Public Service Company of New Hampshire d/b/a Eversource Energy
Docket No. DE 20-170

Date Request Received: February 01, 2023 **Date of Response: February 08, 2023**
Data Request No. RR-001

Request from: New Hampshire Public Utilities Commission

Witness: Findlay, Amy J, Boughan, Kevin

Request:

EXHIBIT 38
Describe in detail the demand response programs in Connecticut and Massachusetts in which EV charging customers participate. The response should include:

i. a description of the specific types of financial and other incentives offered as part of the managed charging program in each jurisdiction;
ii. details on the number of customers by class participating in each of the respective programs;
iii. the results of any studies or reporting required in those states; and
iv. reference to dockets and orders authorizing the programs referred to above.

Response:

Summary of Managed Charging Programs in Connecticut and Massachusetts

Since 2019, Eversource has we have launched several successful Electric Vehicle (EV) offerings in Connecticut (CT) and Massachusetts (MA) that currently have over 1,700 customers enrolled through their chargers and nearly 400 through their vehicle telematics. Evaluations have consistently shown that EV charging is not very coincident with ISO-NE system peak, which demand response (DR) programs are designed to target. For this reason, Eversource, with the support of regulators in CT and MA, is developing more robust managed charging offers that allow for greater customization and targeting of distribution level constraints.

During 2019-2021, Eversource conducted three EV DR demonstrations. The three demonstrations utilized residential managed charging through electric vehicle supply equipment (EVSE) in MA and CT, residential off-peak charging using telematics data in MA, and commercial and industrial managed charging through EVSEs in MA. In 2022, the CT Public Utility Regulatory Authority (PURA) expanded their EV programs and made participation in managed charging a requirement for any customer receiving an upfront EVSE and/or wiring upgrade rebate, with ongoing incentive for participation. Expanded managed charging program offers being introduced in 2023 beyond residential DR include year-round off-peak charging incentives and load management for light duty fleet. In December 2022, MA also approved proposals for expanded EV offers that require enrollment in a load management program for residential customers as a precondition of receiving upfront incentives on wiring upgrades.

2019-2021
Demand Response & Off-Peak Charging Demonstrations

Beginning in 2019 in MA and 2020 in CT, residential customers were invited to participate in ConnectedSolutions EV demand response through eligible level 2 networked EVSEs installed at their home locations. By enrolling their EV chargers, customers agreed to allow Eversource to reduce their rate of charge from level 2 to level 1 during peak demand events called by Eversource.

The Company offered two incentive paths for participation in ConnectedSolutions. With the first option, customers who planned to purchase an eligible EV charger could enroll after installing and activating the charger. Customers selecting this option received a $300 upfront incentive for agreeing to a three-year commitment to stay enrolled in ConnectedSolutions. Alternatively, customers who already owned an eligible EV charger could receive $150 for enrolling with an additional $50 at the end of the first year and the next two years for staying enrolled in ConnectedSolutions. By the end of 2021, 588 customers in MA and 243 in CT had enrolled in the ConnectedSolutions EV DR offer.

The MA EV demand response demonstration has been evaluated across three seasons: summer 2019 (August-October), summer 2020 (June-September), and winter 2020-2021 (October-March). The evaluation is included as Exhibit 38 Attachment 1. Evaluated demand reduction by device during DR events ranged from 0.11 kW to 0.26 kW across the three seasons. This reduction is significantly lower than the value during DR events provided by other residential devices (by comparison, average savings per thermostat is 0.55 kW). Through customer surveys, the evaluations have also found high levels of participant satisfaction with the program, and participants reported very little disruption to their existing charging and driving behavior. Overall there were very few instances of opt-outs, and only a relatively small share of enrolled vehicles (between 11 and 30 percent) were plugged in and charging during events. On average, 30 percent from the 2019 season, 11 percent from the 2020 season, and 19 percentt from winter 2020-2021. Based on these results it appears that charging behaviors were affected by the Covid-19 Pandemic in 2020.

The ConnectedSolutions EV demand response demonstrations were funded through the MA 2019-2021 Three-Year Energy Efficiency Plan, dockets D.P.U. 18-110 through D.P.U. 18-119 in MA, and the 2019-2021 Conservation & Load Management Plan in CT. Connecticut's 2019-2021 Conservation and Load Management Plan is administered by CT DEEP rather than PURA, so there is no docket associated with this program, but it was authorized by Connecticut General

Statutes-Section 16-245m(d). Funding from PURA is authorized through the annual conservation adjustment mechanism process.

Off-Peak Charging Demonstration
In summer 2021, Eversource launched a passive "Off-Peak Charging" EV demonstration. The demonstration was available to Tesla EV owners in MA and rewarded customers for charging during off-peak hours. The evaluation that was conducted found that nearly four times as many participants were motivated to schedule charging during off-peak hours as compared to non-participants. Participants also reported very high satisfaction with the program, with 96% of participants reporting that they would likely continue participating in the program in the future. This evaluation provided additional evidence that times when EVs were charging or plugged are generally not coincident with ISO-NE system peaks, which are targeted by DR programs. Rather, the evaluation pointed to the conclusion that flexible EV loads should be utilized to alleviate constraints at the distribution level through managed charging programs.

Customers in the off-peak demonstration received a $50 enrollment incentive, a $0.05 per kWh incentive for charging during off-peak hours (11 p.m.-7 a.m. EST) from June-September which was lowered to $0.03 per kWh from October-May, and a $10 monthly bonus for avoiding charging during the peak hours of 5 p.m. to 8 p.m.

There were 192 Eversource electric EV customers enrolled in the Off-Peak Charging demonstration. A third-party evaluation was conducted by Guidehouse using a participant survey and the collection and evaluation of EV telemetry and charging session data. The evaluation is included as Exhibit 38 Attachment 2. Data was collected during a pre-program period from May 1, 2021 – June 30, 2021, and during the program period of July 1, 2021 – September 30, 2021. Guidehouse used charging data obtained from a different telematics provider to observe charging behavior for customers who were not enrolled in the off-peak program, which served as a control group.

The evaluation found that the demonstration resulted in increased charging during off-peak hours compared to non-participants as indicated in the graph in Exhibit 38Attachment 2 on page27. During the hours of 7 a.m. to 11 p.m. there was an average reduction in demand of 0.13 kW per EV. During the peak hours of 5 p.m. to 8 p.m. there was an average reduction in demand of 0.25 kW per EV. Conversely, during the off-peak hours of 11 p.m. to 7 a.m. there was an average increase in demand of 0.015 kW per EV.

The Off-Peak Charging demonstration was funded through the MA 2019-2021 Three-Year Energy Efficiency Plan, dockets D.P.U. 18-110 through D.P.U. 18-119.

C&I Managed Charging Demonstration
Eversource conducted a limited commercial active DR demonstration starting in the fall of 2020 for different types of commercial customers who had received upfront incentives on the charger installations through the EV Make Ready program.

Customers were paid $750 per EV charger enrolled in the managed charging demonstration. Three C&I customers enrolled level 2 Wi-Fi-enabled EV chargers in the demonstration. Most of the enrolled chargers were located in a parking garage adjacent to a suburban office complex. The remaining enrolled chargers were for cars owned by an autonomous vehicle start-up company and in a parking lot for an urban university campus.

The DPU did not require any reporting or studies for the C&I managed charging demonstration, however charging data was collected and test demand response events were called. Between 2020-2021, five "test events" were performed with the parking garage chargers and two "test events" were performed at the other two locations. Results showed that very few, if any, chargers were being utilized during the demand response event window of 2pm to 7pm as most charging occurred in the morning. At the office parking garage, on the five event days, there were 60 charging sessions, but only 8 charging sessions that overlapped with the event hours. Based on charging session data from 12/01/2020 to 12/31/2021, the average charging session start time was 9:03 AM and the average charging session duration was 2 hours and 52 minutes. At the autonomous vehicle startup, on the two event days, there was only one charging session which was coincident with the event hours. At the urban university campus, on the two events days, there were 11 charging sessions, and none overlapped with the event times. Based on charging session data from 08/01/2021 to 12/31/2021, the average charging session start time was 10:35 a.m. and the average charging session duration was 1 hour 51 minutes.

The C&I managed charging demonstration was funded through the MA 2019-2021 Three-Year Energy Efficiency Plan, dockets D.P.U. 18-110 through D.P.U. 18-119.

2022
CT EV Charging Program
In CT, customers were required to enroll in managed charging as a condition of taking an upfront EVSE rebate through the new CT EV Charging Program. Eversource also launched a telematics offer at scale in CT in support of the expanded offers. For 2022, PURA allowed the existing DR program to fulfill the managed charging requirement of the CT EV Charging Program, which allowed time for the expanded Managed Charging Program offers to be developed for launch in 2023. The 2022 incentives for participation in the CT EV Charging Program included upfront incentives ranging from $100 for bring-your-own-device enrollment up to $1,000 for EVSE

installation rebates (qualified charger installations and wiring upgrades). For successfully participating in DR events from June 1 to September 30, 2022 CT participants earned $50/per month and up to $200 for the season. In 2022, 640 participants enrolled through chargers and 275 participants enrolled through vehicle telematics in the CT EV Charging program, with 250 customers remaining in the existing ConnectedSolutions DR program. Per event load shed contribution for both groups was similar to MA. An evaluation of the managed charging program is planned for this year with an evaluation report expected to be filed in mid-2024. The docket number for the new CT EV Charging program is 21-08-06 RE03.

MA EV Program
In MA, EV customers with a qualifying charger received $50 for being accepted into the ConnectedSolutions DR program and $20 for participation in the summer DR program. MA had 588 existing participants during the 2022 season and with over 800 enrolled by the end of the year. Across the 13 DR events called during the 2022 season, the MA EV program contributed an average demand reduction of 0.15 kW per EV. The MA EV program was funded through the MA 2022-2024 Three-Year Energy Efficiency Plan docket number, DPU 21-129.

