastructure and/or awareness.

Table C-1 and Table C-2 in the appendix provide key comparisons of EV owner survey responses to the 2019 and 2020 surveys.

### 4.3.1 Key Evaluation Findings: EV Owner Survey

Overall, EV owners in the second-year survey reported very similar behaviors, opinions, and charging station awareness and use as EV owners in the first-year survey. Key findings from the follow-up EV owner survey are below.

- **The COVID-19 pandemic has changed driving patterns significantly, and some do not expect to return to pre-pandemic driving.** The portion of respondents who regularly commute to work or school dropped from 79% to 42%. Furthermore, the majority of EV owners (92%) said that the pandemic changed their driving routines. Eleven percent of

EV owners who said their driving habits changed do not expect them to return to the pre-pandemic norm.

- **There is no change in EV owners' ability to find charging stations in the Commonwealth of Massachusetts.**[29] The proportion of EV owners who have had trouble finding charging stations in Massachusetts in the year before completing the survey has not changed since 2019. About half of EV owners reported issues finding a charging station in Massachusetts and many mentioned issues on trips outside of 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 general satisfaction with driving range among EV owners.
- **EV owners value workplace charging.** The majority of EV commuters with access to charging at work or school used a charging station at their workplace or school within 3 months of completing the survey (93% in 2019, 89% in 2020). Further, most EV commuters that do not have access to charging at work or school (87% in 2019, 100% in 2020) said that they would use a school or workplace charging station if it was available.
- Compared to 2019, fewer EV owners had used charging stations at public locations like parking lots (municipal or paid public parking), retail stores, travel plazas, car dealerships, or hotels in the 3 months before the survey. While the program has installed charging stations in many of these locations, this decline is most likely because of the change in driving habits attributed to the COVID-19 pandemic. One-quarter of EV owners said that they are charging at home more often, 15% said they are charging less often overall, 11% are using public charging stations less often, and 8% are no longer charging at work.
- Charging speed is important, especially for long-distance travel, but most EV owners will generally not go out of their way to use fast charging stations. Nearly half of EV owners cited charging speed or power as something they look for when selecting charging stations, but few (16%) will go out of their way to find a DCFC station. BEV drivers place greater importance on charging speed, with are more saying they will go out of their way for it compared to PHEV drivers. DCFC charging becomes more important for long trips, in which case an additional 11% will seek it out. This is also evident in how EV owners select the vehicle to take on long trips, with many taking an internal combustion engine vehicle or hybrid in the household, and some choosing their EV based on the availability of Superchargers or DCFC on their route.

[29] The survey asked respondents if they had issues finding stations in Massachusetts as it is unlikely survey respondents would know if any issues they had were in National Grid Territory.

### 4.3.2 Vehicles and Travel Behavior

The following sections address responses to questions related to vehicle ownership and travel or commuting behavior.

#### *Vehicle Ownership*

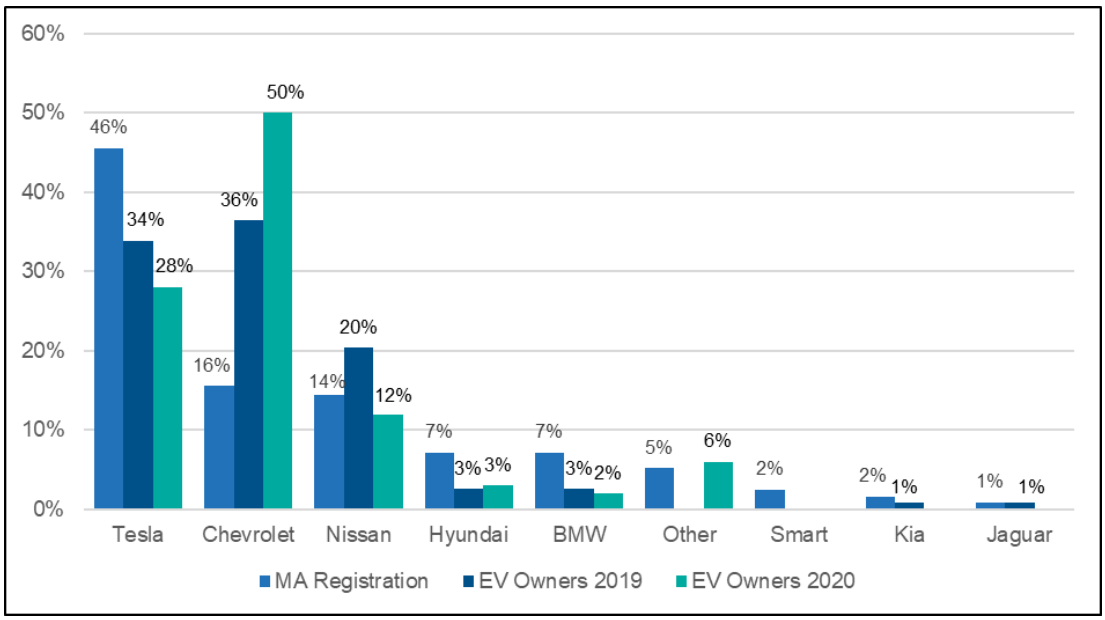
Most EV owners from both the 2019 and 2020 surveys live in a multi-vehicle household, with 87% reporting having two or more household vehicles. Most EV owners (76%) only have one EV in their household, with about one-quarter reporting two or more EVs.

Among all EV owners across the two surveys, 61% reported having a battery-electric vehicle (BEV), and 39% reported having a plug-in hybrid electric vehicle (PHEV). Compared to the Massachusetts personal vehicle registration data, where 45% of registered EVs are BEVs, and 55% are PHEVs, our sample is slightly weighted towards BEV owners. The sample contains more Chevrolet PHEV and BEV owners (Volt and Bolt) than MA registrations due to the high proportion of Chevrolet owners in the third-party list we purchased to contact customers.[30] Conversely, among BEV owners in the sample, fewer own Teslas compared to Massachusetts registration data.[31]

[30] 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 other distribution channels for the EV owner survey, including Massachusetts Clean Cities and the Green Energy Consumers Alliance, both of whom shared the survey link with their supporters (by email or Facebook).

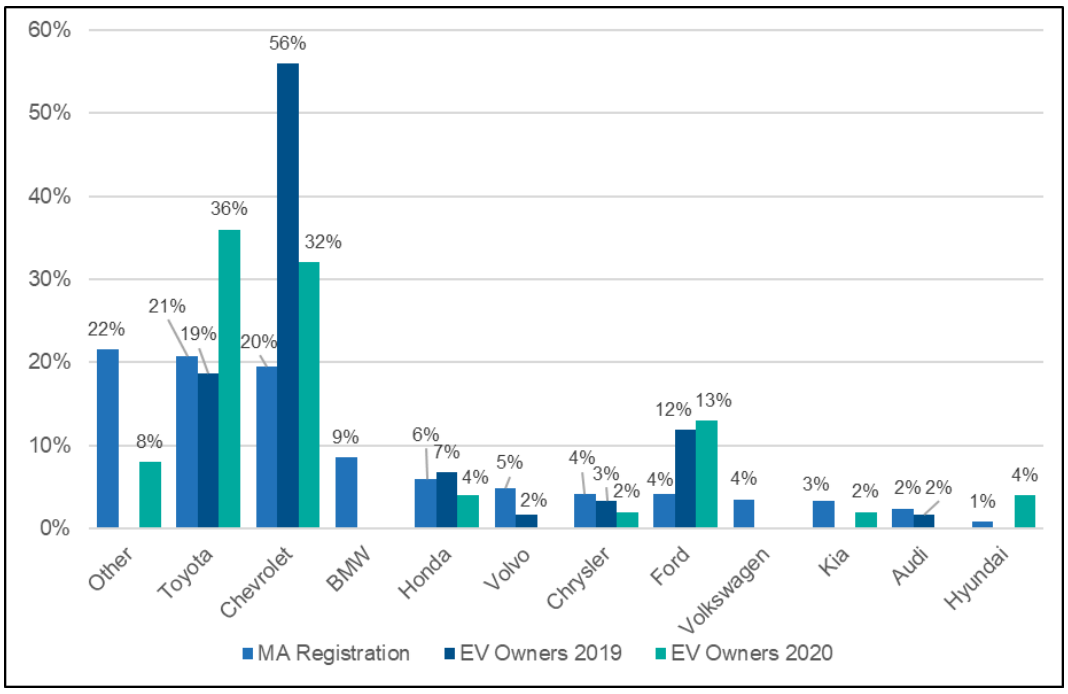
[31] Source: Analysis by ERS Team of IHS Markit Massachusetts EV Registration Data from Q2 2020. Data restricted to personal vehicles.

**Figure 4-13. BEV Ownership – Comparison of EV Owners Sample and Massachusetts Registration Data[32]**




[32] The Massachusetts registration data included some records that could not be distinguished between a BEV and PHEV because the make/model is offered as both a BEV and PHEV on the market. These records were included in the overall total and proportion by makes for the MA registration data.

**Figure 4-14. PHEV Ownership – Comparison of EV Owners Sample and Massachusetts Personal Vehicle Registrations[33]**




***Travel and Commuting Behaviors***

The COVID-19 pandemic appears to have caused changes in driving habits from 2019 to 2020. Over three-quarters of 2019 respondents (79%) said they regularly commuted to work or school, compared to less than half (42%) in 2020.

Of the respondents who do regularly commute, commuting time was similar between survey years. In 2019, half of respondents (50%) commuted 30 minutes or more and just over half (56%) of respondents in 2020 did the same. Respondents from 2019 and 2020 reported similar commutes of 15 minutes or less as well (15% and 16% respectively).

Among the 2019 EV owner respondents who do not regularly commute for work or school, all use a personal vehicle for most of their trips. Almost all non-commuter respondents in 2020 (92%) also use a personal vehicle for most of their trips. In total, 87% of the EV owners from 2019 and 89% of EV owners from 2020 use a personal vehicle for most of their trips (whether commuting or conducting other trips or errands).

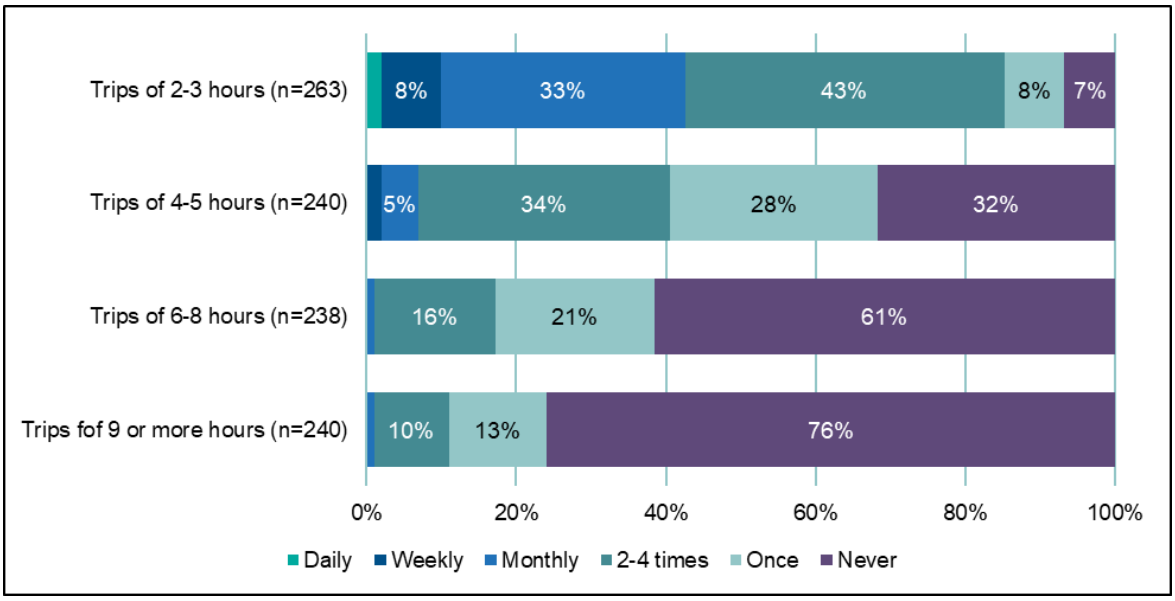
[33] The Massachusetts registration data included some records that could not be distinguished between a BEV and PHEV because the make/model is offered as both a BEV and PHEV on the market. These records were included in the overall total and proportion by makes for the MA registration data.

### *Long Trips*

Similar to the 2019 general population survey respondents, most EV owners reported taking trips of up to 3 hours multiple times a year. EV owners and the general population alike are less likely to drive for longer periods of time (4 or more consecutive hours) in a given year.

In general, EV owners take more frequent long trips than the general population (based on the 2019 general population survey). The majority of all EV owners (85%) took at least two trips of 2–3 hours in the past year, with about 43% taking a 2–3 hour trip at least monthly – both of which are higher rates than reported by the general population in 2019 (74% and 30%, respectively). Just over two-thirds of EV owners (68%) took at least one trip of at least 4–5 hours in the past year, compared to 56% of the general population. About 39% 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 4-15. Frequency of Long-Distance Trips among EV Owners in Last 12 Months**




In 2020, the ERS team added a question to determine which vehicle EV owners use for trips over 2 hours in duration and found that about half (51%) use their BEV or PHEV for long trips. Just over one-quarter (28%) said they use an internal combustion engine vehicle, and 9% use a conventional hybrid. The remaining 11% said it depends on things like the availability of superchargers or DCFC stations on their route, who is going on the trip, or which vehicle they feel like driving at the time.

### 4.3.3 EV Purchase Considerations

Most EV owners (83%) indicated that their top concern about owning or leasing an EV before purchase or lease was the driving range, followed by the purchase price (58%) and where to charge an EV (36%).

In alignment with their top concerns or questions, most EV owners (66%) said that driving range was a deciding factor, along with available incentives or rebates (41%) and final purchase price (40%). About one-quarter of EV owners also took into consideration consumer reviews and ratings (23%) and vehicle performance (22%).

Fewer EV owners indicated that they were concerned or had questions about ongoing ownership factors – such as maintenance and operating costs – before 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 a 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.