2023
CT EV Charging Program
Starting in April 2023, the CT EV Charging Program is expanding managed charging offers to include a baseline off-peak rewards program and advanced managed charging, in which Eversource will schedule a charging schedule for the customer. Additionally, Eversource will launch managed charging for light duty fleets. A summary of the upfront and ongoing managed charging incentives for the CT EV Charging Program are summarized in the table below, as detailed in the 2023 Participant Guide for Residential Customers, included as Exhibit 38 Attachment 3.

Customer Scenario		**Networked Level 2 Charger Rebate** *(up to)*	**Wiring Upgrade to 240v Rebate** *(up to)*	**One-Time Enrollment Incentive**	**Baseline Managed Charging Program (up to)***	**Advanced Managed Charging Program (up to)***
New Networked L2 Charger	*Needs 240v Outlet*	$500	$500	$0	$200/year	$300/year
	Has 240v Outlet	$500	$0	$0	$200/year	$300/year
Telematics with Non-Networked L2 Charger	*Needs 240v Outlet*	$0	$500	$100	$200/year	$300/year
	Has 240v Outlet	$0	$0	$100	$200/year	$300/year

In the baseline program, participants can earn $10/month for year-round participation by charging during off-peak hours, defined as any time outside of 3pm to 9pm on weekdays. Participants also have the option to participate in DR events between June 1 and September 30 to earn an additional $20/month for each of those four months. A baseline participant can earn up to $200 in a year.

In the advanced tier, the participant and utility coordinate to set a daily charging schedule and the participant will earn $25/month for not overriding this schedule. Participants must also agree to participate in occasional EV charging curtailments during times of high stress on the utility system.

MA Load Management Program
Details of the MA load management program offer to fulfill the order in recent Docket D.P.U. 21-90 are still in development.

Electric Vehicle Supply Equipment Direct Load Control Demonstration Evaluation

Prepared for
Eversource

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Reference No.: 211517
September 21, 2021

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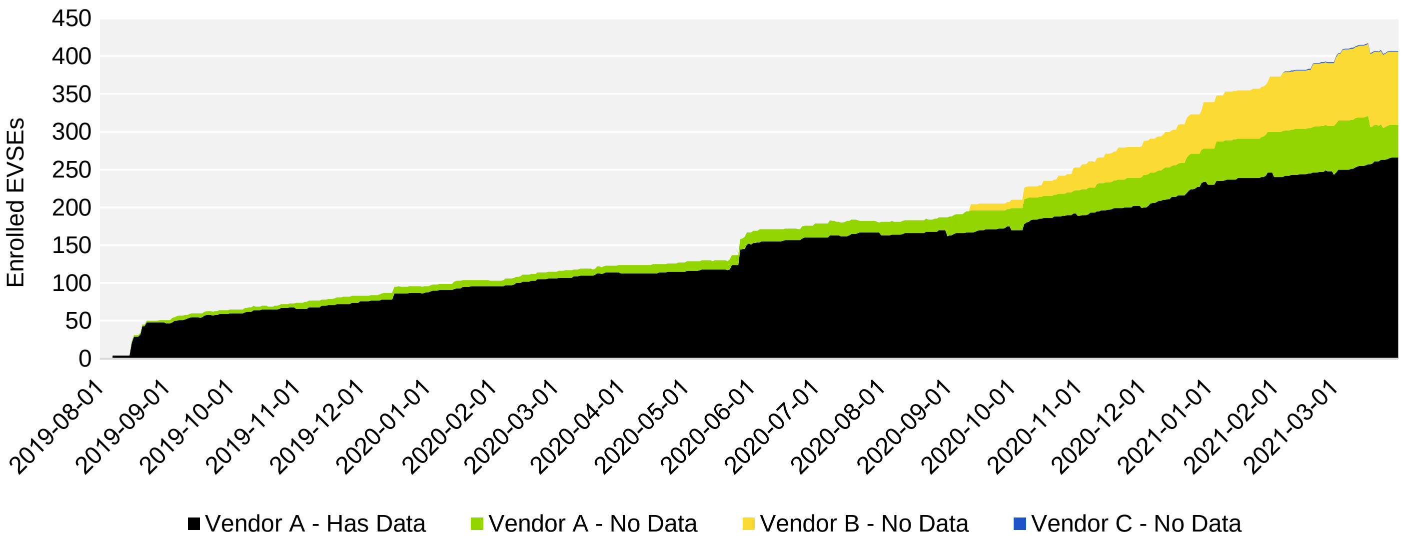
Study Overview

Demonstration Summary

Eversource's Electric Vehicle Supply Equipment (EVSE) direct load control (DLC) demonstration aims to reduce peak demand of home EV charging load by way of Wi-Fi-enabled Level 2 EVSE. Participating customers are provided incentives for the right to throttle their EVSE from Level 2 to Level 1,* and for access to their charging data. The 2019 demonstration enrolled Massachusetts residential customers only. Starting in 2020, Eversource offered the demonstration to Massachusetts and Connecticut residential customers.

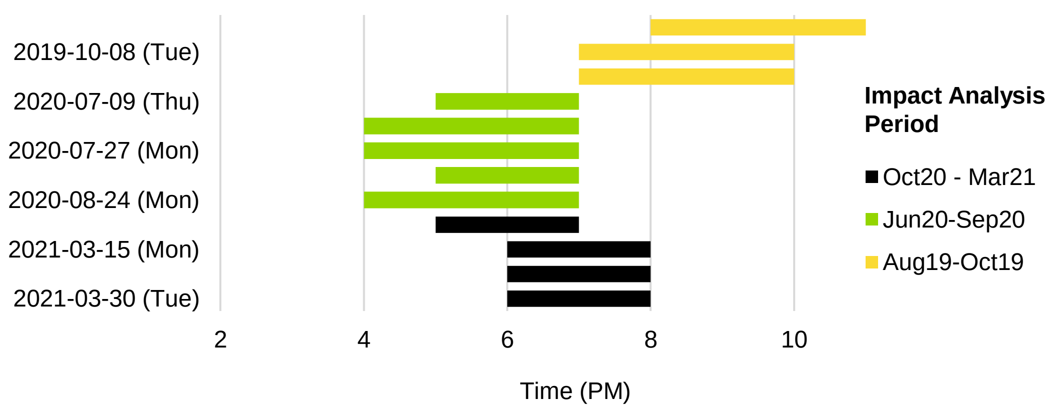
2019-2021 Demonstration Enrollment

The figure below shows enrollment in the demonstration from August 2019 through March 2021. As of March 31, 2021, there were 407 enrolled EVSEs. As the figure exhibits, EVSEs from vendors B and C were eligible for the program starting in September 2020. However, only 315 vendor A devices had useable charging data at some point from August 2019–March 2021.



2019-2021 Events

The following figure summarizes the 12 events called from August 2019 through March 2021. Events across the three demonstration years vary in terms timing, length, and day of week.



* For reference, Level 1 charging use a 120-volt and 20-amp service from a standard household outlet, which typically provides ~1.4-1.8 kW. Level 2 equipment connects to a high-output 240-volt and 40-amp power source enabling faster charging.

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Study Objectives and Approach

The primary objectives of this evaluation were to verify that the solution being tested successfully enables demand reductions (and, if so, by how much) and to assess customer acceptance of the solution. Additionally, the evaluation sought to understand how customers use and interact with their EVSEs on event and non-event days across the year. The evaluation approach is summarized below.

PARTICIPANT SURVEYS

Administered 3 surveys to participants over the course of the evaluation to obtain information on participant driving and charging behavior during summer and winter months. Additionally, the survey asked about experiences with events and how events may have impacted charging behavior.

DATA MANAGEMENT

Performed a QA/QC of the EVSE data from all participating vendors. To facilitate data QA/QC as well as the assessment of charging profiles, created a dynamic dashboard to aggregate and visualize vendor data that was deemed to be usable. Eversource is able to access and interact with the dashboard.

ASSESSMENT OF CHARGING PROFILES

To inform an appropriate baseline for estimating impacts, categorized non-event day usage (e.g., connected and charging, connected and not charging, not connected) from August 2019 through March 2021. Also, characterized typical EVSE usage profiles to understand the broader implications of EV charging, inform future program design changes, and understand changes in charging behavior.

ASSESSMENT OF EVENT PARTICIPATION

Categorized event participation (e.g., Technical Issue, Not Charging, Opt-Out, Partial Participant, Full Participant) for events that occurred between August 2019 and March 2021.

IMPACT ANALYSIS

Estimated demand impacts before, during, and after the DR event for events that occurred between August 2019 and March 2021 using two approaches: a within-subject regression, and an engineering approach.

- **Within-subject approach:** Modeled non-event day charging load to form the event baseline, accounting for variables that may affect charging behavior, such as day of week or month. Similar non-event days were identified and charging behavior was compared to the event days (e.g., when an EV is connected to the EVSE by hour, how much energy is transferred by hour).
- **Engineering approach:** Based on total energy consumption during the charging session, used an algorithm to estimate when charging would have concluded had no event been called.

ASSESSMENT OF SIMULATED EVENTS

Explored the implications of changing charging behavior by simulating events with the same event timing on all non-event weekdays during the study period (August 2019 – March 2021).

LITERATURE REVIEW

Conducted a review of other managed EV charging programs to identify a portfolio of strategies, lessons learned, and best practices from other utilities. Research conducted in 2020 built upon that conducted in 2019 (and documented in a memo dated July 6, 2020*) and included interviews with five program implementers (utilities) of key programs of interest to Eversource.

Note: “Fleet” represents all batteries with telemetry data.

*2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

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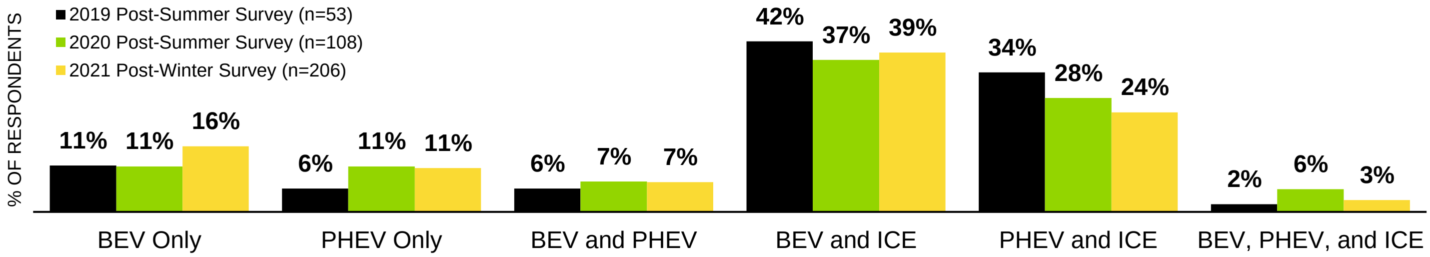
Findings Customer Experience Research

Vehicle Types of Participants



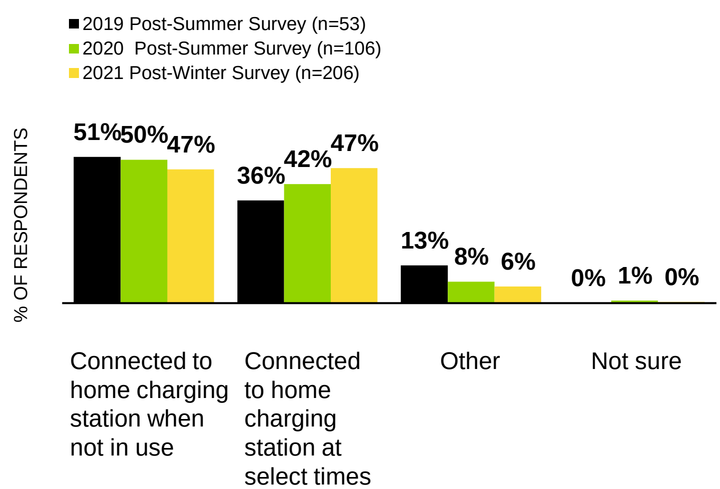
Participant EV Characteristics

- The number of respondents with **only EVs** for their household increased steadily between the 2019 post-summer and 2021 post-winter surveys.
- A greater share of respondents had **battery electric vehicles (BEVs)** than plug-in hybrid electric vehicles (PHEVs).
- Respondents' **BEVs skew newer than respondents' PHEVs** suggesting a trend towards purchase of BEVs. BEVs generally have higher battery capacities than PHEVs. Additionally, newer EVs tend to have higher battery capacities than older ones.

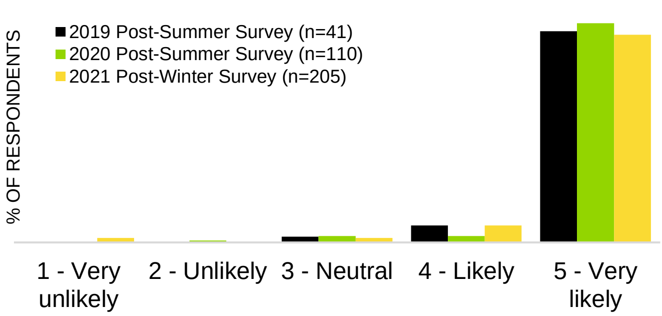
Charging Behavior

- About half of respondents reported **connecting their EV to their home charger whenever it is not in use**. 20% of respondents indicated they **only connect when the battery is low** and another 15% generally have it connected overnight.
- **67% of respondents let their EV fully charge** every time it is connected to their home charging station, and **20% reported using scheduled charging** through an app.
- **25% of respondents indicated that the program influenced their charging schedule**, with some choosing to charge during off-peak hours on a regular basis to align with program goals.
- There were **large changes in use of workplace charging in 2020 and 2021 relative to 2019**. In 2019, 19% of those who had access to workplace charging reported never using it, while this increased to 52% in 2020, likely due to more respondents working remotely because of the COVID-19 pandemic.

Typical EV "Connected" Behavior



Likelihood of Continued Participation



Program Experience

- The vast majority of respondents were **satisfied with the enrollment process.**
- Nearly all of respondents who recalled at least one event said the **events had no impact on their charging or driving behavior.**
- **Only three 2021 post-winter survey respondents recalled opting-out** or overriding an event.
- **Satisfaction with the program is very high**, with 96% of respondents reporting that they are likely to continue participating in the future.

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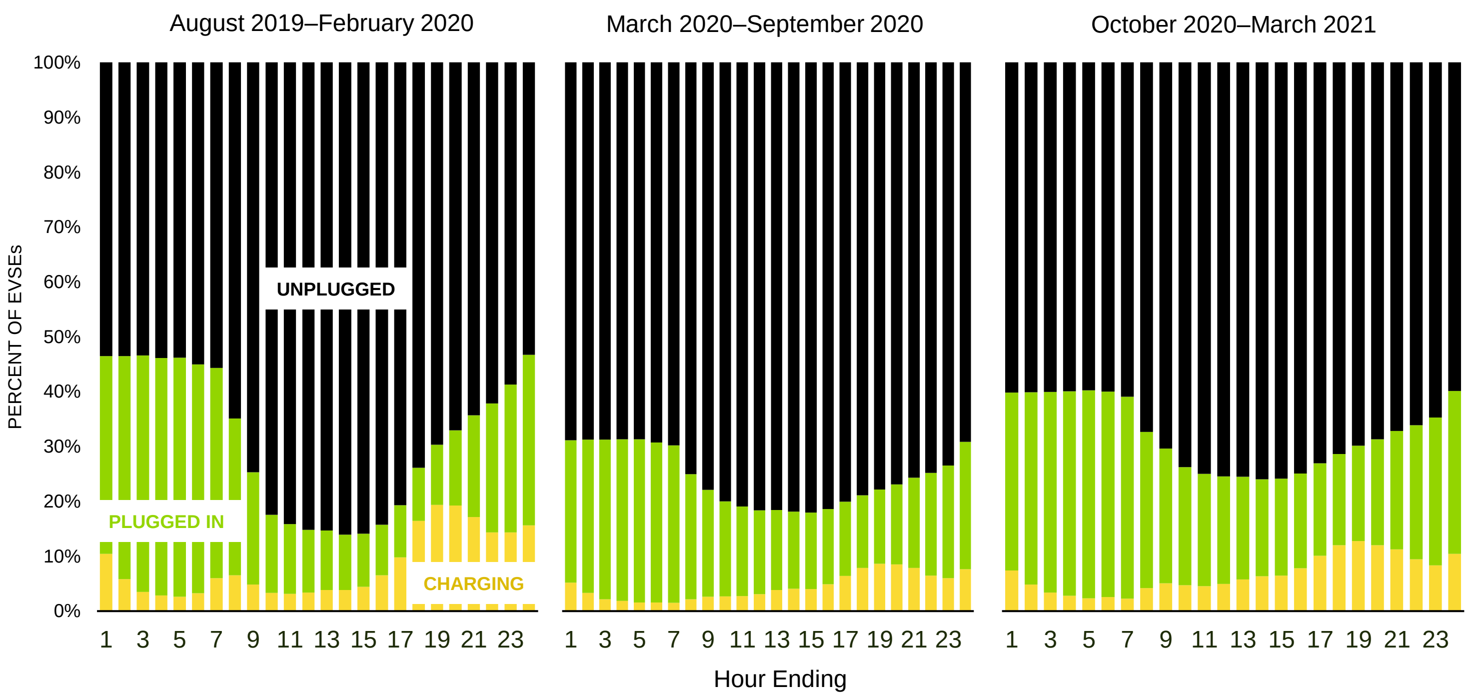
Findings Assessment of Charging Profiles

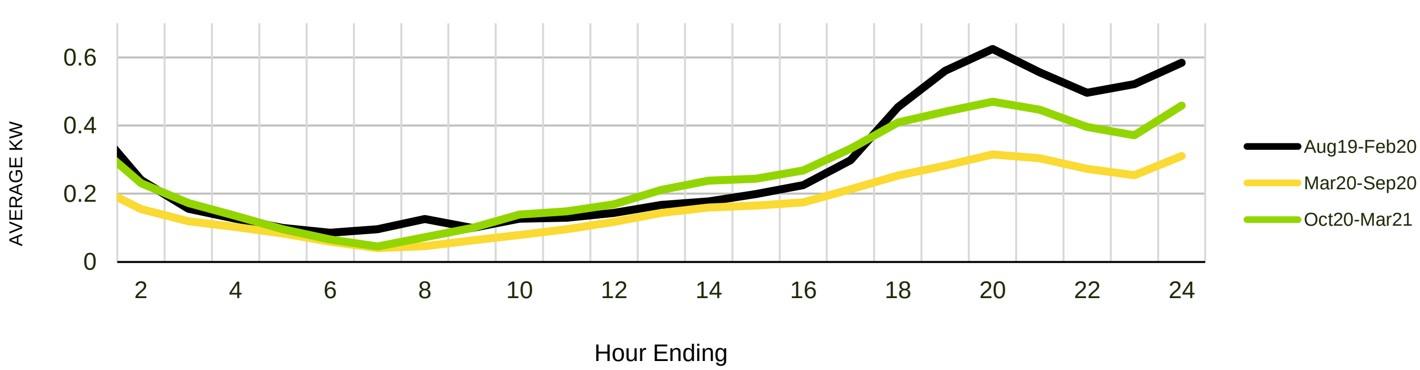
Weekday Hourly Average Charger Status

The following figure shows a plot of average weekday charger status. Looking across the entire evaluation period of August 2019–March 2021, peak charging occurred from 5 p.m. to 9 p.m. (hour ending 18-21 below). During these hours in the pre-pandemic period (August 2019–February 2020), 16%-19% of enrolled EVSEs, on average, were simultaneously charging. The percent of EVSEs charging during these hours dropped to 8%-9% from March 2020–September 2020 and then increased to 11%-13% for October 2020–March 2021.



Average Power Draw on Non-Event Days

Guidehouse also analyzed the hourly average power draw of enrolled EVSEs across time periods to understand when the average power draw per EVSE peaked. From August 2019 to February 2020, the average power draw per EVSE on all non-event days (including weekends) peaked at 0.62 kW from 8 p.m.–9 p.m. During the same hour, average power peaked at 0.32 kW from March 2020–September 2020 and 0.47 kW from October 2020–March 2021.