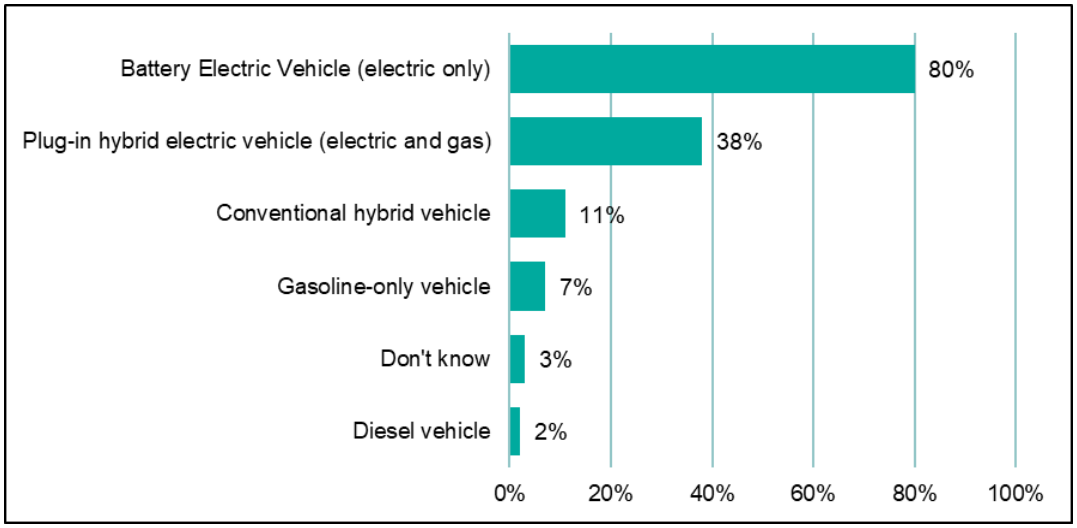
Cost of ownership was one factor that EV owners rated similarly both before purchase and at the time of their final vehicle decision – about 19% of EV owners had questions or concerns about the cost of ownership before purchase, and about 18% of EV owners said that it was a top purchase consideration.

### 4.3.4 Future EV Purchase Considerations

About 36% of EV owners plan to purchase or lease another vehicle within 2 years of responding to the survey. Of these, almost all (96%) are considering another EV – either PHEV or BEV. Most EV owners (58%) planning a purchase in the next 2 years are considering only a BEV, and 16% said they are considering only a PHEV.[34] Fewer EV owners (compared to the 2019 general population sample) are considering non-EV alternatives, like a conventional hybrid vehicle (11%), a gas-only vehicle (7%), or a diesel vehicle (2%).

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

**Figure 4-16. Consideration of Vehicles for Next Vehicle Purchase by Fuel Type (n=97)**




*Among EV owners who plan to purchase or lease their next vehicle in the next two years. Multiple responses allowed.

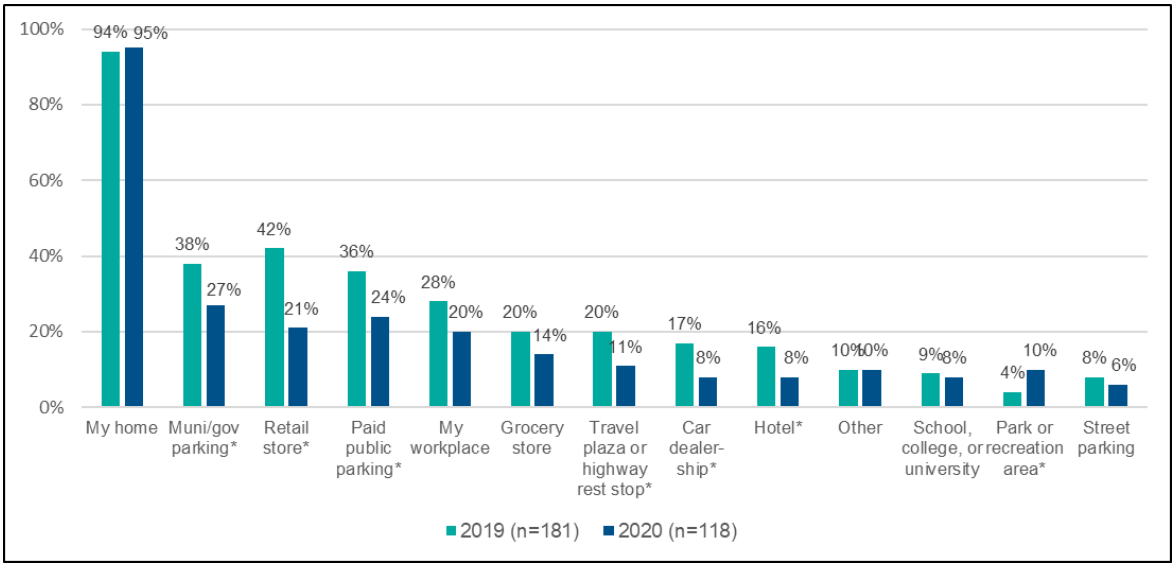
### 4.3.5 Charging Behaviors and Experiences

Almost all EV owners could have access to a personal charging station. Ninety-two percent have private parking, either in a garage or carport (57%) or a driveway (35%). About 8% park in some form 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.

Across the two surveys, EV owners most frequently charge their vehicles at home (95%), followed by municipal or government parking (33%), retail stores (32%), paid public parking (29%), and their workplace (25%).

As shown in Figure 4-17, significantly fewer EV owners charged their vehicles at several different locations in 2020, compared to 2019. While the program installed charging stations in many of these types of locations in 2020, it is likely that fewer EV owners used them because of the COVID-19 pandemic.

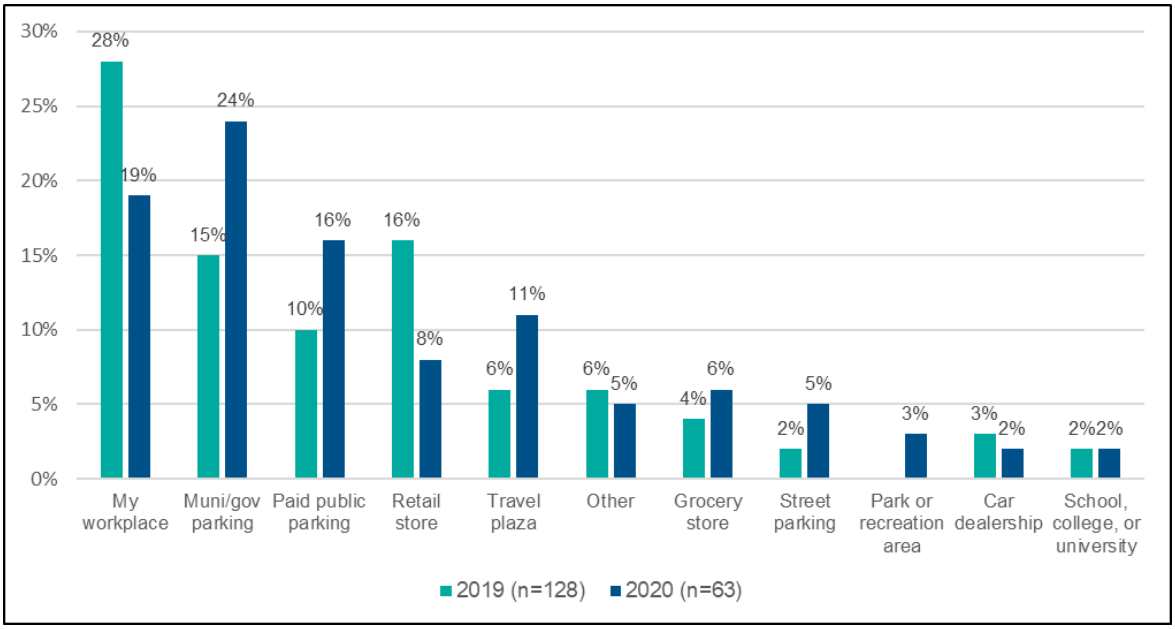
**Figure 4-17. Top Charging Station Locations Used by EV Owners in the Past 3 Months**




*Difference significant at p < 0.05.

In addition to understanding the *variety* of places EV owners charge their vehicles, we also wanted to know the *single* location where EV owners most frequently charged their vehicles, since most EV owners (86%) reported charging their EVs in more than one location in the past 3 months. Among EV owners who reported charging in multiple locations, almost three-quarters (74%) reported charging most frequently at home. Aside from EV owners' homes, we found that the most common places they charged were their workplace, municipal or government parking, paid public parking, and retail stores (Figure 4-18). There are no significant differences between years in the most frequently used non-home charging stations.

**Figure 4-18. Most Frequently Used Non-Home Charging Station Location**




### *Access to Workplace Charging*

The proportion of EV commuters that have access to a charging station at work or school increased significantly since 2019 (increasing from 38% to 53%), however, the proportion of EV owners that commute dropped from 79% in 2019 to 42% in 2020. This may indicate that the increase in access to workplace charging among EV commuters is more reflective of changing commuting habits due to the COVID-19 pandemic than an increase in the availability of workplace charging. In both years, the majority of EV commuters with access to charging at work or school (93% in 2019, 89% in 2020) used a charging station at their workplace within 3 months of completing the survey.

Most EV commuters that do not have access to charging at work (87% in 2019, 100% in 2020) said that they would use a workplace charging station if it was available.

### *Impact of the COVID-19 Pandemic on Charging Behaviors*

As most EV owners were already charging their EVs at home most frequently, the largest percentage of 2020 EV owners (28%) said that the COVID-19 pandemic has not affected how frequently or where they charge. Large numbers reported that they are only charging at home or charging at home more frequently than they used to (25%), charging less often due to less driving (15%), charging at public charging stations less often (11%), and no longer charging at work (8%).

While most comments indicated less need for charging or using fewer charging locations, a handful of respondents indicated that they are charging away from home more often as they

visit new locations. They reported that they are using DCFC stations as a destination or are finding that their home's electrical system cannot handle the demands of the occupants being home all the time on top of EV charging, with comments such as:

> *"Yes, less charging at home because we are home all the time and the house electric system is not built for full occupancy plus car charging." - 2020 EV Owner*

> *"I no longer have a commute, so the majority of charging is at home. My partner and I find it fun to plan long scenic drives around the location of a fast charger within a few hours of our home, though in general our longer drives to visit friends and family have decreased." - 2020 EV Owner*

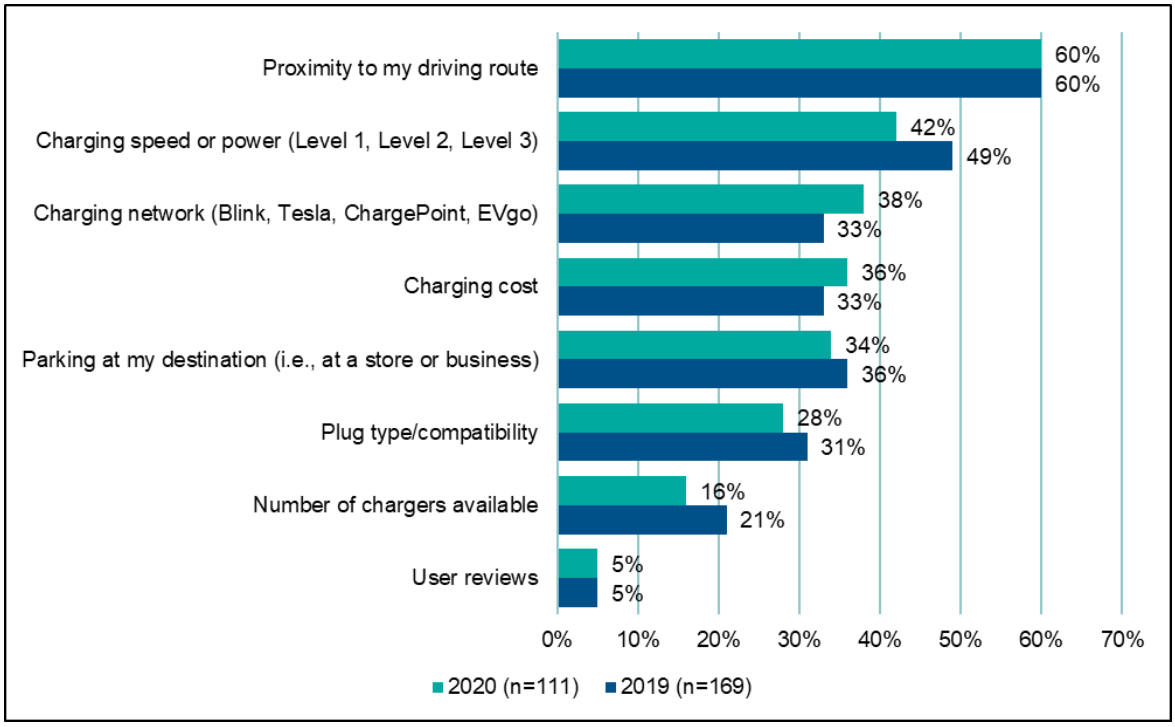
### *Deciding Where to Charge*

The ways EV owners find charging stations away from home is similar to what they reported in 2019, though there was a significant decrease in the proportion that use in-car navigation.[35] Most EV owners use a web-based tool to find charging stations, with just over half using an app (54% in 2019, 60% in 2020), about one-fifth or less using in-car navigation (21% in 2019, 13% in 2020), and about 10% using a web search (10% in 2019, 8% in 2020). While it is still a small percentage of EV owners overall, in 2020 significantly more said they typically find charging stations by seeing them (14%) than in 2019 (8%), which could be a result of improved range, differences in vehicle mix, or potentially that as stations become more prevalent, EV owners are more comfortable with happening upon them.

EV owners look for a variety of features when selecting a charging station away from home. The top two features that respondents considered when selecting a charging station were the same in both years: 1) proximity to their driving route (60% in 2019 and 60% in 2020) and 2) charging speed or power (49% in 2019 and 42% in 2020). Very few EV Owners (5% in each year) cited user reviews as something they consider when selecting a charging station. None of the differences between years are statistically significant (Figure 4-19).

[35] This may be attributed to the higher proportion of PHEV's, which less commonly have in-car navigation, in the 2020 EV owner sample. Overall, 28% of BEV drivers use in-car navigation and 3% of PHEV drivers use in-car navigation.

**Figure 4-19. Features EV Owners Consider When Selecting a Charging Station Away from Home**




Fewer than half (42%) of EV owners from both years of the survey have a subscription or membership to a charging network. Of those with a subscription/membership, almost all (96%) have a ChargePoint membership. EVgo was the next most common (42%) subscription/membership among EV owners, followed by Tesla (14%) and Blink (13%).

### *Types of Chargers*

Overall, most EV owners use Level 2 chargers when charging at home (64%), and about one-third use a Level 1 charger, though BEV owners (77%) are significantly more likely than PHEV owners (23%) to have Level 2 charging at home.

PHEV owners account for about three-quarters (71%) of the EV owners who use a Level 1 charger at home, while 29% 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.

Most EV owners use Level 2 charging when away from home as well. Just under three-quarters (72%) 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 6% 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.

While most EV owners have access to free charging away from home, far fewer have access to free fast-charging. Nearly three-quarters (74%) of EV owners said that they did not have to pay to charge their vehicle at their most-frequented, non-home charging station, whereas fewer than one-third (29%) said that they have access to free DCFC, predominantly through a manufacturer or dealer network[36] (25%).

Nearly half (46%) of EV owners identified charging speed or power as a feature they sought when selecting a charging station away from home. Yet only 16% of EV owners indicated that they would go out of their way to find a DCFC station, and about 12% said that while they prefer fast-charging, it is not something that they go out of their way to use. Some EV owners (11%) specified that DCFC stations were most important to them on long trips rather than day-to-day travel, with some mentioning how DCFC is bad for the battery's longevity. BEV owners were more likely than PHEV owners to say they would go out of their way for fast charging.

#### *Issues Finding Charging Stations*

The proportion of EV owners who have experienced issues finding charging stations in Massachusetts has not changed in the past year. While not all EV owners have looked for charging stations away from home (12% had not looked in 2019, 14% had not looked in 2020), half of all EV owners (49% in 2019, 50% in 2020%) reported issues finding a charging station or finding a functioning charging station. Many EV owners noted that they experienced these issues finding a charging station while on long trips, many of which were outside National Grid's service territory, including driving to western Massachusetts, Cape Cod, or out of state. This was consistent across both 2019 and 2020 surveys.

The focus on long trips mirrors concerns that the 2019 general population respondents expressed about the perceived lack of charging stations within (and outside of) Massachusetts. Together, the 2019 and 2020 EV owner and 2019 general population comments suggest that the availability of stations beyond National Grid's territory influence range anxiety and perceptions about charging station availability.

### 4.3.6 EV Ownership Experience

We asked EV owners to share their biggest surprises about owning or leasing an EV. Most survey respondents (in both years) reported how fun and easy their EV is to drive, specifically citing that it is smooth, powerful, and quiet. Many owners simply pointed out that it is an excellent car to have. Others went more in-depth, stating that they were surprised how easy it is to keep charged and how much money they save not buying gasoline.

[36] 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, 88% of EV owners reported that they were either somewhat (37%) or very satisfied (51%) with the driving range of their EV. The average driving range reported by BEV owners was 217 miles. PHEV owners reported that the average driving range for their electric battery was 34 miles. However, sentiments that EV owners expressed in comments about range were split; some EV owners expressed that their range anxiety was decreasing and that it was easy to find charging, 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." – 2019 EV Owner*

> *"How much range decreases in cold weather. How hard to find charging stations at times and [in] certain places." – 2020 EV Owner*

Some respondents also commented on how their maintenance costs were much lower than expected and the convenience of never having to go to the gas station.

> *"So, so easy to transition to it. It's true that transitioning to electric charging is different, but the HUGE overall cost of ownership reductions and reduction in vehicle maintenance make it far more convenient. (i.e. never having to "go" to the gas station, never needing my oil or other fluids changed, etc.) I only have to visit the dealership once per year to rotate my tires and maybe change my cabin air filter." – 2020 EV Owner*

In 2019, some EV owners noted that they have had issues with non-EVs parked in spots designated for charging stations. This topic also came up during interviews conducted in 2019 with the National Grid sales and implementation teams. This issue might signal future tensions related to parking spaces between EV owners, non-EV owners, and site hosts. However, this issue was not mentioned at all in the 2020 survey, which could be a result of fewer people being out in general during the COVID-19 pandemic.

### 4.3.7 Demographics

The vast majority of EV owners own their homes (95%). Most (86%) 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 (49%), far more than the 2019 general population (7%).

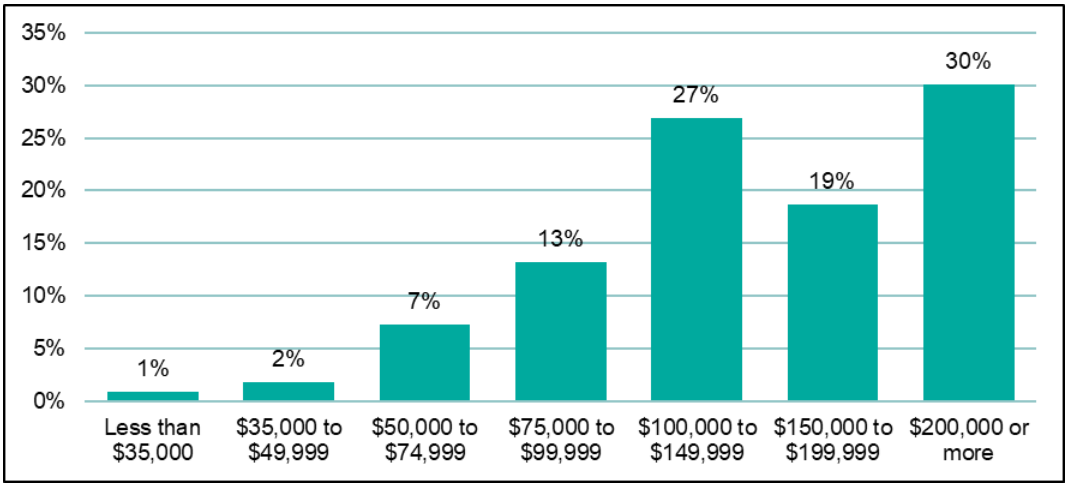
The average EV owner household has 2.5 people, and two-person households are the most common (48%). Over half of the households have at least one person over age 55 (59%), and just

over one-quarter have children under age 18 (30%). The age distribution is similar to the 2019 general population sample.

About 57% of EV owner households have at least one adult working or attending school full-time out of the home, and 36% have an adult who works or attends school full-time from home. There is at least one retired adult in 29% of the EV owner homes.

EV owners reported higher incomes than the general population sample. Among those who reported income, 11% had a household income less than $75,000 in 2019, while 76% reported incomes of $100,000 or more (compared with 39% among the 2019 general population sample). The majority of respondents had a bachelor's degree or higher (90%).

**Figure 4-20. Household Income of EV Owner Respondents (n=219)**




Almost three-quarters (70%) of the EV owner respondents identified as male, compared with 45% of the 2019 general population sample.

### 4.3.8 Upcoming Activities for PY3

There are no EV owner survey activities planned in PY3.

## 4.4 Participant Community Member Follow-up Survey

In 2019, the ERS team, in consultation with National Grid, identified three communities that had recently installed public-access charging stations through National Grid's program: Lowell, Haverhill, and Boxford. At the time the communities were selected, there were additional public-access charging stations planned in each of the communities, but the Boxford stations did not get installed.

The evaluation team surveyed customers in these towns in November 2019 and October 2020 to determine if there were changes in residents' awareness and perceptions of EVs and charging

opportunities over time. Any significant changes between years could be associated with general marketing, media, or education (market effects), as well as the Charging Program. We understand from sales staff interviews conducted in 2019 that each of these communities may have already had public-access charging stations before the installation of program-funded stations (and some were visible on PlugShare.com). Therefore, baseline awareness of local charging may be a function of program and non-program stations.

As of the November 4, 2020, program tracking data, the City of Lowell had installed 30 stations using National Grid incentives, Haverhill had installed 8 stations, and Boxford had installed 3 stations. One of the municipal Haverhill stations is the third most highly utilized station in the program (and the most utilized "public" station). Four charging sites in Lowell, comprised of 13 stations, are among the top 30 most-utilized sites in the program.

**Table 4-20. Activated Stations in Target Communities for Participant Community Sample**

| Community | Program Stations Installed before 2019 Survey (through 11/14/2019) | | Program Stations Installed before 2020 Survey (through 11/04/2020) | | Total Program Stations Installed between 2019 and 2020 |
|---|---|---|---|---|---|
| | Installed Station Count | Activation Date Range | Installed Station Count | Activation Date Range | Installed Station Count |
| Lowell | 16 Municipal[2] | 5/31/2019 | 7 Workplace<br>7 MUD | 3/10/2020 to 9/12/2020 | 16 Municipal[2]<br>7 Workplace<br>7 MUD |
| Haverhill | 4 Municipal | 3/26/2019 | 4 Municipal | 4/23/2020 | 8 Municipal |
| Boxford | 3 Municipal | 6/28/2019 | 0 Municipal | – | 3 Municipal |

[1] Most stations have two ports per station.

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

The evaluation team invited a stratified random sample of customers within these communities (proportional to community) to take the general population baseline survey conducted in 2019. For the 2020 follow-up survey, the evaluation team used a similar approach to develop the new random sample of community members from the three locations. In 2019, the ERS team included in the baseline participant community results (n=68) the responses from the participant community oversample (n=24) and responses from the general population survey from people who live or work in these communities (n=44). In 2020, all responses (n=131) are from a targeted participant community sample, as there was not a 2020 general population survey conducted.

### 4.4.1 Key Evaluation Findings: Participant Community Member Survey

The key findings from the participant community member survey are summarized here:

- **Awareness of and interest in EVs may be growing in the three participating communities.** In 2020, significantly more community members reported seeing one of the program-funded charging stations in their community, and significantly more test drove an EV at a dealership compared to the 2019 baselines. While in 2020, the proportion of community members who test drove at a dealership was still small, it is a notable increase since none of the 2019 community respondents test drove at a dealership.
- Overall, community members seem less concerned about EV driving ranges, but their concerns related to accessing charging stations and maintaining an EV's charge held steady. Between years, EV awareness and perceptions remained similar, but the perceived barriers to owning EVs did trend downward overall. Specifically, the constant concern about "running out of battery power" decreased significantly in 2020 and is no longer the primary barrier among community respondents. The concern about "where to charge" an EV also trended downward but did not significantly change and is now the primary barrier among community respondents. Similarly, concerns about the "time and effort to keep an EV charged" trended downward, but without significant change, which may signal that people are more aware or knowledgeable of EV driving ranges but may still have concerns about station availability and charging speeds.
- **The share of EVs within National Grid's territory and these three participating communities has not changed in the past year.** Using state-wide vehicle registration data, the ERS team found that about 1,239 personal EVs were registered to zip codes in National Grid's electric or combination-fuel service territory – of which, 50 were registered in Lowell, Haverhill, or Boxford – between 2019 Q2 and 2020 Q2. However, these 2020 registrations did not shift the proportion of EVs registered in National Grid's territory or the three communities. Between 2019 and 2020, the proportions of registered EVs statewide remained steady with about 43% in National Grid's territory and 2% in the communities. However, with 31% of respondents in 2019 and 35% of respondents in 2020 planning to purchase a vehicle within two years, it may take time for changes in perceptions to be reflected in vehicle purchases. That said, between 2019 and 2020, there has not been a significant change in the percentage of community survey respondents considering EVs for their next purchase (24% and 27% respectively). Therefore, trends in vehicle purchases may not change much since there are not more people who are planning to get a vehicle in the next two years who are currently considering an EV.

### 4.4.2 Respondent Overview

In 2020, the ERS Team received 131 survey responses from residential customers who live and/or work in Lowell, Haverhill, or Boxford. All the 2020 respondents lived in one of the

participant communities, which is a statistically significant increase from 2019, where 9% of respondents only worked in the participant communities. As shown in Table 4-21, the distribution of communities is similar across years.

**Table 4-21. Comparison of Wave 1 and Wave 2 Participant Community Respondents by Town**

| | 2019 (n=68) | 2020 (n=131) |
|---|---|---|
| Live in participant communities | 91% | 100% |
| Lowell | 50% | 54% |
| Haverhill | 38% | 40% |
| Boxford | 3% | 6% |
| Work (or attend school) in participant communities | 31% | 45% |
| Work but do not live in participant communities | 9% | 0% |

Respondents' commuting patterns did not change significantly between 2019 and 2020. Despite the lockdown resulting from the COVID-19 pandemic, most 2020 respondents regularly commuted either to one of the three communities (27%) or another city or town (40%). That said, between years, there was an upward trend in respondents who said they did not regularly commute for work or school (25% in 2019 and 33% in 2020). While this change was not statistically significant, it likely signals that the COVID-19 pandemic may have impacted commuting patterns.

In both years, a relatively small percentage of respondents were municipal employees at one of the three participant communities (2% in 2020, 7% in 2019). Comparable to 2019, about 2% indicated that they are employees or students at UMass Lowell, which activated six Level 2 stations in 2020 (according to the November 4, 2020, program tracking data).

Vehicle ownership rates stayed relatively consistent across years – 88% own or lease at least one vehicle, and of these, 2% reported owning an EV.

### 4.4.3 Market Awareness and Perceptions of EVs

The purpose of the participating community surveys was to gather information on EV awareness, perceptions, and purchase considerations and then assess how these metrics change 12 months after the 2019 survey, which served as a baseline. Table 4-22, below, presents participant community survey results from 2019 and 2020, along with analogous results from the baseline general population survey conducted in 2019.

While we show the baseline general population metrics as a reference, we cannot attribute any differences at this point 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 before 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.

In 2020, EV awareness and perceptions remained similar between community respondents and the general population baseline, but their perceived barriers to owning EVs did trend downward overall. Notably, the constant concern about "running out of battery power" decreased significantly in 2020 and is no longer the primary barrier among community respondents. Community respondents are now most concerned about where they would charge an EV; however, about two-thirds feel confident that they would figure it out.

Significantly more community respondents test drove an EV at a dealership in 2020 compared to the 2019 baselines from the general population and target communities, which may signal that community members' interest and curiosity in EVs is growing.

**Table 4-22. Baseline EV Awareness, Perception, and Purchase Metrics for Participant Community Surveys and the General Population Survey**

| Survey Question | General Population Baseline (2019) (n=642) | Participant Community Baseline (2019) (n=68) | Participant Community Follow-Up (2020) (n=131) |
|---|---|---|---|
| **EV Awareness** | | | |
| Able to name at least one make/model | 72% | 66% | 73% |
| Aware of Electric Vehicles[1] | 69% | 69% | 72% |
| **EV Barriers (Among EV Aware Non-Owners)[2]** | | n=45 | n=88 |
| If I had an electric vehicle, I'd always worry about where to charge it. | 62% | 64% | 52% |
| If I had an electric vehicle, I'd constantly worry about running out of battery power. | 61% | 76% | 47%** |
| It would take a lot of time and effort to keep an electric vehicle charged. | 32% | 42% | 28% |
| I am confident that I could figure out how and where to charge an electric vehicle. | 64% | 60% | 63% |
| **Actions Taken Toward EV Purchase (Among EV Aware Non-Owners)[1]** | | n=41 | n=82 |
| Test drove a friend or family member's EV | 9% | 9% | 7% |
| Test drove at a dealership | 3% | 0%* | 7%* |
| Looked for nearby charging stations | 14% | 25% | 17% |
| Researched charging costs | 4% | 9% | 9% |
| **Vehicle Purchase Consideration** | | n=68 | n=128 |
| Considering purchasing/leasing a vehicle in the next two years | 34% | 31% | 35% |
| **EV Purchase Consideration** | | n=21 | n=45 |
| Considering PHEV or BEV for next purchase (*among those purchasing/leasing in two years*) | 23% | 24% | 27% |
| **EV Ownership** | | | |
| Self-reported EV Ownership | 2% | 4% | 2% |
| | | | |

[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.

* *Statistically significant at the 0.10 level*

** *Statistically significant at the 0.05 level*

The share of EVs within National Grid's territory and these communities has not changed in the past year. 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 Q2 2020, about 6,371 personal EVs were registered to zip codes in National Grid's electric or combination-fuel service territory (43% of the statewide total).[37] Of these, 294 vehicles (2%) were registered to homes in Lowell, Haverhill, or Boxford.

[37] Source: Analysis by ERS Team of IHS Markit Massachusetts EV Registration Data from Q2 2020. Data restricted to personal vehicles.