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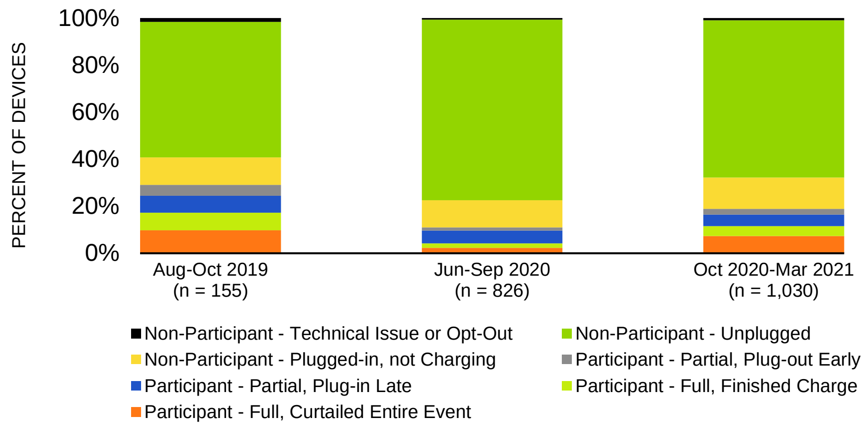
Findings Event Participation and Impacts

Participation Status by Impact Analysis Period

The figure below represents the average participation across the three impact analysis periods for the demonstration. Low participation in the June 2020–September 2020 impact analysis period was likely due to the COVID-19 pandemic and the associated reduction in charging overall and decreased likelihood that devices would be plugged in during event periods.



Although full and partial participation increased between the June 2020–September 2020 impact analysis period (11%) and the October 2020–March 2021 impact analysis period (19%), participation had not returned to August 2019–October 2019 levels (30%).

Variety in event timing and participation makes it difficult to isolate factors contributing to differences in impacts between analysis periods. Events were called at different hours, different days of the week, and lasted for differing amounts of time. In addition, there were changes in max observed power draw of participants, non-event day charging behavior, and participation rates during events. Period-average demand impacts for all devices ranged from 0.11 kW to 0.26 kW across the three analysis periods.

Event Characteristics and Impacts by Analysis Period		August 2019 – October 2019	June 2020 – September 2020	October 2020 – March 2021
Unique Devices Considered in Impact Analysis		60	175	255
Event Timing		7 p.m.-10 p.m. or 8 p.m.-11 p.m.	4 p.m.-7 p.m. or 5 p.m.-7 p.m.	5 p.m.-7 p.m. or 6 p.m.-8 p.m.
Event Day-of-Week		M, T, Th	Mx4, Th	F, M, Tx2
Average kW Impact per Device (All Enrolled)	Within-Subject Impact Approach	0.24 kW	0.13 kW	0.23 kW
	Engineering Impact Approach	0.26 kW	0.11 kW	0.25 kW

In order to quantify the effect of changes in charging behavior on event impacts, Guidehouse simulated hypothetical events on non-event days and estimated average potential impacts using the engineering method. **Theoretical event impacts decrease after February 2020 because of changes in charging behavior, assumed to be due primarily to the COVID-19 pandemic.** Months with data before and during the pandemic had an average 32% decrease of theoretical impacts year-over-year for events simulated from 5 p.m.–7 p.m.

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Key Considerations

Research Category	Considerations
Impacts	**Consideration 1:** When the EVSE DLC demonstration becomes a program and/or in implementing additional managed charging program designs, continue to monitor the effects of the program on participants' charging behavior on all days (not just event days) through surveys and other methods, as possible. Develop a method of evaluating this type of behavioral effect to enable Eversource to claim the savings associated with participants choosing to charge during off-peak hours as a result of their participation in the program.
Program Design	**Consideration 2:** Consider offering a behavioral program pathway that educates customers about the benefits of charging off-peak and offers a modest incentive to follow an off-peak charging schedule (e.g., default charging schedule on EVSE app that begins at 11 p.m. on weekdays).
Program Design	**Consideration 3:** Continue to track the use of scheduled charging. Customers using a schedule, who were not influenced to do so by the program, will typically not contribute to peak demand and may be program free riders.
Program Design	**Consideration 4:** Consider assessing the default charging schedules on EVSE apps may have in the future of creating a smaller secondary peak. Assess whether there should be an effort to change defaults (perhaps random starts between 10 p.m. and 4 a.m.) or an effort to educate customers to change their schedule time as starts between these times but not at the default given in the app.
Impacts	**Consideration 5:** Develop a framework that establishes baseline charging behavior and how the changes to charging behavior as a result of different programs (e.g., DLC, behavior, rate) should be accounted for.
Program Design	**Consideration 6:** Depending on Eversource's load management goals, consider changing the program to use longer events (3-4 hours) or shut off charging entirely for a two-hour event window. Most EV charging sessions finish in under two hours and could potentially be throttled more without customer satisfaction issues.
Impacts	**Consideration 7:** As EVs with high maximum observed power draw (i.e., greater than 8 kW) account for an increasing share of enrolled participants' EVs, average impacts per EVSE are expected to increase. Continue to monitor the observed maximum power draw of enrolled participants through charging telemetry data.
Effects of Seasons	**Consideration 8:** Consider conducting future research to further explore the effect of seasons on EV charging behavior (e.g., range effects of heating/cooling of the EV, changes in driving behavior due to weather).
Effects of COVID-19	**Consideration 9:** Continue to track differences in charging behavior, event participation, and impacts across seasons as COVID-19 pandemic and its consequences continue to evolve, including work location, work travel requirements, employment, economy, among others. (Whether to follow-through on this consideration may hinge on assessing the value of doing so versus the costs that would be required.)

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ABOUT GUIDEHOUSE

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Eversource Electric Vehicle Supply Equipment Direct Load Control Demonstration Evaluation

Final Report

Prepared for:

Eversource

Submitted by:

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Reference No.: 211517
September 21, 2021

Table of Contents

1. Introduction

The Electric Vehicle Supply Equipment (EVSE) Direct Load Control (DLC) demonstration is part of Eversource's broader active demand reduction initiatives. This evaluation report describes the customer experience research, assessment of charging profiles, analysis of impacts, and literature review conducted by Guidehouse, in support of the EVSE DLC demonstration (hereafter referred to as the demonstration). This evaluation covers the demonstration of Eversource Massachusetts and Eversource Connecticut from August 2019 through March 2021.[1] Guidehouse's methodology, data sources used, and key findings are detailed in subsequent sections of this report. As part of this evaluation, Guidehouse developed an interim memorandum summarizing the results of the 2019 process evaluation, which included a participant survey and secondary research of managed charging programs administered by other utilities.[2]

The Eversource EVSE DLC demonstration will continue after March 2021 and is one of three EV managed charging demonstrations being implemented in Massachusetts during summer 2021. Along with the Eversource EVSE DLC demonstration, Eversource recently began implementing a pricing-based off-peak charging demonstration. Additionally, National Grid has launched an EV DLC demonstration. Guidehouse will develop a stand-alone memorandum comparing the outcomes of the three offerings for the 2021 summer period. The analysis will compare the peak demand savings achieved by each offering as well as the customer acceptance of and satisfaction with the offering.[3]

1.1 Demonstration Summary

Eversource's EVSE DLC demonstration aims to reduce peak demand of home EV charging load by way of Wi-Fi-enabled Level 2 EVSE. Participating customers are provided incentives for the right to throttle their EVSE from Level 2 to Level 1,[4] and for access to their charging data. The 2019 demonstration enrolled Massachusetts residential customers only. Starting in 2020, Eversource offered the demonstration to Massachusetts and Connecticut residential customers. Table 1-1. summarizes the characteristics of the demonstration project from 2019 through 2021.

Table 1-1. EVSE Demonstration Summary 2019 - 2021

	Program Attributes	2019	2020	2021
Program Participants	**States**	Massachusetts	Massachusetts and Connecticut[5]	Massachusetts and Connecticut[6]

[1] Connecticut did not have a demonstration in 2019 and so is included in the evaluation analysis starting in 2020.

[2] *2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings*, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

[3] Customer acceptance of and satisfaction with the program offerings will be assessed by exploring enrollment and unenrollment rates, unenrollment reasons, rate of opt-out, and self-reported feedback on the degree to which the program interventions are viewed as an inconvenience to participants or require participants to adjust their driving or charging behavior, as well as on how satisfied participants are with program design features (e.g., rebate structure, information provided through the technology provider's app and dashboard).

[4] For reference, Level 1 charging use a 120-volt and 20-amp service from a standard household outlet, which typically provides ~1.4-1.8 kW. Level 2 equipment connects to a high-output 240-volt and 40-amp power source enabling faster charging.

[5] Massachusetts and Connecticut will have the same program design and event parameters in 2020 and 2021.

[6] Ibid.

	Program Attributes	2019	2020	2021
	Customer Segment	Residential, Single-Family	Residential, Single-Family	Residential, Single-Family
	Customer Subsegments	Customers buying a new Level 2 EVSE Customers that have an existing Level 2 EVSE	Customers buying a new Level 2 EVSE Customers that have an existing Level 2 EVSE	Customers buying a new Level 2 EVSE Customers that have an existing Level 2 EVSE
	Enrolled EVSEs	Through Dec. 2019 - Total: 96 MA: 96 CT: N/A	Through Dec. 2020 - Total: 339 MA: 284 CT: 55	Through Mar. 2021 - Total: 407 MA: 328 CT: 79
Key Vendors	**EVSE Manufacturers**	A	A, B, C[7]	A, B, C[8]
Event Characteristics	**Number of Events**	3	5	4
	Event Duration	3 hours	2-3 hours	2 hours
	Event Timing	Between 7 p.m. and 10 p.m. on non-holiday weekdays[9]	Between 4 p.m. and 7 p.m. on non-holiday weekdays	Between 5 p.m. and 8 p.m. on non-holiday weekdays
	Demand Reduction Approach	Throttling (i.e., Level 2 to Level 1)	Throttling (i.e., Level 2 to Level 1)	Throttling (i.e., Level 2 to Level 1)

[7] Although there were three EVSE vendors participating in the demonstration in 2020 and 2021, Guidehouse's assessment of charging profiles and impact analysis only covers one EVSE vendor (vendor A) from 2019-2021. The two additional EVSE vendors added to the demonstration in 2020 (vendors B and C) were excluded from the analysis due to data issues (B) and very low enrollment (C).

[8] Ibid.

[9] In 2019, Eversource called the three events to begin at either 3 p.m. or 4 p.m. Due to an issue with time zones, event throttling initiated 4 hours later than intended. This had no impact on the evalution and the issue was corrected for subsequent events.

	Program Attributes	2019	2020	2021
Event Notification	**Event Notification Option(s)**	In-app; email and SMS text message are additional options	In-app; email and SMS text message are additional options[10]	In-app; email and SMS text message are additional options[11]
	Event Notification Timing	Day-ahead	Day-ahead[12]	Day-ahead[13]
Incentives	Residential customers buying a **new*** Level 2 charger	Enrollment incentive of $300§	Enrollment incentive of $300§	Enrollment incentive of $300§
	Residential customers that have an **existing** Level 2 charger	Enrollment incentive of $150§ plus an annual participation incentive of $50‡	Enrollment incentive of $150§ plus an annual participation incentive of $50‡	Enrollment incentive of $150§ plus an annual participation incentive of $50‡

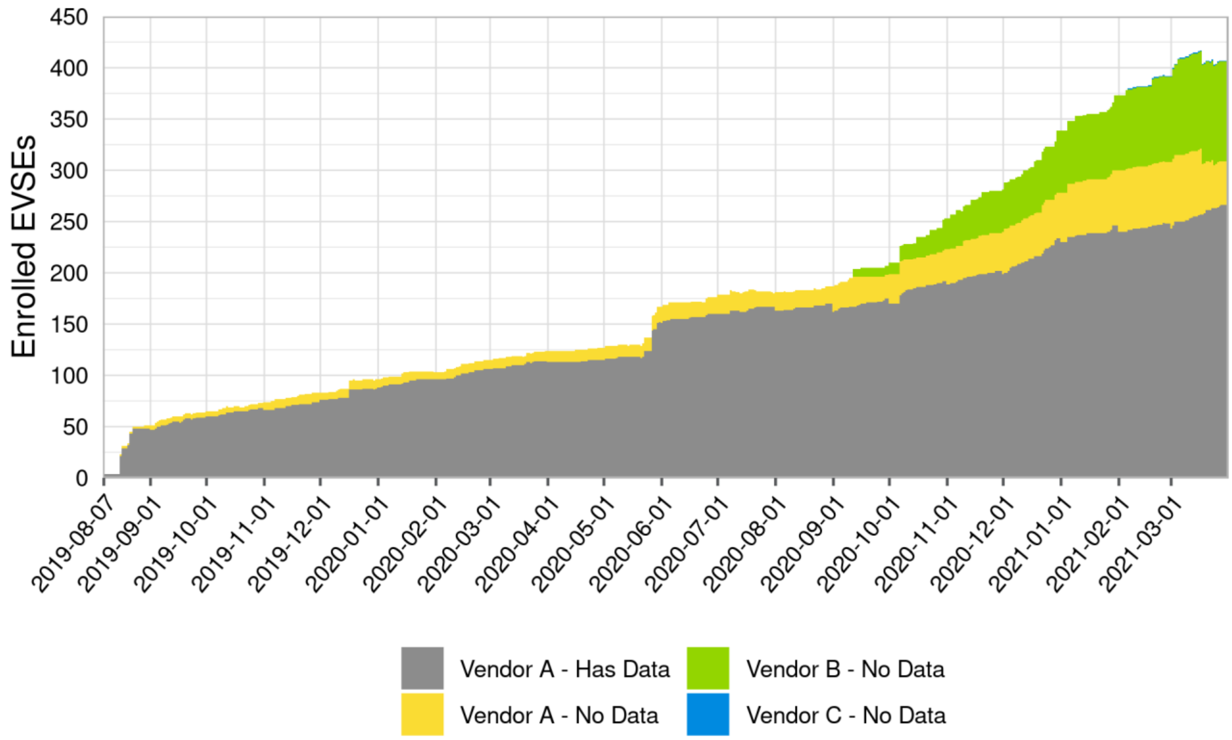
* Determined based on first activation date (on or after March 1 and September 1 of each year).
§ Based on agreement to participate in the program for the remainder of the three-year demonstration period.
‡ Contingent on not opting out of more than three events per year.

Source: Guidehouse

Figure 1-1 shows enrollment in the demonstration from August 2019 through March 2021. As of March 31, 2021, there were 407 enrolled EVSEs. As the figure exhibits, EVSEs from vendors B and C were eligible for the program starting in September 2020. However, only 315 vendor A devices had useable charging data at some point from August 2019–March 2021.

[10] Vendor B does not offer advance notification.
[11] Ibid.
[12] Contingent on events being scheduled day-ahead. Does not apply to vendor B, ibid.
[13] Contingent on events being scheduled day-ahead. Does not apply to vendor B, ibid.

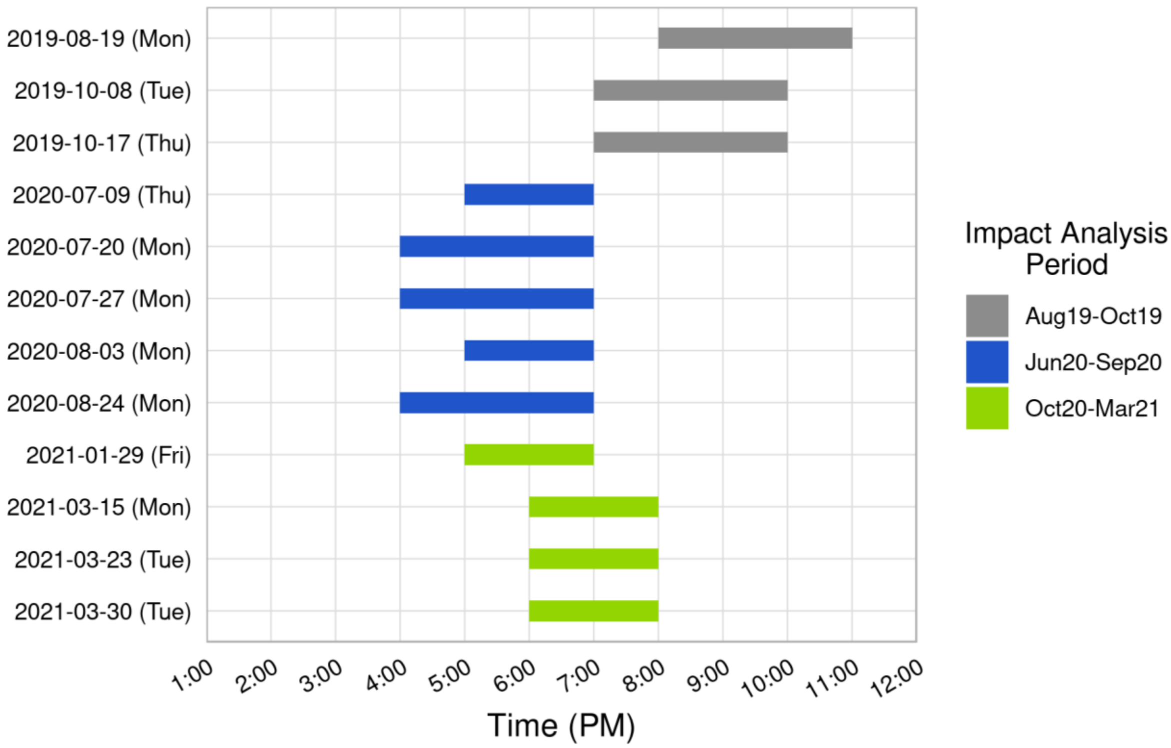
Figure 1-1. EVSE DLC Demonstration Enrollment 2019–2021



Note: Vendor C only had 2 EVSEs enrolled.
Source: Guidehouse

Figure 1-2 summarizes the 12 events called from August 2019 through March 2021. Events across the three demonstration years vary in terms timing, length, and day of week.

Figure 1-2. EVSE DLC Events Times 2019–2021



Source: Guidehouse

1.2 Evaluation Objectives

The primary objectives of this evaluation were to verify that the solution being tested successfully enables demand reductions (and, if so, by how much) and to assess customer acceptance of the solution. Additionally, the evaluation sought to understand how customers use and interact with their EVSEs on event and non-event days across the year.

Table 1-2. EVSE Demonstration Evaluation Research Questions

Category	Research Question
Customer Segments	• What are typical charging patterns for residential chargers both during demand response (DR) event periods and outside of DR event periods? • What types of EVs do participants have? • What is typical participant driving behavior? • What participant characteristics impact charging and driving patterns? E.g., type of EV, access to and use of workplace EVSE

Category	Research Question
DR Impacts	• What are demand impacts before, during, and after the DR event? What are demand impacts for all enrolled EVSEs vs. impacts for participating[14] EVSEs only? • What percentage of participants are still charging when they disconnect following an event? How does this compare to when there is no event? • Is the solution applicable to address both summer peak and winter demand? • What is the estimated impact of a scaled-up EVSE DLC program on the grid throughout the year?[15]
COVID-19 Implications	• What effect has COVID-19 had on driving and charging behavior? • How have changes in charging behavior due to COVID-19 affected DR event impacts?
Program Design and Scalability	• For participants who purchased a new EVSE in conjunction with program enrollment, how much did the enrollment incentive influence the purchase? • What type of EVSE did participants replace (if applicable)? • What is the customer acceptance of program design features (e.g.,event notification, event frequency, event duration)? • How does customer satisfaction with the program vary between summer 2019, summer 2020 versus winter 2021? • How should program parameters be modified to achieve greater savings or increase customer acceptance of the solution? • How likely are customers to continue to participate in the program in the future? • What managed charging program designs and strategies have other utilities tested? What are key lessons learned from other pilots?

Source: Guidehouse

[14] i.e., actively contributing to load reduction.