Between 2019 Q2 and 2020 Q2, an additional 1,239 personal EVs were registered to zip codes in National Grid's electric or combination-fuel service territory (42% of the statewide total). Of this total, 50 personal EVs were registered to homes in Lowell, Haverhill, or Boxford.

### 4.4.4 Charging Station Awareness and Perceptions

Table 4-23, below, presents participant community survey results from 2019 and 2020, along with analogous results from the baseline general population survey. Per above, we cannot attribute any differences between the general population and the community survey respondents 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 before the Charging Program.

Overall, the percentage of community respondents that had seen charging stations in Massachusetts or their workplace trended upward since 2019, but the difference is not yet statistically significant. There is also an upward trend of respondents' recollection of charging stations at travel plazas or highway rest stops and grocery stores. Note that none of the completed program stations in these communities appear to be at these types of locations; however, this difference is also not yet statistically significant.

Significantly more respondents in 2020 recalled seeing a charging station at retail locations (including restaurants, convenience stores, pharmacies, and malls). None of the activated Haverhill, Lowell, or Boxford stations in the project tracker appear to be retail locations; however, this change in respondents' ability to recall retail charging stations may indicate:

- Retail locations are destinations that people visit when they leave their community, and therefore station visibility might be greater.
- Awareness of EVs and/or charging stations is increasing, resulting in community members noticing charging stations more frequently.

**Table 4-23. Charging Station Awareness, Perception, and Purchase Metrics for Participant Community Surveys and the General Population Survey**

| Survey Question | General Population Baseline (2019) (n=642) | Participant Community Baseline (2019) (n=68) | Participant Community Follow-Up (2020) (n=131) |
|---|---|---|---|
| **Charging Station Awareness** | | | |
| Have seen charging stations in MA (among non-owners) | 72% | 71% | 79% |
| Have seen charging stations within 10 minutes of home | 20% | 19% | 22% |
| Have seen charging stations within 10 minutes of work (among commuters) | 23% | 25% | 24% |
| Have seen charging station AT workplace (among commuters) | 10% | 14% | 24% |
| **Charging Station Location Recall (Among Those Who Have Seen Stations in MA)** | | | |
| Retail store (including restaurants, convenience stores, pharmacies, malls) | 40% | 20%* | 34%* |
| Paid public parking[1] | 28% | 47% | 43% |
| Travel plaza or highway rest stop | 24% | 14% | 24% |
| Municipal or government parking (e.g., town hall, library or municipal parking lot)[1] | 22% | 29% | 28% |
| Grocery store | 16% | 8% | 16% |
| School, college or university | 12% | 18% | 22% |
| **Charging Station Recall in Participant Communities** | | | |
| Have seen one of the program-funded charging stations in their community | N/A | 13%** | 38%** |
| Have NOT seen a program-funded charging station in their community | N/A | 87%** | 62%** |
| **Understanding of How to Pay to Charge (Among Those Aware of EVs)[2]** | | | |
| % who *don't know* how you pay | 60% | 60% | 55% |
| % who think charging is paid | 21% | 27% | 26% |
| % who think charging is free | 7% | 7% | 8% |
| % who think it depends | 12% | 7% | 11% |

[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.

[2] 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."

* *Statistically significant at the 0.10 level*

** *Statistically significant at the 0.05 level*

The percentage of respondents that had seen a charging station at one of the program-funded installation locations in their town increased significantly, with about 13% of respondents reporting seeing one of the program-funded stations at a location in their town in 2019, compared to 38% in 2020. Respondents in Lowell were most likely to recall hearing about or seeing a specific program station in their community, with 51% of Lowell respondents hearing about or seeing one of the program stations compared to 26% of Haverhill respondents and

none of the Boxford respondents. The most commonly recalled program stations in each town were similar to 2019:

- **Lowell:** City of Lowell – City Hall Plaza (11%) and UMass Lowell South Parking Garage (11%)
- **Haverhill:** City of Haverhill – City Hall (10%)
- **Boxford:** None of the Boxford respondents recalled seeing or hearing about charging stations at program project sites, however, there were the fewest stations installed there.

### 4.4.5 Upcoming Activities for PY3

There are no community survey activities planned in PY3.

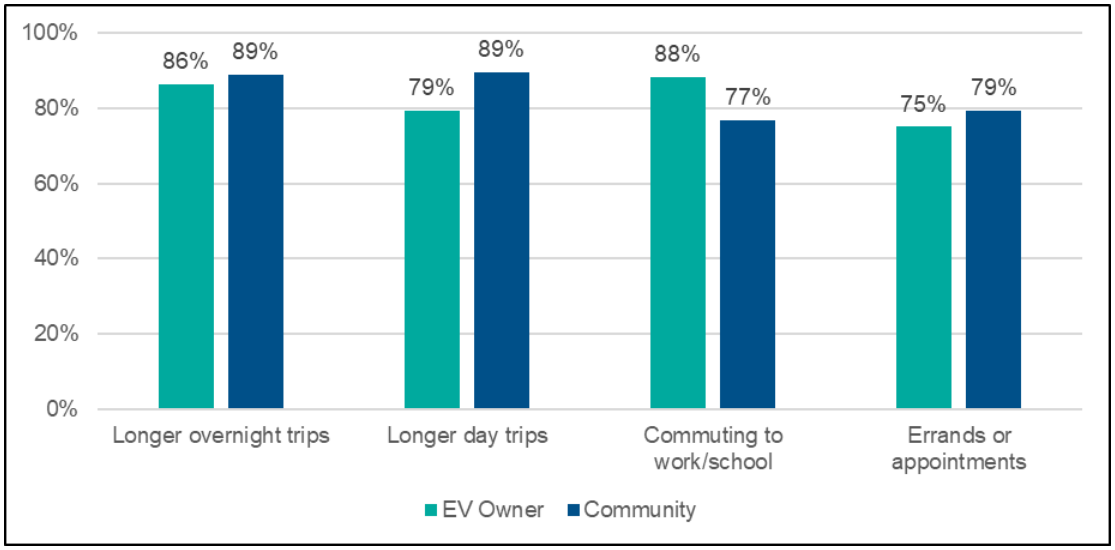
## 4.5 Impacts of the COVID-19 Pandemic

Both the Community and EV Owner follow-up surveys (October 2020) contained questions about the impact of the COVID-19 pandemic on driving habits and vehicle purchase decisions. This section shares results for both groups.

### 4.5.1 Impact of the COVID-19 Pandemic on Travel Behavior

The majority of community survey respondents (69%) and EV owners (92%) said the COVID-19 pandemic affected their regular driving habits or how often they take long trips. The biggest impact was on longer overnight trips, with 86% of EV owners and 89% of community respondents saying they are driving less than usual. Large percentages of respondents also reported commuting less, where 77% of community respondents and 88% of EV owners reported driving less than usual (Figure 4-21).

**Figure 4-21. Percentage of Respondents Driving Less Due to the COVID-19 Pandemic***

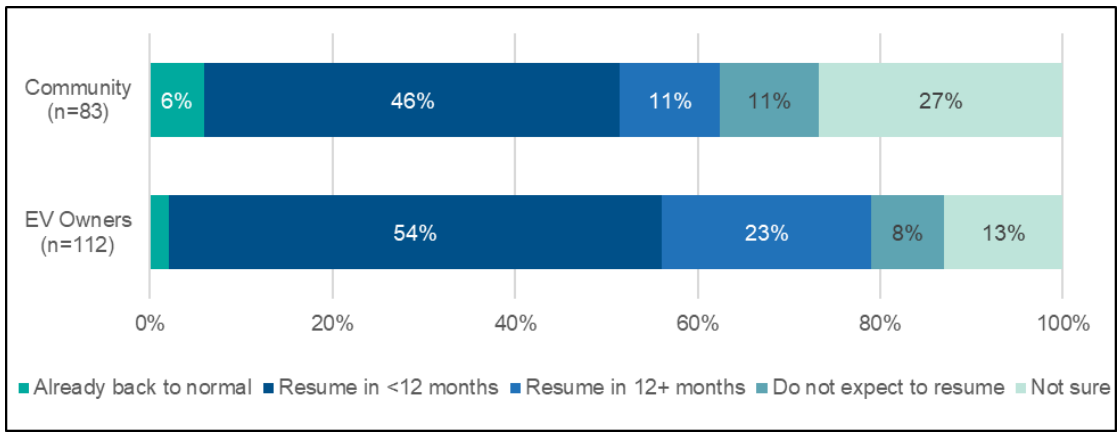



*Percentage of respondents who are driving less due to the COVID-19 pandemic. Overnight trips (EV Owner n=103, Community n= 63), Day trips (EV Owner n=106, Community n=66), Commuting (EV Owner n=84, Community n=69), Errands (EV Owner n=112, Community n=77). The n for each question reflects the number of respondents that typically drive for each item.

While no EV owners reported commuting more, 9% reported taking more day trips, 6% reported driving more for overnight trips, and 4% are driving more for errands or appointments. Fewer community respondents reported driving more because of the pandemic.

The largest proportions of drivers who reported a change in habits think they will resume their typical driving habits in less than 12 months (46% of community respondents and 54% of EV respondents). That said, some drivers do not expect to resume their pre-pandemic driving habits. Eleven percent of community respondents and 8% of EV owners who reported a change do not expect to resume their prior driving habits (Figure 4-22).

**Figure 4-22. When Respondents Expect to Resume Typical Driving Habits**



### 4.5.2 Impact of the COVID-19 Pandemic on Vehicle Purchase Consideration

Between the baseline and follow-up surveys (2019 and 2020), both participating community members and EV owners reported a longer purchase horizon. When asked directly, 30% of community respondents and 22% of EV owners said the COVID-19 pandemic affected when they expect to purchase their next vehicle. However, as shown in the table below, there are no significant differences between survey years in when EV owners or community members are planning to purchase their next vehicles. There are, however, statistically significant differences between EV owners and participant community members. In both years, significantly more community survey respondents say they do not have plans to purchase or lease a new vehicle.

**Table 4-24. Timeline for Next Vehicle Purchase**

| | 2019 Surveys | | 2020 Surveys | |
|---|---|---|---|---|
| | Participant Community (n=68) | EV Owner (n=182) | Participant Community (n=131) | EV Owner (n=119) |
| **Timeline for next purchase or lease** | | | | |
| Within 1 year | 9% | 11% | 12% | 15% |
| 1-2 years | 22% | 26% | 23% | 19% |
| 3-5 years | 31% | 34% | 33% | 35% |
| More than 6 years | 15%* | 25%* | 10%** | 28%** |
| Do not plan to purchase/lease | 24%** | 4%** | 22%** | 3%** |

*** Statistically significant at the 0.05 level*
** Statistically significant at the 0.10 level*

The COVID-19 pandemic has not affected the type of vehicle customers are considering. Only one community respondent and one EV owner said it affected the types of vehicles they are considering.

## 4.6 Workplace Surveys

This section summarizes findings from the workplace surveys conducted with a large manufacturing facility in eastern Massachusetts and a large city in Massachusetts. The workplace surveys focused on EV and EV charging awareness as well as knowledge, travel patterns, and vehicle purchase plans.

To measure potential effects of having charging stations at one's workplace on interest in and knowledge of EVs, the ERS team compared results of these surveys to the general population survey conducted in the fall of 2019. The PY1 report presents full results from that survey. All differences noted between workplace respondents and the general population are significant at at least $p < .10$.

### 4.6.1 Key Evaluation Findings: Workplace Surveys

The key findings from the surveys of site host employees are summarized here:

- The availability of charging stations at the workplace has motivated employees to consider or purchase EVs and has increased knowledge and awareness of EV charging. Approximately two-thirds of manufacturing facility respondents who do not own EVs indicated that the presence of charging stations at work affected their likelihood to purchase an EV, motivated them to learn about EVs, and contributed to their knowledge about how and where to charge an EV to some extent. Respondents from both workplaces are significantly more likely than the general population to have seen charging stations. Further, all 10 manufacturing facility EV owner respondents and four of the five city respondents who purchased their EVs after the charging stations were installed reported that the availability of charging at work affected their decision to purchase an EV to some extent.
- **Workplace respondents show greater interest in and knowledge of EVs than the general population.** Respondents from both sites are significantly more likely to be considering an EV for their next vehicle (of those planning to purchase a vehicle in the next two years, 61% of the manufacturing facility and 50% of the city respondents compared to 23% of the general population) and to have some knowledge of EVs (97% of the manufacturing facility respondents and 87% of the city respondents compared to 69% of the general population). Manufacturing facility respondents were also more likely to have researched EVs, including vehicle pricing or talking to an EV owner about their experience. While some of the differences between workplace respondents and the general population may be due to demographic or other population differences, the previous finding indicates at least some effect on EV knowledge and interest can be attributed to the charging stations.
- **Workplace respondent opinions on the barriers to purchasing an EV are generally the same as the general population.** Like the general population, employee respondents consider price the top barrier to purchasing an EV. While large percentages of workplace and general population respondents thought they would always worry about where to charge an EV if they owned one, nearly as many were confident they could figure out how and where to charge the vehicle. The only significant difference between workplace respondents and the general population is that compared to the general population, significantly more manufacturing facility respondents expressed concern that an EV might not meet their needs for long trips (62%, compared to 47%). Most respondents from both workplaces thought an EV would meet their daily driving needs, with only around 30% expressing concern, which is similar to the general population.

### 4.6.2 Workplace Survey – Large Manufacturing Facility

This facility installed six charging stations in 2017 as part of a large solar project, four charging stations in 2019 through the Charging Program, and the site has plans to install six more stations in 2021. Employees may charge their vehicles at no cost. In addition to communicating station activation to employees, this employer held a "Ride and Drive" event in 2017.

This employer distributed the survey to 1,200 employees, and the ERS Team received 312 completed responses. The survey ran from December 11, 2020, through January 4, 2021.

#### *Vehicle Ownership and Travel Patterns*

The survey assessed vehicle ownership, travel patterns, and among EV owners, charging behavior.

***Vehicle Ownership***. The majority of respondents (95%) own or lease a vehicle and live in multi-vehicle households; slightly over half (52%) have two vehicles and just over one-quarter (28%) own three or more vehicles. One-fifth (20%) of households who own or lease have only one vehicle.

Gas is the most popular fuel type among respondents who own or lease a vehicle, with 92% reporting they own or lease gas-only cars, 2% reporting they own or lease conventional hybrids, and 4% reporting they own or lease electric vehicles as their primary vehicle.

Of the nine battery electric vehicle (BEV) owners who responded to the survey, eight own a Tesla and one owns a Chevrolet.

Five plug-in hybrid electric vehicle (PHEV) owners responded to the survey. All five own PHEVs of different makes.

***Travel Patterns***. The COVID-19 pandemic has greatly reduced how often respondents travel to the facility . While the majority of respondents (91%) traveled to the facility five days per week prior to the COVID-19 pandemic, just over one-third of respondents (35%) travel there five days per week currently.