[15] The goal for this research question is to multiply kilowatt-hours saved by a forecasted number of EVSEs enrolled in the program.

2. Evaluation Methods

The evaluation assessed the extent to which the technology solution achieves demand savings, as well as on customer acceptance of the demand response (DR) offering. Table 2-1 summarizes the evaluation approach.

Table 2-1. EVSE DLC Demonstration Evaluation Methods

Task	Description
Participant Surveys	• Guidehouse administered three surveys of demonstration participants over the course of the evaluation to obtain information on participant driving and charging behavior (and factors that influence these behaviors) during summer and winter months (including how behaviors may be different from previous summers/winter months). Additionally, the survey asked about experiences with events and how events may have impacted charging behavior.
Data Management	• Guidehouse performed a QA/QC of the EVSE data from all participating vendors. Guidehouse received raw interval telemetry, charging session, and event participation data from EVSE vendors through DR management system (DRMS) provider. [16] • To facilitate data QA/QC as well as the assessment of charging profiles, Guidehouse created a dashboard to aggregate and visualize vendor data that was deemed to be usable. The dashboard allowed for dynamic visualization of charging behavior for individual EVSEs and in aggregate over different time periods (hours, days, weeks, months) and characteristics (state, incentive type, charging frequency, etc.). The dashboard included filters for characteristics derived from the survey (e.g., EV types, battery capacities, access to workplace charging). Eversource is able to access and interact with the dashboard.
Assessment of Charging Profiles	To inform an appropriate baseline for estimating impacts, Guidehouse categorized non-event day usage (e.g., connected and charging, connected and not charging, not connected) from August 2019 through March 2021. This analysis also characterized typical EVSE usage profiles to understand the broader implications of EV charging, inform future program design changes, and understand changes in charging behavior.
Assessment of Event Participation	Guidehouse categorized event participation (e.g., Technical Issue, Not Charging, Opt-Out, Partial Participant, Full Participant) for events that occurred between August 2019 and March 2021.
Impact Analysis	Guidehouse estimated demand impacts during and after the DR event for events that occur between August 2019 and March 2021 using two approaches: a within-subject regression, and an engineering approach. • For the within-subject approach, Guidehouse modeled non-event day charging load to form the event baseline, accounting for variables that may affect charging behavior, such as day of week or month. Similar non-event days were identified and charging behavior was compared to the event days (e.g., when an EV is connected to the EVSE by hour, how much energy is transferred by hour).[17] • Guidehouse also utilized an engineering approach, which, based on total energy consumption during the charging session, used an algorithm to estimate when charging would have concluded had no event been called.

[16] Although there were three EVSE vendors participating in the demonstration in 2020 and 2021, Guidehouse's assessment of charging profiles and impact analysis only covers one EVSE vendor (vendor A) from 2019-2021. The two additional EVSE vendors added to the demonstration in 2020 (vendors B and C) were excluded from the analysis due to data issues (B) and very low enrollment (C).

[17] The selection of "similar" non-event days was informed by the Assessment of Charging Profiles.

Task	Description
Assessment of Simulated Events	In conjunction with the assessment of charging behavior, Guidehouse also explored the implications of changing charging behavior by simulating events with the same event timing on all non-event weekdays during the study period (August 2019 – March 2021). Guidehouse estimated average theoretical impacts by month to assess the effect of charging behavior changes that may have been due to the COVID-19 pandemic or changes in enrolled customers' vehicle characteristics.
Literature Review	Guidehouse conducted a review of other managed EV charging programs to identify a portfolio of strategies, lessons learned, and best practices from other utilities. Research conducted in 2020 built upon that conducted in 2019 (and documented in a memo dated July 6, 2020[18]), with a focus on reviewing updated evaluation results for programs reviewed in 2019 and conducting interviews with five program implementers (utilities) of key programs of interest to Eversource.

Source: Guidehouse

Table 2-2 displays the data periods included in the assessment of charging behavior and impact analyses. The assessment of charging on non-event days includes breakouts by the following three time periods to distinguish changes in behavior that were likely caused by the COVID-19 pandemic:

1. August 2019–February 2020
2. March 2020–September 2020
3. October 2020–March 2021

Each of these time periods includes one of the three impact analysis periods.

Table 2-2. Data Periods Included in Analysis

Analysis	2019					2020												2021		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Charging Profiles Analysis	Aug 2019 – Feb 2020							Mar 2020 – Sep 2020							Oct 2020 – Mar 2021					
Event Behavior & Impact Analysis	1										2				3					

Source: Guidehouse

The remainder of this section provides additional detail regarding the evaluation approach for each of the items listed in Table 2-2.

2.1 Customer Experience Research

Guidehouse administered online participant surveys in December 2019, October 2020, and April 2021. Survey invitations were sent by email and reminders were sent to participants between 3

[18] *2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings*, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

and 5 days after the initial invite was sent. Table 2-3 summarizes the time period covered by the surveys, the vendors included, and completion rates for each survey. Response rates to the surveys were very high but decreasing over time.

The surveys were administered to all Massachusetts and Connecticut program participants, including those who previously responded to a survey. Respondents were provided $10 for completing the survey.

Table 2-3. Participant Survey Summary

Survey Topics	2019 Post-Summer Survey	2020 Post-Summer Survey	2021 Post-Winter Survey
Time Period Covered	2019 summer/fall	2020 summer	2020/2021 winter
Survey Fielded	December 16–23, 2019	October 7–18, 2020	April 8–23, 2021
EVSE Vendors Reflected in Respondent Population	Vendor A	Vendor A	Vendor A, Vendor B, Vendor C*
Invites Sent	74	184	383
Completes	53	110	206
Response Rate	72%	60%	54%

*Note: By the third survey, there were 282 enrolled EVSEs from vendor A, 100 from vendor B, and only 1 enrolled EVSE from vendor C. In terms of completes, there were 154 respondents with EVSEs from vendor A , 51 respondents with EVSEs from vendor B, and 1 respondent with an EVSE from vendor C.

Source: Guidehouse

Table 2-4 summarizes the topics covered in each survey. Certain topics were only included for respondents who did not previously complete a survey (i.e., motivations for enrolling, experience with the enrollment process). Other topics, such as charging behavior, are time period dependent, and so were asked of all respondents to each survey since each survey covered a different time period.

Table 2-4. Participant Survey Topics

Survey Topics	Time Period Covered	2019 Post-Summer Survey	2020 Post-Summer Survey	2021 Post-Winter Survey
Motivations and enrollment process	N/A	All respondents	Those who did not previously respond	Those who did not previously respond
EVSE purchase context[19]	N/A	N/A	All respondents	Those who did not previously respond
EV information	N/A	All respondents	All respondents	All respondents
Driving and charging behavior	2019 summer	All respondents	N/A	N/A
	2020 summer	N/A	All respondents	N/A

[19] Including whether new EVSE is replacing another EVSE and, if so, was the replaced EVSE L1 or L2.

Survey Topics	Time Period Covered	2019 Post-Summer Survey	2020 Post-Summer Survey	2021 Post-Winter Survey
	Differences between summers 2020 and 2019	N/A	All respondents	N/A
	2020/2021 winter	N/A	N/A	All respondents
	Differences between winters 2020/21 and 2019/2020	N/A	N/A	All respondents
Event experience	2019 Aug/Oct	All respondents	N/A	N/A
	2020 summer	N/A	All respondents	N/A
	2020/2021 winter	N/A	N/A	All respondents
Other comments about the program	N/A	All respondents	All respondents	All respondents
Participant Demographics	N/A	N/A	All respondents	All respondents

Source: Guidehouse

Table 2-5 summarizes the representativeness of each survey respondent population (those who completed the survey) compared to the overall population (enrolled demonstration participants) for each survey. As shown, across surveys, the respondent population was representative of the overall participant population in terms of the percentage that had newly purchased their EVSE, the breakdown by EVSE manufacturer, the percentage that had responded to a previous survey, and the breakdown by state.

Table 2-5. Participant Survey Sample Representativeness

Characteristic	2019 Post-Summer Survey	2020 Post-Summer Survey	2021 Post-Winter Survey
% of Newly Purchased EVSEs *(vs. existing EVSE)*	• Pop: 38% • Respondent Pop: 40%	• Pop: 55% • Respondent Pop: 55%	• Pop: 75% • Respondent Pop: 73%
EVSE Vendor: % of A | % of B*	• N/A	• N/A	• Pop: 74% | 26% • Respondent Pop: 75% | 25%
% of Past Survey Respondents	• N/A	• Pop: 27% • Respondent Pop: 32%	• Pop: 28% • Respondent Pop: 34%
% in MA *(vs. CT)*	• N/A	• Pop: 89% • Respondent Pop: 92%	• Pop: 79% • Respondent Pop: 77%

Note: “Pop” refers to population targeted for survey and “Respondent Pop” refers to the ultimate pool of respondents.
*Vendor C % not shown (<1%).
Source: Guidehouse

Table 2-6 includes Guidehouse’s activities for each participant survey. Survey instruments for each survey effort are contained in Appendix A.

Table 2-6. Participant Survey Activities

Category	Activities
Survey Design and Programming	• Developed draft survey instruments (maintain similarity in question structure across survey efforts) • Finalized survey instruments based on feedback from Eversource and EEAC EM&V Consultants • Programmed survey • QA/QC of programmed survey
Sample Preparation	• Received latest enrolled participant information (including contact information) • Prepared samples (e.g., flagging those who responded to a previous survey)
Survey Implementation	• Provided Eversource call center with information about each survey effort • Contacted demonstration participants with link to online survey • Monitored survey completions • Sent reminder emails • Administered $10 e-gift cards
Data Cleaning and Analysis	• Cleaned/recoded data in preparation for analysis (including cleaning and coding of verbatim/open-ended responses) • Analyzed data using appropriate tool (e.g., SPSS, R)

Source: Guidehouse

2.2 Assessment of Charging Profiles

Understanding how customers use their EVSEs throughout the year and by season helps inform the appropriate baseline approach for use in the impact analysis, provides insight into the observed per event savings (e.g., opt-out rates, utilization rates), and informs Eversource's scalability assessment.

The assessment of charging on non-event days includes breakouts by the following three time periods to distinguish the potential changes in behavior likely caused by the COVID-19 pandemic. Each of these time periods includes one of the three impact analysis periods:

1. August 2019–February 2020
2. March 2020–September 2020
3. October 2020–March 2021

For this analysis, Guidehouse assessed metrics including average session frequency, session start times, charging and plugged-in session durations, hourly power draw and energy consumption, scheduled charging frequency, and utilization rates (percent of EVSEs charging, plugged-in, or unplugged).

Additionally, Guidehouse analyzed indicators of differential charging during the winter months for those that have EVSE in attached heated garages, attached garages without heat, unattached garages with and without heat, and outside (no garage).

2.3 Assessment of Event Participation

Guidehouse categorized enrolled EVSEs into event participation status categories (e.g., full participants, partial participants, non-participants) and analyzed participation status by event. The participation status categories are as follows:

- **Full Participant:** EVSE was occupied and charging at the start of the event and not used during the event
- **Partial Participant:** EVSE was occupied and charging at the start of the event but then unplugged during the event, or EVSE was plugged-in after event started.
- **Not Charging:** EVSE was not charging at the start of and throughout the event
- **Unplugged:** EVSE was not occupied at that start of and throughout the event
- **Technical Issue or Opt-Out:** EVSE did not participate due to connectivity, failure to receive DR signal, or participant chosing to opt-out of event and charge normally.[20]

2.4 Impact Analysis

Guidehouse estimated demand impacts during and after the DR event for events that occurred from August 2019 through March 2021 using a within-subject regression approach and an engineering approach.

On average, there were large decreases in vehicle usage and charging behavior in 2020 and 2021 from that seen prior to March 2020. The likely cause for most if not all of these behavioral changes are effects from the COVID-19 pandemic. Guidehouse assessed the effect of charging behavior changes that may have been due to the COVID-19 pandemic or changes in enrolled customers' vehicle characteristics by simulating hypothetical events on all non-event weekdays from August 2019 through March 2021. Guidehouse subsequently estimated average potential impacts using the engineering approach.

2.4.1 Within-Subject Approach

The within-subject approach employs a regression (individual customer regression) for determining the baseline. The regression uses the loads of participating customers on non-event days to predict the baseline for each individual customer.

Guidehouse tested a variety of within-subject baselines in which the selection of non-event days included in the regression model will vary. The base model included all non-event days during the impact analysis period to predict the baseline. Guidehouse used the findings from the assessment of charging profiles to identify trends in charging patterns and inform which factors would be most important to consider when modeling the baseline.

To estimate impacts, Guidehouse regressed demand on a set of fixed effects (e.g., month, day-of-week) and an indicator for the periods during and following an event. Equation 2-1 shows the model specification.

[20] From the data, Guidehouse was not able to distinguish opt-outs from EVSEs with technical issues.

Equation 2-1. Model Specification

$$kW_t = \lambda_t + \sum_{j=0}^{e} \beta_{1jt} Event_{jt} * EventHour_t + \sum_{j=0}^{e} \beta_{2jt} PostEvent_{jt} * PostHour_t + \beta_{3t} \mathrm{PM}_t + \varepsilon_t$$

Where,

kW_t	is the given EVSE's demand during period *t*
λ_t	is a series of time-specific fixed effects for period *t;* these pick up temporal differences, such as daylight hours
e	is the number of events in an impact analysis period
$Event_{jt}$	is a binary variable taking a value of 1 when *t* is in the hours during event *j* and 0 otherwise
$PostEvent_{jt}$	is a binary variable taking a value of 1 when *t* is in the hours following event *j* and 0 otherwise
PM_t	is a binary variable taking a value of 1 when *t* is between 3-11 PM and the EV is charging and 0 otherwise
ε_t	is the error term during period *t*

2.4.2 Engineering Approach

The engineering approach used an algorithm to estimate when charging would have concluded had no event been called. The counterfactual for each device participating in the event was estimated using total energy consumption during the charging session coinciding with the event and an estimation of a typical charging rate (kW) for that device. The engineering approach assumed all charging sessions as fixed and did not capture any behavioral effects on charging resulting from the event.

The engineering approach estimated a counterfactual charging rate and a counterfactual charging duration for each curtailed charging session. The approach to estimating counterfactual power draw differed based on the following three scenarios:

- The charging session starts prior to the event start
- The charging session starts during the event and ends after the event concludes
- The charging session starts during the event and ends prior to the event conclusion

In these three scenarios, Guidehouse considered the median or maximum charging rate before the event, after the event, or from a previous charging session as the counterfactual charging rate. The counterfactual charging rate and charging session energy consumption was used to calculate a counterfactual charging session duration.

2.4.3 Assessment of Simulated Events

The three impact analysis periods occurred from August 2019 through March 2021, during which there were large changes in charging behavior and event impacts that were likely due in large part to the COVID-19 pandemic. However, the impacts of these changes could not be isolated for the twelve demand response events because they had different characteristics such as day of week, event start time, and event duration. In order to quantify the effect of changes in charging behavior, assumed to be due to consequences of the COVID-19 pandemic, on event impacts, Guidehouse simulated hypothetical events on non-event days and estimated average potential impacts using the engineering method.

Synthetic event days and estimated charging were established using the following assumptions:

- Simulations only included non-holiday, non-event weekdays
- Events were simulated for a period of 5 p.m.–7 p.m.
- All charging EVSEs curtailed their power draw to 1.8 kW, the Level 1 charging rate
- All EVSEs charging during the event window continued charging until they consumed the same amount of energy as they did in their real charging session, or until they plugged-out

Using the outlined event day criteria and charging assumptions, Guidehouse estimated hypothetical impacts for the synthetic events. The average of these impacts was then compared across different months to quantify the potential effect of the large behavioral changes in 2020 and early 2021 on event impacts, assumed to be the effect of COVID-19.

2.5 Literature Review

Guidehouse reviewed other managed charging programs to identify a portfolio of strategies, lessons learned, and best practices from other utilities. Research conducted in 2020 built upon that conducted in 2019 (and documented in a memo dated July 6, 2020[21]), updating evaluation results for programs reviewed in 2019 and conducting interviews with five program implementers of key managed charging programs of interest to Eversource.

Guidehouse interviewed managed charging program managers in December 2020 and January 2021.

[21] *2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings*, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

3. Data Sources and Data Review

This section describes the data sources used for this evaluation and the steps taken to prepare the data for analysis. The data sources used included survey data (described in Section 2.1), various data streams from the DRMS provider, charging data from EVSE vendors, and temperature data from NOAA.

3.1 Data from DRMS Provider

- **EVSE enrollment data:** This data identified each thermostat enrolled in the EVSE DLC demonstration and provided key information about the device's enrollment, including: the date(s) the device was accepted to the program, the date the device unenrolled from the program (if applicable), the geographic location of the device, and the incentive received.
- **EVSE telemetry data:** The telemetry data was provided in 15-minute intervals, and included average power, peak power, and energy consumed.
- **Event summary data:** For each event, the DRMS provider sent aggregate 15-minute minute load (kW) for all enrolled EVSEs. General event information such as start and stop time was also included.

3.2 Data from EVSE Vendors

- **EVSE session data:** Vendors provided one row per charging session with high level summary information including (but not limited to) plug-in and plug-out times, charge start and end times, and total energy consumption. One vendor also provided an indicator for whether a session was a scheduled charging session.
- **EVSE telemetry data:** The telemetry data was provided in 15-minute intervals, and included average power, peak power, and energy consumed. Depending on the vendor, data was provided for either only intervals that an EV was plugged-in or for all intervals.

Guidehouse used the vendor session and telemetry data for the assessment of charging behavior and impact analyses. Prior to those analyses, the telemetry data was cleaned using the following steps:

- **Narrowed dates by device:** Data was limited to analysis periods when an EVSE was enrolled. There were 346 EVSEs in the enrollment file for vendor A, but only 315 were also in the vendor's telemetry data.
- **Forced 15-minute intervals:** Interval data was modified to have the observation always start and end on a quarter-hour mark.
- **Filled gaps between charging sessions (when applicable):** For the vendor that only provided intervals for charging sessions, 15-minute intervals with no charging were added between the sessions to indicate unplugged periods. This completion was necessary to calculate EVSE utilization across enrolled devices and to construct baselines for the impact analysis. Missing intervals were only filled for each EVSE through the end of their last month with charging data.

3.3 NOAA Temperature Data

To investigate the effect of temperature on EVSE power draw, Guidehouse pulled 2019-2021 temperature data from the NOAA database for a select number of quality controlled local climatological data weather stations across Massachusetts. Using a ZIP code to weather station map, each EVSE was assigned to a single weather station based on its location. Thus, location-specific temperature data was combined with EVSE charging data to inspect the relationship of temperature and power draw.

4. Analysis and Results

This section summarizes findings from the customer experience research, assessment of charging Profiles, event participation analysis, impact analysis, and the literature review.

4.1 Customer Experience Research

The following section summarizes key findings related to customer experience research. As part of this evaluation, Guidehouse developed an interim memorandum summarizing the results of the 2019 post-summer survey.[22] This section includes the findings from the 2019 post-summer survey, the 2020 post-summer survey, and the 2021 post-winter survey.