Currently, just under half of respondents (45%) travel to the facility less than four times per month. Very few respondents (2%) said they traveled to the facility fewer than four times per month prior to the COVID-19 pandemic.

The majority of respondents who travel to work reported driving to work alone both before and after the COVID-19 pandemic (95% currently, 92% prior to pandemic). A small number of respondents reported using public transportation (2% currently, 6% prior to pandemic) and carpooling (3% currently, 3% prior to pandemic).

***EV Owner Charging Behaviors.*** While EV owners reported that they charge most frequently at home, over half (n=8) have used the charging stations at the facility. One EV owner reported

charging at work once a month or twice a month. Three EV owners reported charging at the facility once per week. Two EV owners reported charging 2-3 times per week. One EV owner reported charging at the facility 4-5 times per week.

EV owners who charge at work generally leave their vehicles plugged in for long periods of time. Six EV owners who charge at the facility reported leaving their vehicle plugged in for six or more hours. One EV owner reported typically leaving their vehicle plugged in for 1-2 hours and another EV owner reported typically leaving their vehicle plugged in for 4-6 hours.

Over half of the surveyed EV owners who charge their vehicles at the facility reported being "very satisfied" (5/8) or "somewhat satisfied" (3/8) with the charging stations at the facility. Four EV owners noted issues charging at the facility, including high demand for chargers, and one owner reported inconvenient charging station locations for some buildings.

Just over half of the EV owners (n=8) reported having experienced issues finding charging stations in Massachusetts. Two EV owners had no issues finding charging stations in Massachusetts and four EV owners reported never looking for a charging station away from home. Some of the issues reported by EV owners included high parking costs to access some stations, high demand or low availability of chargers, and scarcity of charging stations.

#### *Awareness and Knowledge of Electric Vehicles and Charging*

The survey also included questions about EV and station awareness and knowledge, barriers to purchase, and EV education.

***EV Awareness and Knowledge.*** The ERS Team developed four questions to determine respondent awareness and knowledge of EVs. For each of the items below, respondents selected *"I know nothing about this," "I know a little about this,"* or *"I know a lot about this."* [38]

- 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

Compared to the 2019 general population survey, significantly more manufacturing facility respondents are classified as *EV Aware*, and they are more familiar with different aspects of EVs than members of the general population. Almost all (97%) of the non-EV owners at the facility reported they knew at least a little about one or more of the EV knowledge categories,

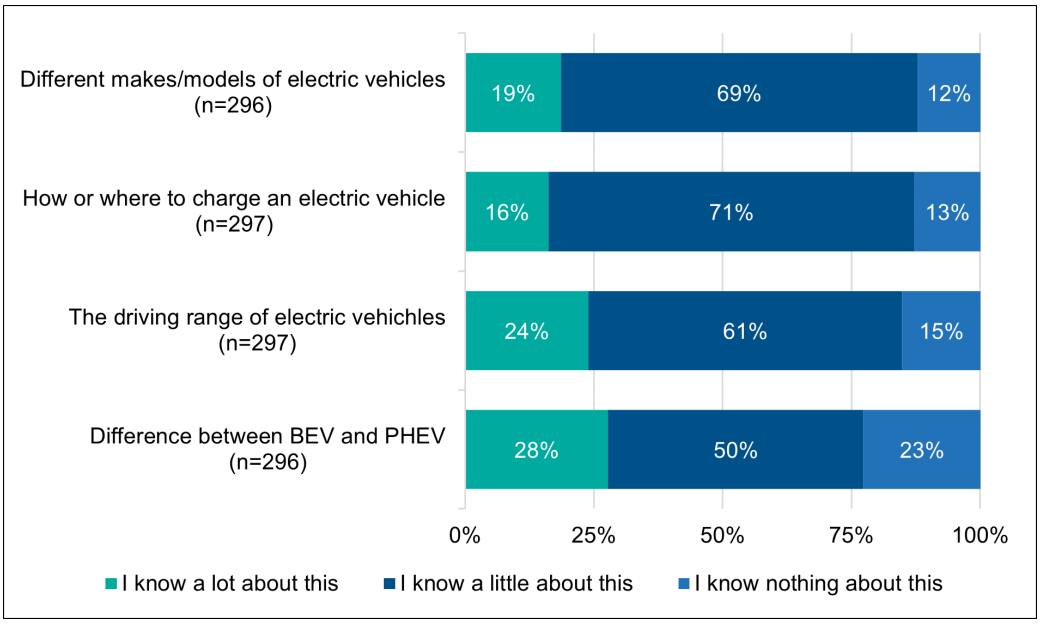
[38] The ERS Team classified anyone who reported *"I know a little about this"* or *"I know a little about this"* to any of the four statements as *Aware* and anyone who reported *"I know nothing about this"* to all four statements as *Unaware* in our analysis.

compared to 69% of the general population. Only 3% of respondents said they knew nothing about any of the EV awareness questions.

The majority of respondents were knowledgeable about makes and models of EVs (88%), how or where to charge an EV (87%), and the driving ranges of EVs (85%), reporting they knew at least a little bit about these aspects of EVs. Respondents know the least about the difference between BEHs and PHEVs, with around three-quarters (77%) reporting they knew at least a little about it.

Of the respondents who do not own an EV, 65% reported that the charging stations at the facility contributed to their knowledge about how and where to charge an EV (39% to a small extent, 19% to a moderate extent, and 7% to a great extent).

**Figure 4-23. Knowledge of EVs Among Non-EV Owners**




Note: Percentages may be over 100% due to rounding.

***Charging Station Awareness and Knowledge.*** Most respondents have seen EV chargers in the state and know about those at the facility; 91% of non-EV owners have seen charging stations in Massachusetts and almost all (98%) knew that the facility has chargers for electric vehicles.[39] The majority of respondents (94%) who are aware that the facility has chargers have also seen the EV chargers there in person.

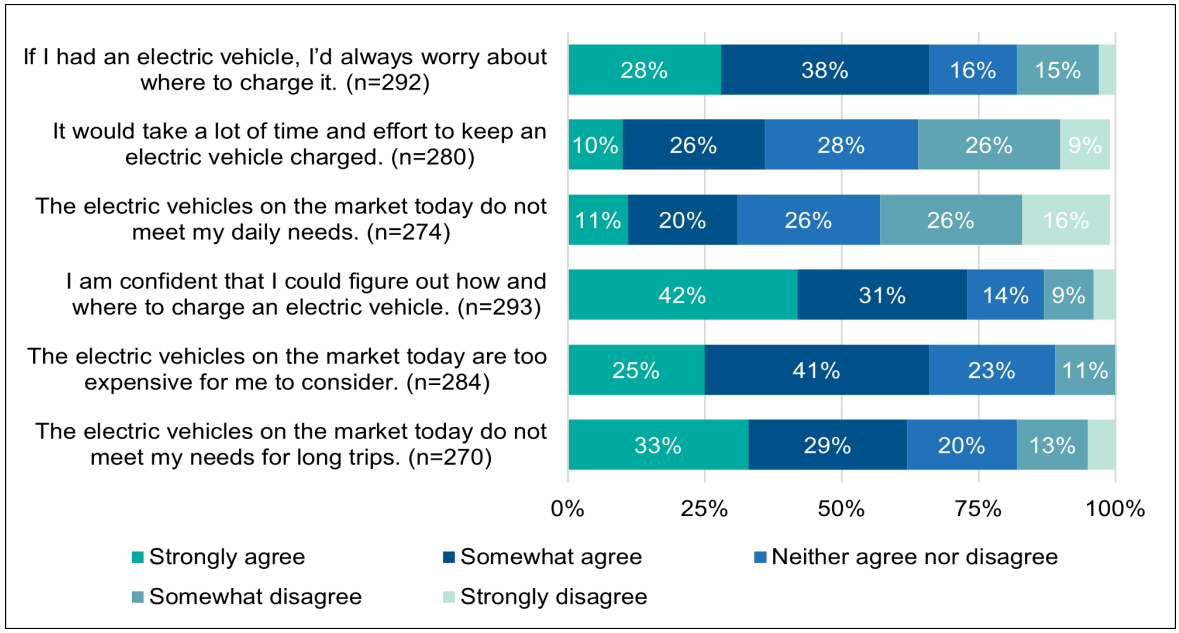
[39] The percent of non-EV owners who have seen chargers in Massachusetts is significantly higher than the percentage of the general population respondents who have ($p<0.01$), 91% of the facility respondents compared to 72% of general population respondents.

Respondents were unsure about who could use the charging stations at the facility, but most knew there was not a fee. While most respondents (87%) said that employees/staff can use them, equal proportions of respondents (32%) believe customers and visitors or guests can use them, and 14% are not sure who can use them. Most of the respondents (97%) said that payment was not required and only four respondents (2%) said payment was required. Only one respondent (1%) said payment for chargers "depends."

***Perceptions and Barriers of EVs.*** Similar to 2019 general population survey respondents, the manufacturing facility respondents reported concerns about the price of EVs as the most prevalent barrier, with two-thirds of respondents agreeing that the EVs on the market today are too expensive for them to purchase (66%). Compared to the general population, significantly more manufacturing facility respondents were concerned that EVs might not meet their needs for long trips (62% compared to 47% of the general population).

Opinions on other potential barriers to EV ownership were similar to those of the general population. Nearly three-quarters of manufacturing facility respondents (73%) said that they were confident they could figure out where to charge an EV and about one-third of respondents (32%) thought that EVs would not meet their daily needs (Figure 4-24).

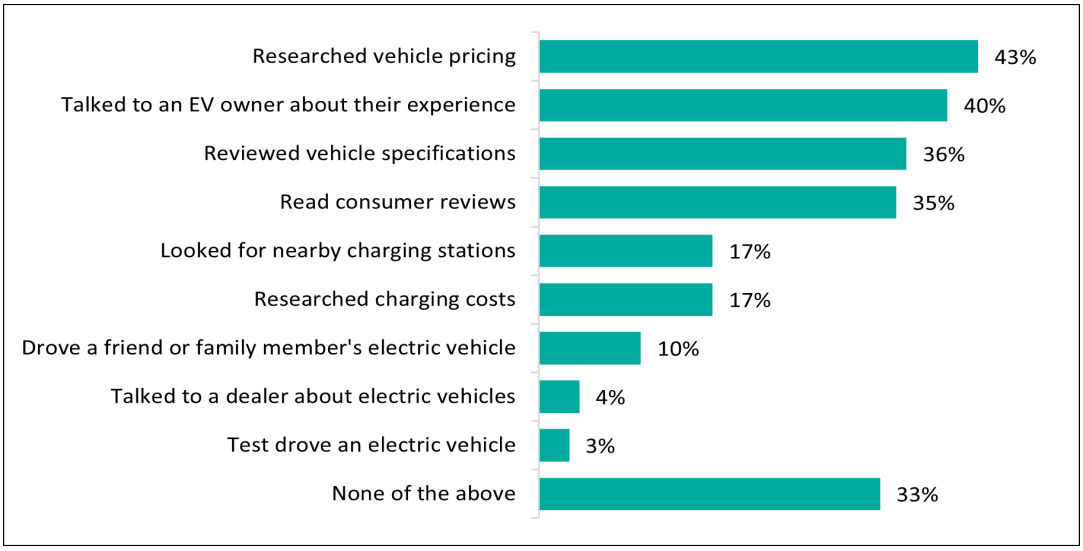
**Figure 4-24. Opinions of EVs Among Non-EV Owners**




***Actions Taken Toward EV Education.*** Most manufacturing facility respondents who do not own an EV have researched electric vehicles (67%, compared to 47% of the 2019 general population survey respondents). Among those manufacturing facility respondents who have

done some research, the three most popular actions taken are *researched vehicle pricing* (43%), *talked to an electric vehicle owner about their experience with electric vehicles* (40%), and *reviewed vehicle specifications* (36%). Very few respondents (4%) reported that they have test driven an electric vehicle. Of the respondents who did a test drive, five respondents test drove with a family member or friend, four respondents test drove through a dealership, two respondents drove at a "Ride and Drive" event outside of the facility, and one test drove at a facility "Ride and Drive" event. Figure 4-25 details the actions taken by respondents.

**Figure 4-25. Actions Taken Related to EVs (n=290)**




Nearly two-thirds (64%) of non-EV owners said that having the charging stations at work motivated them to take the actions they did to learn about EVs (30% to a small extent, 20% to a moderate extent, 14% to a great extent).

### *Vehicle Purchase Plans*

Just over a third of respondents (38%) plan to purchase or lease a new vehicle within the next two years. Nearly two-thirds of those planning to purchase in the next two years are considering an electric vehicle (63%). This is significantly higher than in the general population survey, where 23% of respondents planning to purchase a vehicle in the next two years are considering an EV.

Of those planning to purchase in the next two years, 43% are considering a PHEV and 37% are considering a BEV. Of the people considering a PHEV, 35% are *very likely* to purchase one as their next vehicle and 57% are *somewhat likely*. Of the people considering a BEV, 41% are *very likely* to purchase one as their next vehicle and 51% are *somewhat likely*.

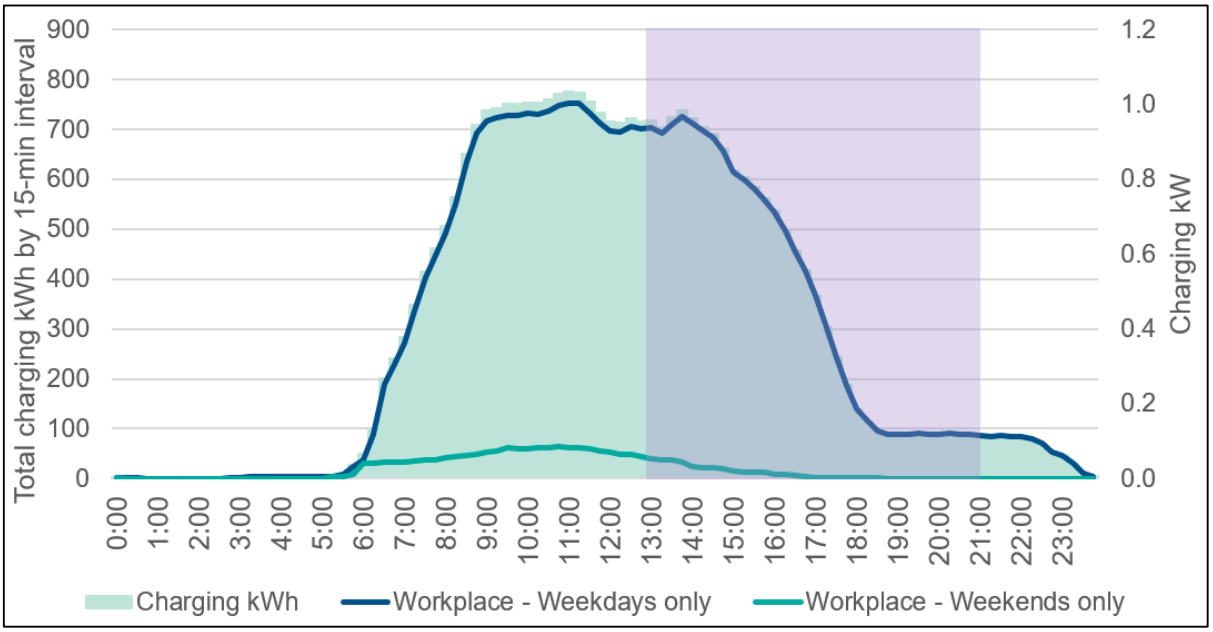
When asked directly if the charging stations at the facility increased their likelihood to purchase an EV, over a quarter (28%) of respondents who do not own EVs and had personally seen the charging stations said that it would not. However, 31% said it would affect their likelihood to purchase an EV to a small extent and another 38% said it would to more than a small extent.

Ten respondents reported purchasing an EV after the facility installed EV charging stations and said that the availability of charging at work affected their decision to purchase an EV to at least some extent.[40]

***Workplace Charging Load Profile***

Figure 4-26**,** below, presents the load profile for the four Level 2 stations (eight ports) installed at this manufacturing facility. Through PY2, 41% of the kWh charged at this station occurred on-peak.[41] The average weekday on-peak demand is 0.5 kW, and the average weekend on-peak demand is 0.0 kW. This station's first charge was recorded on July 29, 2019.

Figure 4-26. 24-Hour Charging Load Profile – Workplace




[40] Four respondents reported that the availability of charging affected their decision to some extent, two reported that the availability of charging affected their decision to a moderate extent, and four reported that it affected their decision to a great extent.

[41] The "peak period" (including the use of the phrases "on-peak" or "off-peak") here refers to the 1–9 p.m. window defined by the SmartCharge Massachusetts Program, not the distribution system/coincident peak.

On weekdays, the charging load at this station begins to climb in the morning, around 6 a.m., and peaks at approximately 9 a.m. around 1 kW. This peak load remains roughly constant until 2 p.m. and then tapers off until 6 p.m. As expected for a workplace facility, there is very little evening and no overnight charging. What little weekend charging this charger does support aligns with working hours, with the load rising slightly in the morning and falling back to zero after 5 p.m.

### 4.6.3 Workplace Survey – Large City

The Charging Program has installed a total of 30 charging stations in the city since 2019; 16 of the stations are municipally owned, 7 are installed at workplaces, and 7 are installed at MUDs. Charging at the municipally owned stations is free, though users do have to pay any associated parking fees.

The city's Energy Manager distributed the survey to city employees and members of the city's sustainability council via email. The ERS Team received 96 completed responses – 88 from employees, 3 from sustainability council members, and 5 from others affiliated with the city. The survey ran from January 26, 2020, through February 3, 2021.

#### *Vehicle Ownership and Travel Patterns*

***Vehicle Ownership.*** The majority of respondents (99%) own or lease a vehicle. The majority of respondents live in multi-vehicle households; slightly less than half (49%) have two vehicles and just over one-quarter (26%) own three or more vehicles. One-quarter (25%) of households who own or lease a vehicle have only one.

Gas is the most popular fuel type among respondents; 83% of respondents who own or lease a vehicle drive gas-only cars while 9% drive conventional hybrids as their primary vehicle. Seven percent of respondents drive EVs.

Of the seven battery electric vehicle (BEV) owners who responded to the survey, four own a Tesla, two own a Nissan, and one owns a Smart Car.

***Travel Patterns.*** The COVID-19 pandemic has reduced how often respondents travel to the city. While the majority of respondents (90%) traveled to the city five days per week prior to the COVID-19 pandemic, just under two-thirds of respondents (63%) travel there five days per week currently.

Of the 37% of respondents who do not currently travel to the city five days per week, most (22%) travel there three to four days per week. Nine percent travel there one to two days per week, and 6% travel there less than four times per month.

The majority of respondents who travel to work reported driving to work alone both before and after the COVID-19 pandemic (98% currently, 98% prior to pandemic). One respondent reported using public transportation prior to the pandemic and one reported carpooling.

***EV Owner Charging Behaviors.*** All seven EV owners reported that they charge most frequently at home. Four EV owners reported that they do not charge their vehicle at city charging stations because they are unfamiliar with or unaware of the locations.

Three have used city charging stations (two use them less than once per month and one uses them 4 to 5 times per week) and reported varied satisfaction levels with them. Reasons for dissatisfaction included a space not being labeled for EVs only, resulting in it being occupied by other vehicles, and an EV space that is not aligned properly with the other parking spaces, making it difficult for some EVs to fit.

Four of the seven EV owners reported experiencing issues finding charging stations in Massachusetts. Two EV owners had no issues finding charging stations in Massachusetts and one EV owner reported never looking for a charging station away from home. The primary issue reported by EV owners is the scarcity of charging stations, particularly along the highway or for longer trips.

#### *Awareness and Knowledge of Electric Vehicles and Charging*

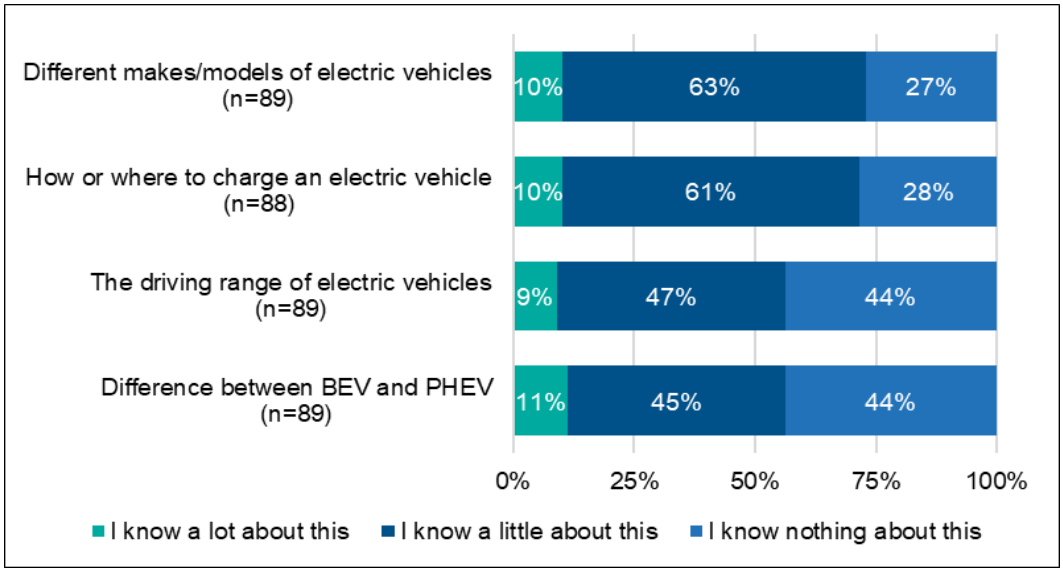
***EV Awareness and Knowledge.*** Compared to the 2019 general population survey, significantly more city respondents are classified as *EV Aware*, and they are more familiar with different aspects of EVs than members of the general population. Of non-EV owners, 87% reported they knew at least a little about one or more categories of EV knowledge compared to 69% of the general population.

The majority of respondents were knowledgeable about makes and models of EVs (73%) and how or where to charge an EV (71%). Over half (56%) knew the difference between BEVs and PHEVs. City respondent knowledge in these three areas was significantly higher than among the general population.

City respondent understanding of the driving range of EVs was similar to that of the general population, with just over half of city respondents (56%) and general population respondents (51%) reporting they knew at least a little about the driving range.

Only 13% of respondents said they knew nothing about any of the EV awareness questions above.

**Figure 4-27. Knowledge of EVs Among Non-EV Owners**

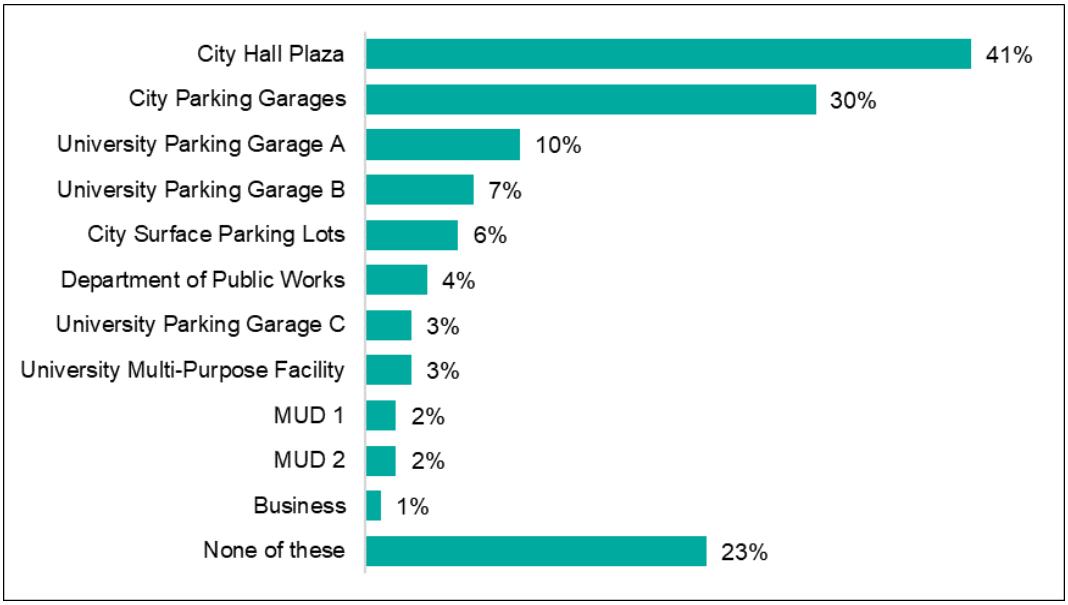



Note: Percentages may not add to 100% due to rounding.

***Charging Station Awareness and Knowledge.*** Most respondents have seen EV chargers in the Commonwealth and know about those in the city. Most respondents that do not own EVs (89%) have seen charging stations in Massachusetts and the same proportion (89%) knew that the city has chargers for EVs.[42] The majority of respondents (77%) who are aware that the city has chargers have also seen the EV chargers in the city in person, and just over half have seen the city-owned stations (51%). Non-EV owners had most commonly seen charging stations at the City Hall Plaza (40%), city parking garages (30%), and one of the parking garages at a university within the city (10%).

[42] The percent of non-EV owners who have seen chargers in MA is significantly higher than the percentage of the general population respondents who have at $p<0.01$ – a total of 88% of city respondents compared to 72% of general population respondents.

**Figure 4-28. Program-Installed Charging Stations Respondents Have Seen (n = 96)**



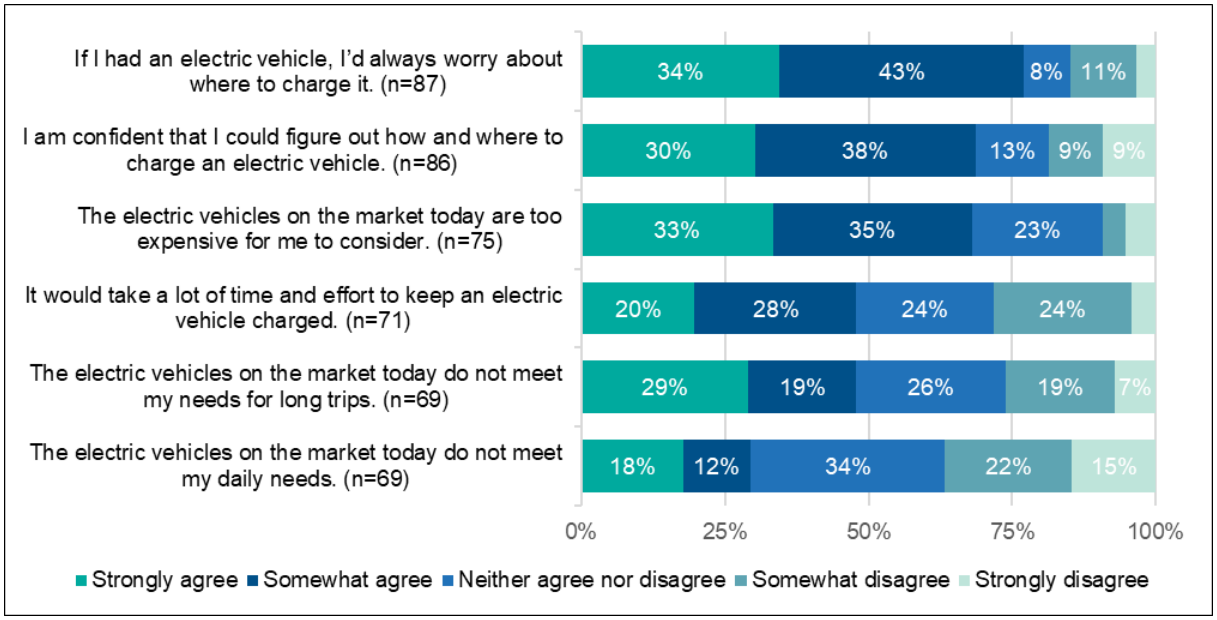

Respondents who reported seeing one of the city-owned stations were unsure about who could use the charging stations. While most respondents (51%) said that visitors can use them, fewer respondents (37%) believe employees or staff can use them, 29% believe contractors or vendors can use them, 22% believe the sustainability council can use them, 12% believe anyone can use them, and 39% were not sure who can use them.

EV owners are required to pay for parking, however, there are no charging fees at the city charging stations. Knowledge of whether or not you have to pay to use the city stations is quite low. Most of the respondents (61%) did not know if payment was required. Nine respondents (18%) said payment was required and eight respondents (16%) said payment was not required. Only two respondents (4%) said payment for chargers "depends."

***Perceptions and Barriers of EVs.*** The barriers to purchasing EVs for the city respondents were similar to the 2019 general population survey. Concerns about where to charge EVs was the most prevalent concern, with just over three-quarters of city respondents (77%) agreeing it would be something they would worry about. However, nearly as many (68%) were confident they could figure out how and where to charge an EV. Price is another barrier, with just over two-thirds (68%) of the city respondents agreeing that the EVs on the market today are too expensive for them to purchase.

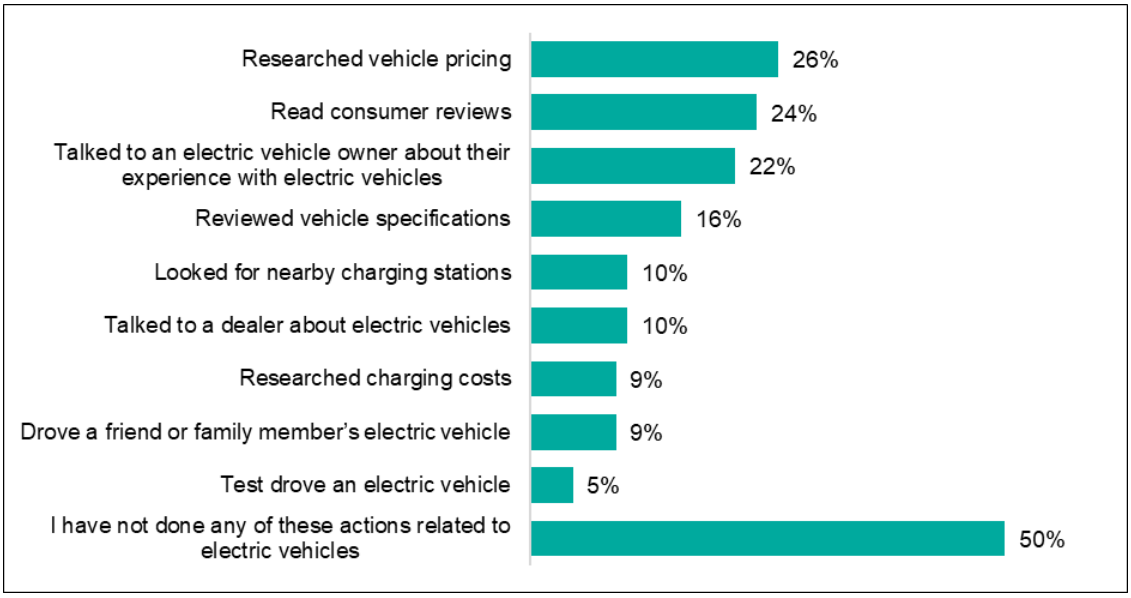
City respondents' concerns that EVs would not meet their needs for long trips or daily driving were similar to those of the general population. About half (48%) thought they might not meet needs for long trips and 30% thought an EV would not meet there daily driving needs (see Figure 4-29).

**Figure 4-29. Opinions of EVs Among Non-EV Owners**




***Actions Taken Toward EV Education.*** Like the general population survey respondents, half of the respondents (50%) who do not own an EV have researched EVs. Among those who have done some research, the three most popular actions taken are *researched vehicle pricing* (26%), *read consumer reviews* (24%), and *talked to an EV owner about their experiences owning an EV* (22%). Very few respondents (5%) reported that they have test driven an EV. Of the respondents who did a test drive, three respondents test drove with a family member or friend, two respondents test drove through a dealership, and one respondent drove at a car show or expo. Figure 4-30 details the actions taken by respondents.

**Figure 4-30. Actions Taken Related to EVs (n=88)**




### *Vehicle Purchase Plans*

Just over a third of respondents (39%) plan to purchase or lease a new vehicle within the next two years. Unlike the general population, half of the city respondents planning to purchase in the next two years are considering an EV.

Thirteen of the City respondents are considering a PHEV and eleven respondents are considering a BEV. Of the thirteen people considering a PHEV, four (31%) are *very likely* to purchase one as their next vehicle and eight (62%) are *somewhat likely*. Of the eleven people considering a BEV, three (27%) are *very likely* to purchase one as their next vehicle and three (27%) are *somewhat likely*.

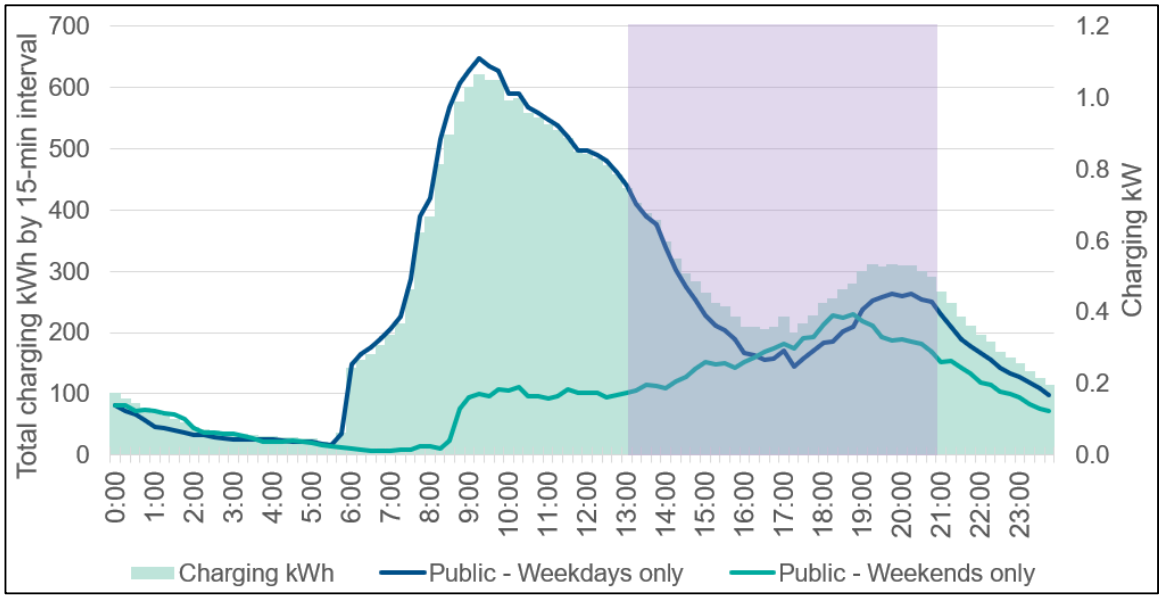
Five EV owners purchased their EV after the city installed EV charging stations and four reported that the availability of charging at work affected their decision to purchase an EV to at least some extent. Three reported that the availability of charging affected their decision to a small extent, one reported that the availability of charging affected their decision to some extent, and one reported that it did not affect their decision.

### *Large City load profile*

The load profile presented in Figure 4-31, below, is for a public charging station consisting of four Level 2 chargers (eight ports) located at a municipal parking facility in this city. Through

PY2, 37% of the kWh charged at this station occurred on-peak.[43] The average weekday on-peak demand is 0.4 kW, and the average weekend on-peak demand is 0.3 kW. This station's first charge was recorded on January 2, 2019.

**Figure 4-31. 24-Hour Charging Load Profile – Public Station in Large City**




On weekdays, the charging load at this station begins to climb in the morning, around 6 a.m., and peaks at approximately 9 a.m. around 1.1 kW. This load drops to roughly 0.9 kW by 12 p.m., falls to 0.3 kW at 5 p.m., and then increases again to 0.4 kW by 8 p.m., suggesting this charging location may be frequented by a mix of commuters using the station to refuel during the workday and residents using the station to refuel when they return from work. The weekend charging profile shows moderate usage in the afternoon and evening and a fair amount of overnight charging as well.

[43] The "peak period" (including the use of the phrases "on-peak" or "off-peak") here refers to the 1–9 p.m. window defined by the SmartCharge Massachusetts Program, not the distribution system/coincident peak.

# 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 – Station Utilization by Project

Table B-1 summarizes the utilization of the co-located chargers for PY2 across multiple metrics; the anonymized stations are ranked by the total amount of charging (kWh) they have provided through PY2.

**Table B-1. Charging Station Utilization by Station**

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 38 | Workplace | Level 2 | 4 | 2,024 | 28,333 | 14 | 27 | 380 | 17,289 | 07/29/2019 |
| EVSE 33 | Workplace | Level 2 | 4 | 1,550 | 27,271 | 18 | 18 | 323 | 16,640 | 05/21/2019 |
| EVSE 6 | Public | Level 2 | 1 | 1,167 | 24,105 | 21 | 13 | 262 | 14,709 | 03/29/2019 |
| EVSE 12 | Public | Level 2 | 4 | 1,817 | 23,435 | 13 | 17 | 225 | 14,300 | 01/02/2019 |
| EVSE 22 | Public | Level 2 | 1 | 1,557 | 19,763 | 13 | 21 | 273 | 12,059 | 08/13/2019 |
| EVSE 191 | Workplace | Level 2 | 2 | 1,015 | 18,688 | 18 | 17 | 321 | 11,404 | 11/21/2019 |
| EVSE 26 | Public | Level 2 | 1 | 1,206 | 17,873 | 15 | 14 | 200 | 10,906 | 04/17/2019 |
| EVSE 209 | Workplace | Level 2 | 1 | 660 | 16,415 | 25 | 13 | 335 | 10,017 | 01/24/2020 |
| EVSE 36 | Public | Level 2 | 2 | 1,611 | 15,962 | 10 | 19 | 190 | 9,740 | 05/23/2019 |
| EVSE 29 | Public | Level 2 | 2 | 1,168 | 14,062 | 12 | 15 | 180 | 8,581 | 07/05/2019 |
| EVSE 23 | Public | Level 2 | 1 | 1,629 | 11,319 | 7 | 22 | 155 | 6,907 | 08/08/2019 |
| EVSE 190 | Public | Level 2 | 2 | 664 | 10,667 | 16 | 13 | 214 | 6,509 | 01/18/2020 |
| EVSE 17 | Public | Level 2 | 1 | 868 | 8,949 | 10 | 11 | 113 | 5,461 | 06/26/2019 |
| EVSE 30 | Public | Level 2 | 2 | 667 | 8,297 | 12 | 8 | 105 | 5,063 | 06/26/2019 |
| EVSE 35 | Public | Level 2 | 2 | 458 | 8,260 | 18 | 6 | 101 | 5,040 | 06/06/2019 |
| EVSE 171 | Workplace | Level 2 | 2 | 363 | 7,226 | 20 | 6 | 126 | 4,410 | 11/27/2019 |
| EVSE 13 | Public | Level 2 | 4 | 699 | 7,209 | 10 | 8 | 87 | 4,399 | 05/30/2019 |
| EVSE 498 | Public | Level 2 | 4 | 251 | 6,976 | 28 | 10 | 277 | 4,257 | 07/09/2020 |
| EVSE 2 | Public | DCFC | 1 | 348 | 6,655 | 19 | 5 | 88 | 4,061 | 07/23/2019 |
| EVSE 192 | Public | Level 2 | 2 | 2,354 | 6,506 | 3 | 45 | 124 | 3,970 | 01/01/2020 |
| EVSE 28 | Workplace | Level 2 | 1 | 213 | 5,861 | 28 | 3 | 91 | 3,576 | 10/07/2019 |
| EVSE 37 | Public | Level 2 | 4 | 827 | 5,651 | 7 | 10 | 70 | 3,448 | 06/14/2019 |
| EVSE 15 | Workplace | Level 2 | 4 | 294 | 4,187 | 14 | 4 | 61 | 2,555 | 09/10/2019 |

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 1 | Public | Level 2 | 5 | 543 | 4,041 | 7 | 7 | 53 | 2,466 | 07/18/2019 |
| EVSE 167 | Public | Level 2 | 1 | 201 | 3,978 | 20 | 3 | 68 | 2,428 | 11/20/2019 |
| EVSE 11 | Public | Level 2 | 4 | 352 | 3,792 | 11 | 4 | 46 | 2,314 | 06/02/2019 |
| EVSE 10 | Workplace | Level 2 | 1 | 185 | 3,763 | 20 | 2 | 46 | 2,296 | 06/07/2019 |
| EVSE 72 | Workplace | Level 2 | 5 | 369 | 3,728 | 10 | 7 | 72 | 2,275 | 01/02/2020 |
| EVSE 20 | Public | Level 2 | 1 | 503 | 3,598 | 7 | 6 | 43 | 2,195 | 05/30/2019 |
| EVSE 127 | Public | Level 2 | 2 | 279 | 3,486 | 12 | 6 | 74 | 2,127 | 02/05/2020 |
| EVSE 31 | Public | Level 2 | 1 | 303 | 3,114 | 10 | 4 | 39 | 1,900 | 06/27/2019 |
| EVSE 7 | Public | Level 2 | 3 | 323 | 3,101 | 10 | 4 | 34 | 1,893 | 03/29/2019 |
| EVSE 512 | Public | Level 2 | 4 | 181 | 2,904 | 16 | 14 | 226 | 1,772 | 10/03/2020 |
| EVSE 86 | Public | Level 2 | 1 | 109 | 2,828 | 26 | 4 | 97 | 1,726 | 06/10/2020 |
| EVSE 202 | Workplace | Level 2 | 4 | 156 | 2,650 | 17 | 3 | 48 | 1,617 | 12/11/2019 |
| EVSE 18 | Public | Level 2 | 2 | 379 | 2,594 | 7 | 5 | 33 | 1,583 | 07/02/2019 |
| EVSE 63 | Workplace | Level 2 | 4 | 136 | 2,394 | 18 | 3 | 54 | 1,461 | 02/27/2020 |
| EVSE 552 | Public | Level 2 | 1 | 72 | 2,242 | 31 | 2 | 74 | 1,368 | 06/04/2020 |
| EVSE 136 | Public | Level 2 | 2 | 87 | 2,088 | 24 | 2 | 43 | 1,274 | 01/29/2020 |
| EVSE 545 | MUD | Level 2 | 3 | 97 | 1,843 | 19 | 8 | 143 | 1,124 | 10/03/2020 |
| EVSE 51 | Public | Level 2 | 10 | 206 | 1,835 | 9 | 6 | 57 | 1,120 | 05/19/2020 |
| EVSE 21 | Public | Level 2 | 1 | 237 | 1,636 | 7 | 3 | 19 | 998 | 05/22/2019 |
| EVSE 113 | Workplace | Level 2 | 1 | 50 | 1,633 | 33 | 1 | 31 | 996 | 01/04/2020 |
| EVSE 159 | Public | Level 2 | 2 | 68 | 1,612 | 24 | 2 | 44 | 984 | 04/18/2020 |
| EVSE 8 | Public | Level 2 | 1 | 176 | 1,515 | 9 | 2 | 18 | 925 | 05/30/2019 |
| EVSE 58 | Workplace | Level 2 | 2 | 77 | 1,375 | 18 | 6 | 109 | 839 | 10/05/2020 |
| EVSE 89 | Public | Level 2 | 4 | 51 | 1,312 | 26 | 4 | 106 | 801 | 10/06/2020 |
| EVSE 124 | MUD | Level 2 | 2 | 93 | 1,291 | 14 | 2 | 26 | 788 | 01/24/2020 |
| EVSE 138 | Workplace | Level 2 | 4 | 87 | 1,281 | 15 | 1 | 21 | 782 | 11/07/2019 |
| EVSE 215 | Public | Level 2 | 2 | 53 | 1,083 | 20 | 4 | 89 | 661 | 10/08/2020 |
| EVSE 156 | Workplace | Level 2 | 1 | 48 | 1,025 | 21 | 1 | 20 | 626 | 01/03/2020 |
| EVSE 541 | MUD | Level 2 | 1 | 49 | 981 | 20 | 5 | 106 | 598 | 10/28/2020 |

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 5 | Public | Level 2 | 1 | 106 | 887 | 8 | 1 | 12 | 541 | 08/05/2019 |
| EVSE 19 | Public | Level 2 | 1 | 104 | 841 | 8 | 1 | 10 | 513 | 06/20/2019 |
| EVSE 40 | Workplace | Level 2 | 2 | 105 | 777 | 7 | 2 | 15 | 474 | 01/02/2020 |
| EVSE 271 | Public | Level 2 | 1 | 91 | 733 | 8 | 7 | 58 | 447 | 10/05/2020 |
| EVSE 480 | Public | Level 2 | 4 | 43 | 732 | 17 | 4 | 65 | 447 | 10/14/2020 |
| EVSE 497 | Public | Level 2 | 3 | 84 | 716 | 9 | 4 | 32 | 437 | 07/28/2020 |
| EVSE 550 | MUD | Level 2 | 1 | 64 | 696 | 11 | 1 | 16 | 425 | 03/03/2020 |
| EVSE 9 | Public | Level 2 | 2 | 83 | 659 | 8 | 1 | 8 | 402 | 06/05/2019 |
| EVSE 16 | Public | Level 2 | 1 | 37 | 650 | 18 | 0 | 7 | 397 | 03/02/2019 |
| EVSE 125 | Workplace | Level 2 | 2 | 71 | 637 | 9 | 6 | 51 | 389 | 10/05/2020 |
| EVSE 544 | MUD | Level 2 | 2 | 27 | 564 | 21 | 2 | 46 | 344 | 10/08/2020 |
| EVSE 503 | Public | Level 2 | 2 | 30 | 563 | 19 | 1 | 16 | 344 | 05/06/2020 |
| EVSE 90 | Public | Level 2 | 8 | 61 | 534 | 9 | 5 | 42 | 326 | 10/05/2020 |
| EVSE 344 | Public | Level 2 | 4 | 44 | 529 | 12 | 6 | 66 | 323 | 11/06/2020 |
| EVSE 161 | Public | Level 2 | 2 | 49 | 495 | 10 | 1 | 8 | 302 | 11/13/2019 |
| EVSE 499 | Public | Level 2 | 2 | 125 | 480 | 4 | 2 | 7 | 293 | 08/06/2019 |
| EVSE 27 | Public | Level 2 | 1 | 75 | 427 | 6 | 1 | 4 | 261 | 02/05/2019 |
| EVSE 141 | Workplace | Level 2 | 1 | 29 | 420 | 14 | 1 | 8 | 256 | 01/11/2020 |
| EVSE 220 | Public | Level 2 | 1 | 80 | 416 | 5 | 6 | 32 | 254 | 10/03/2020 |
| EVSE 262 | Public | Level 2 | 3 | 35 | 397 | 11 | 3 | 38 | 242 | 10/19/2020 |
| EVSE 135 | Public | Level 2 | 2 | 21 | 376 | 18 | 2 | 30 | 230 | 10/05/2020 |
| EVSE 148 | Public | Level 2 | 1 | 23 | 369 | 16 | 1 | 9 | 225 | 03/12/2020 |
| EVSE 14 | Public | Level 2 | 2 | 74 | 364 | 5 | 1 | 6 | 222 | 10/03/2019 |
| EVSE 93 | Public | Level 2 | 2 | 20 | 359 | 18 | 2 | 39 | 219 | 10/29/2020 |
| EVSE 111 | Public | Level 2 | 1 | 46 | 353 | 8 | 1 | 10 | 215 | 04/19/2020 |
| EVSE 437 | Workplace | Level 2 | 5 | 19 | 342 | 18 | 2 | 37 | 209 | 10/29/2020 |
| EVSE 152 | Public | Level 2 | 2 | 49 | 336 | 7 | 1 | 7 | 205 | 02/17/2020 |
| EVSE 515 | Public | Level 2 | 6 | 49 | 303 | 6 | 2 | 13 | 185 | 07/28/2020 |
| EVSE 257 | Public | Level 2 | 1 | 27 | 296 | 11 | 1 | 9 | 181 | 05/07/2020 |

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 543 | MUD | Level 2 | 1 | 14 | 292 | 21 | 1 | 23 | 178 | 10/04/2020 |
| EVSE 96 | Public | Level 2 | 2 | 31 | 275 | 9 | 4 | 32 | 168 | 11/02/2020 |
| EVSE 104 | Public | Level 2 | 2 | 37 | 274 | 7 | 3 | 22 | 167 | 10/05/2020 |
| EVSE 49 | Public | Level 2 | 2 | 43 | 259 | 6 | 3 | 20 | 158 | 10/03/2020 |
| EVSE 261 | Public | Level 2 | 3 | 28 | 246 | 9 | 3 | 22 | 150 | 10/16/2020 |
| EVSE 68 | Public | Level 2 | 2 | 23 | 238 | 10 | 2 | 19 | 145 | 10/07/2020 |
| EVSE 77 | Public | Level 2 | 1 | 4 | 238 | 59 | 0 | 20 | 145 | 10/10/2020 |
| EVSE 41 | Workplace | Level 2 | 2 | 30 | 223 | 7 | 1 | 4 | 136 | 01/06/2020 |
| EVSE 95 | Public | Level 2 | 2 | 20 | 221 | 11 | 2 | 26 | 135 | 11/03/2020 |
| EVSE 4 | Public | Level 2 | 1 | 54 | 206 | 4 | 1 | 3 | 126 | 08/25/2019 |
| EVSE 347 | Public | Level 2 | 5 | 7 | 202 | 29 | 3 | 78 | 123 | 12/14/2020 |
| EVSE 230 | Public | Level 2 | 2 | 24 | 201 | 8 | 3 | 25 | 122 | 11/05/2020 |
| EVSE 260 | Public | Level 2 | 2 | 19 | 200 | 11 | 2 | 18 | 122 | 10/16/2020 |
| EVSE 514 | Workplace | Level 2 | 1 | 31 | 157 | 5 | 2 | 12 | 96 | 10/05/2020 |
| EVSE 164 | Public | Level 2 | 2 | 25 | 146 | 6 | 3 | 18 | 89 | 11/06/2020 |
| EVSE 546 | MUD | Level 2 | 2 | 4 | 145 | 36 | 0 | 11 | 89 | 10/04/2020 |
| EVSE 84 | Public | Level 2 | 1 | 31 | 136 | 4 | 1 | 3 | 83 | 01/14/2020 |
| EVSE 91 | Public | Level 2 | 5 | 12 | 129 | 11 | 1 | 12 | 79 | 10/18/2020 |
| EVSE 494 | Public | Level 2 | 3 | 7 | 121 | 17 | 1 | 10 | 74 | 10/09/2020 |
| EVSE 70 | Public | Level 2 | 1 | 19 | 115 | 6 | 2 | 9 | 70 | 10/06/2020 |
| EVSE 452 | Public | Level 2 | 3 | 8 | 104 | 13 | 8 | 104 | 63 | 12/25/2020 |
| EVSE 94 | Public | Level 2 | 2 | 14 | 103 | 7 | 2 | 12 | 63 | 10/31/2020 |
| EVSE 39 | Public | Level 2 | 2 | 29 | 94 | 3 | 1 | 2 | 58 | 01/09/2020 |
| EVSE 62 | Public | Level 2 | 2 | 12 | 92 | 8 | 1 | 5 | 56 | 08/25/2020 |
| EVSE 83 | Public | Level 2 | 6 | 12 | 89 | 7 | 0 | 2 | 54 | 01/03/2020 |
| EVSE 166 | MUD | Level 2 | 2 | 7 | 81 | 12 | 0 | 3 | 50 | 06/22/2020 |
| EVSE 42 | Workplace | Level 2 | 1 | 10 | 79 | 8 | 1 | 6 | 48 | 10/03/2020 |
| EVSE 61 | Public | Level 2 | 2 | 5 | 78 | 16 | 0 | 5 | 48 | 09/17/2020 |
| EVSE 256 | Public | Level 2 | 1 | 28 | 76 | 3 | 1 | 2 | 47 | 04/14/2020 |

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 146 | Public | Level 2 | 1 | 2 | 72 | 36 | 0 | 3 | 44 | 06/24/2020 |
| EVSE 482 | Public | Level 2 | 1 | 5 | 67 | 13 | 0 | 6 | 41 | 10/19/2020 |
| EVSE 69 | Public | Level 2 | 1 | 17 | 60 | 4 | 1 | 5 | 37 | 10/03/2020 |
| EVSE 516 | Public | Level 2 | 1 | 9 | 58 | 6 | 1 | 6 | 36 | 10/22/2020 |
| EVSE 521 | Public | Level 2 | 2 | 5 | 56 | 11 | 0 | 5 | 34 | 10/08/2020 |
| EVSE 442 | Public | Level 2 | 2 | 2 | 55 | 27 | 0 | 7 | 33 | 11/08/2020 |
| EVSE 97 | Public | Level 2 | 2 | 7 | 54 | 8 | 0 | 3 | 33 | 08/18/2020 |
| EVSE 235 | Public | Level 2 | 2 | 6 | 44 | 7 | 0 | 2 | 27 | 08/27/2020 |
| EVSE 237 | MUD | Level 2 | 4 | 1 | 43 | 43 | 4 | 151 | 26 | 12/30/2020 |
| EVSE 532 | Workplace | Level 2 | 1 | 4 | 43 | 11 | 0 | 5 | 26 | 11/05/2020 |
| EVSE 481 | Public | Level 2 | 3 | 1 | 39 | 39 | 0 | 14 | 24 | 12/12/2020 |
| EVSE 487 | Workplace | Level 2 | 5 | 3 | 39 | 13 | 5 | 69 | 24 | 12/28/2020 |
| EVSE 343 | Workplace | Level 2 | 5 | 13 | 35 | 3 | 4 | 11 | 21 | 12/10/2020 |
| EVSE 474 | Public | Level 2 | 1 | 2 | 35 | 17 | 0 | 3 | 21 | 10/20/2020 |
| EVSE 508 | Public | Level 2 | 2 | 7 | 34 | 5 | 1 | 3 | 21 | 10/19/2020 |
| EVSE 234 | Public | Level 2 | 2 | 6 | 28 | 5 | 2 | 11 | 17 | 12/15/2020 |
| EVSE 500 | Public | Level 2 | 1 | 3 | 27 | 9 | 0 | 2 | 16 | 10/10/2020 |
| EVSE 526 | Public | Level 2 | 1 | 5 | 26 | 5 | 0 | 2 | 16 | 09/09/2020 |
| EVSE 170 | Workplace | Level 2 | 2 | 5 | 23 | 5 | 0 | 0 | 14 | 01/27/2020 |
| EVSE 210 | Public | Level 2 | 2 | 2 | 22 | 11 | 0 | 1 | 13 | 08/25/2020 |
| EVSE 531 | Public | Level 2 | 1 | 1 | 22 | 22 | 0 | 1 | 13 | 08/14/2020 |
| EVSE 368 | Public | Level 2 | 5 | 3 | 21 | 7 | 1 | 9 | 13 | 12/16/2020 |
| EVSE 65 | MUD | Level 2 | 1 | 4 | 18 | 5 | 0 | 0 | 11 | 01/15/2020 |
| EVSE 154 | Public | Level 2 | 2 | 4 | 15 | 4 | 0 | 1 | 9 | 10/16/2020 |
| EVSE 427 | Workplace | Level 2 | 5 | 7 | 15 | 2 | 2 | 5 | 9 | 12/11/2020 |
| EVSE 455 | Public | Level 2 | 5 | 9 | 14 | 2 | 2 | 3 | 9 | 12/02/2020 |
| EVSE 169 | Workplace | Level 2 | 2 | 3 | 14 | 5 | 0 | 0 | 9 | 01/15/2020 |
| EVSE 280 | Public | Level 2 | 2 | 3 | 14 | 5 | 0 | 2 | 9 | 11/18/2020 |
| EVSE 162 | Public | Level 2 | 2 | 6 | 14 | 2 | 0 | 0 | 9 | 01/08/2020 |

| Station Identifier | Station Use | Charging Level | Number of Stations (Tracking) | Charging Session Count | Energy Charged (kWh) | kWh per Session | Charging Sessions per Week | kWh per Week | GHG Savings (kg) | First Charge Date |
|---|---|---|---|---|---|---|---|---|---|---|
| EVSE 502 | Public | Level 2 | 5 | 8 | 12 | 1 | 0 | 0 | 7 | 07/07/2020 |
| EVSE 504 | Workplace | Level 2 | 2 | 3 | 10 | 3 | 0 | 1 | 6 | 09/26/2020 |
| EVSE 511 | Workplace | Level 2 | 2 | 1 | 8 | 8 | 0 | 1 | 5 | 11/16/2020 |
| EVSE 520 | MUD | Level 2 | 1 | 2 | 7 | 4 | 0 | 0 | 5 | 06/05/2020 |
| EVSE 533 | Public | Level 2 | 2 | 4 | 5 | 1 | 2 | 3 | 3 | 12/18/2020 |
| EVSE 109 | Public | Level 2 | 1 | 1 | 3 | 3 | 7 | 21 | 2 | 12/31/2020 |
| EVSE 535 | Public | Level 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 12/23/2020 |
| EVSE 233 | Public | Level 2 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 12/08/2020 |
| EVSE 420 | Workplace | Level 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 12/15/2020 |
| EVSE 419 | Public | Level 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 12/15/2020 |

# Appendix C – Supplementary EV Owner Follow-Up Survey Tables

**Table C-1. EV Owner Characteristics**

| Survey Question | EV Owner Baseline (2019) (n=182) | EV Owner Follow-Up (2020) (n=121) |
|---|---|---|
| **Vehicle Type** | | |
| PHEV | 34%*** | 56%*** |
| BEV | 66%*** | 44%*** |
| Lease their primary vehicle | 14% | 15% |
| **Vehicle Experience** | | |
| Satisfaction with EV driving range | 90% | 85% |
| EV used for long trips | N/A | 51% |
| Top concerns prior to EV purchase | Driving range (81%)<br>Purchase price (61%)<br>Where to charge (37%) | Driving range (87%)<br>Purchase price (55%)<br>Where to charge (35%) |
| Top 3 factors selecting make/model | Driving range (71%)<br>Purchase price (42%)<br>Rebates/incentives (37%) | Driving range (61%)<br>Rebates/incentives (47%)<br>Purchase price (40%) |
| **Home Charging** | | |
| Have private parking at home | 92% | 93% |
| Level 1 charger at home | 31%** | 42%** |
| Level 2 charger at home | 68%* | 58%* |
| Percent who have *only* charged at home in past 3 months | 14%*** | 32%*** |
| **Level 3 (DC) Fast-Charging** | | |
| Importance of DCFC: Willing to go out of their way for Level 3 stations | 20%** | 12%* |
| Have free access to level 3 charging through manufacturer or dealer | 25%*** | 12%*** |
| Have free access to level 3 charging through work, school or other | 8% | 2% |
| **Future EV Purchase Consideration** | | |
| Considering PHEV for next purchase [b] | 41% | 38% |
| Considering BEV for next purchase [b] | 78% | 85% |
| Not considering *any* EV | 6% | 0% |
| **Income** | | |
| Income <$75k | 12% | 9% |
| Income between $75-150k | 44% | 36% |
| Income >$150k | 45% | 55% |
| **Gender** | | |
| Male | 73%* | 64%* |

[b] *Among those purchasing/leasing in two years*

*** *Statistically significant at the 0.01 level*

** *Statistically significant at the 0.05 level*

* *Statistically significant at the 0.10 level*