4.1.1 Key Findings

- **The number of respondents with only EVs for their household increased steadily** between the 2019 post-summer and 2021 post-winter surveys.
- For all three surveys, a **greater share of respondents had battery electric vehicles (BEVs) than plug-in hybrid electric vehicles (PHEVs)**.
- **Respondents' BEVs skew newer than respondents' PHEVs suggesting a trend towards purchase of BEVs.** BEVs generally have higher battery capacities than PHEVs. Additionally, newer EVs tend to have higher battery capacities than older ones.
- Helping the environment was the most commonly cited primary motivator to purchase an EV, while **program incentives was most commonly cited as the top reason for enrolling in the program**. 88 of 150 respondents (59%) who had purchased a new charger around the time of enrolling in the program became aware of the program before purchasing the new charger. Of these respondents , 84% reported being at least partially influenced by the program to buy the new charger.
- Over half of respondents who purchased a new charger did not have a charger at home prior to enrolling in the program, likely due to having recently purchased their EV. Another **one-third replaced a Level 1 charger**.
- The vast majority of respondents were **satisfied with the enrollment process**.
- **Those who used their EV on a regular schedule (e.g., work commuting) during summer months declined from approximately 80% to 40%** between the 2019 post-summer and 2020 post-summer surveys.
- **About half of respondents reported connecting their EV to a charger whenever it is not in use.** 20% of respondents indicated they only connect when the battery is low and another 15% generally have it connected overnight.
- Consistent across surveys, the **most common times for respondents' EVs to be connected to their chargers on weekdays was between 6 p.m. and 6 a.m.**

[22] *2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings*, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

- Two-thirds of respondents let their EV fully charge every time it is connected to their home charging station, and **20% use scheduled charging through an app**. Common scheduled start times for charging ranged from 9 p.m.–1 a.m. on weekdays.
- One-quarter of respondents to the 2021 post-winter survey indicated that **the program influenced their charging schedule**, with some choosing to charge during off-peak hours on a regular basis to align with program goals.
- **There were large changes in respondents' use of workplace charging in 2020 and 2021 relative to 2019.** During the 2019 post-summer survey, 19% of those who had access to workplace charging reported never using it, while this increased to 52% in the 2020 post-summer survey, likely due to more respondents working remotely because of the COVID-19 pandemic.
- Nearly all of respondents who recalled at least one event said the **events had no impact on their charging or driving behavior. Only three 2021 post-winter survey respondents recalled opting-out or overriding an event**.
- **Satisfaction with the program is very high**, with 96% of respondents reporting that they are likely to continue participating in the future.

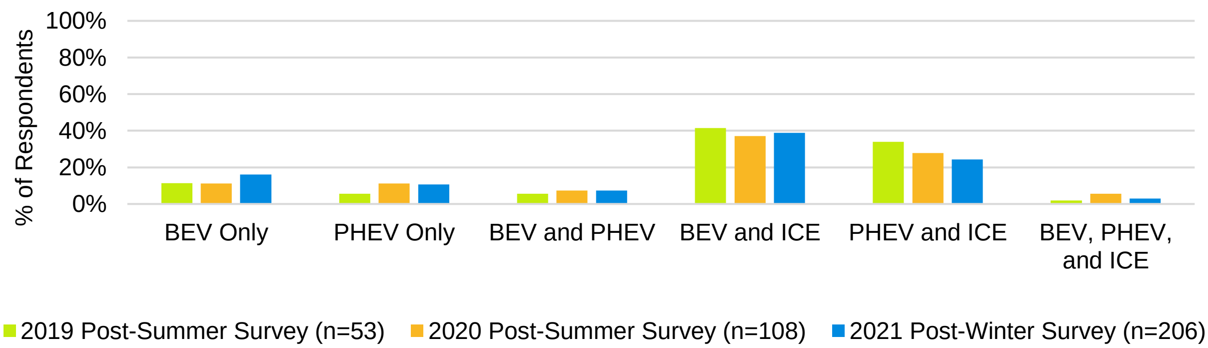
4.1.2 Participant Survey Results

The section below provides a summary of the key findings from the 2019 post-summer survey (conducted in December 2019), the 2020 post-summer survey (conducted in October 2020), and the 2021 post-winter survey (conducted in April 2021). Appendix B includes the output for every survey question across the three survey efforts.

4.1.2.1 Participant EV and EVSE Characteristics

The number of respondents with only EVs for their household (as opposed to an EV and an internal combustion engine (ICE) vehicle) increased steadily from 23% to 34% between the 2019 post-summer and 2021 post-winter surveys. As of April 2021 (the time of the 2021 post-winter survey), 35 respondents owned multiple EVs, with 21 of these owning both a BEV and PHEV. Additionally, BEVs were more popular than PHEVs among respondents—65% of respondents had at least one BEV while 45% had at least one PHEV as of April 2021.

Figure 4-1. Types of Vehicles Owned by Participants



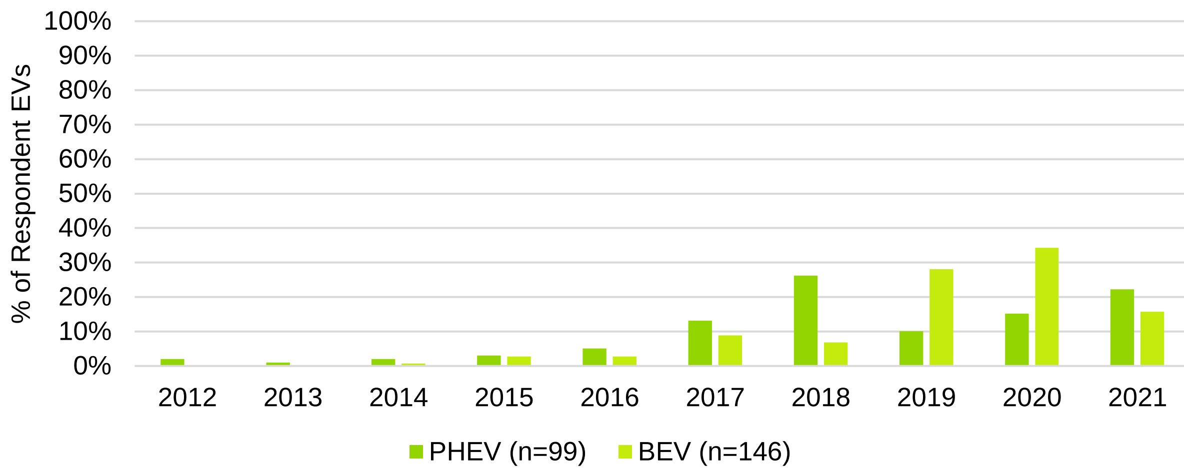
Q. Please indicate the number of each type of vehicle your household owns.

Note: This chart does not reflect total EV vehicle count (i.e., if a respondent has more than one of a given EV type, it is counted only once).

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Figure 4-2 shows that respondents' BEVs skew newer than respondents' PHEVs suggesting a trend toward BEVs. BEVs generally have higher battery capacities than PHEVs. Additionally, newer EVs tend to have higher battery capacities than older ones.

Figure 4-2. Participant EV Model Years by Type



Q. Please provide the make, model, and year for your [EV type].
Note: Values shown reflect the total number of EVs owned, not respondents.
Source: Guidehouse analysis of 2021 post-winter survey.

In terms of EVSE installation environment, the 2021 post-winter survey found that 50% of survey respondents keep their charging station in an unheated attached garage, while 37% keep it outside (see Appendix B). Only 7% have their charging station located in an unheated unattached garage and only 6% in a heated attached garage.

4.1.2.2 Motivations and Enrollment

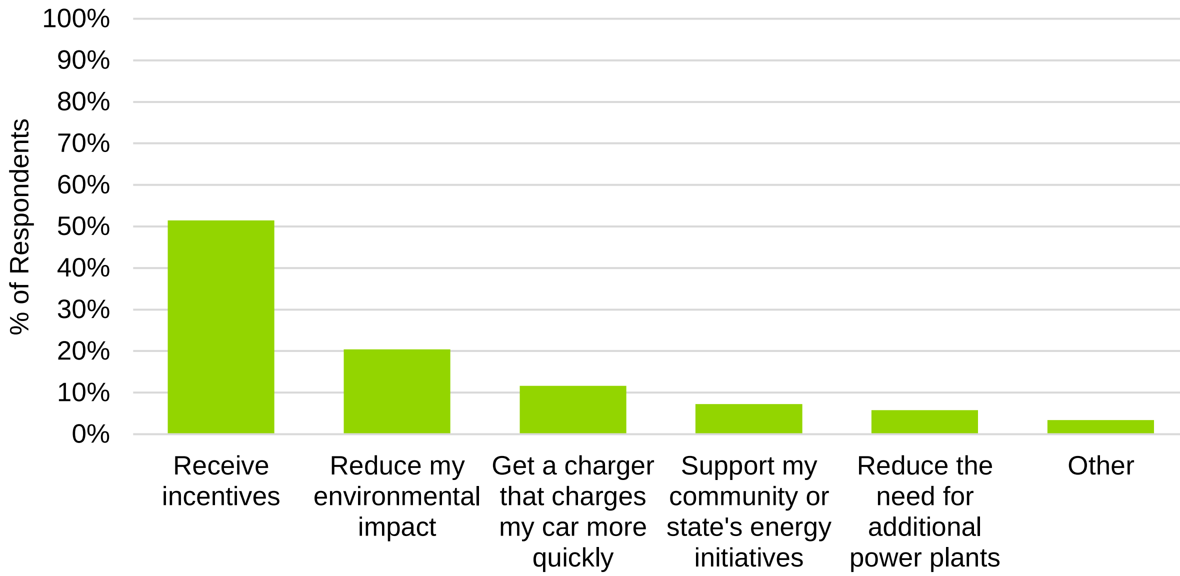
The participant surveys asked newly enrolled respondents about their motivations as well as their experience enrolling in the program. For most of the survey questions discussed in this section, if a respondent took multiple surveys, they were only asked these questions one time (during the first survey they completed). Therefore, the results described below are a composite of responses to all three participant surveys - 71 of the 206 survey respondents to the 2021 post-winter participant survey also took the 2020 post-summer participant survey and/or the 2019 participant survey. Responses for these respondents were taken from the first survey that they completed.

When asked to identify their top motivation for purchasing their EV(s), the most commonly cited motivation was to help the environment (102, 50%). Fuel independence and a desire for the latest technology were the next most commonly cited primary reasons (both with 25, 12%).

Figure 4-3 shows that, despite the environment being a primary motivator to purchase an EV, respondents cited program incentives as their top reason for enrolling in the program (106, 51%). The second most common reason cited was to reduce their environmental impact (42, 20%).

For respondents who had purchased a new charger around the time of enrolling in the program (150), 88 respondents became aware of the program before purchasing the new charger. Of these 88, 74 (84%) reported being at least partially influenced by the program to buy the new charger.

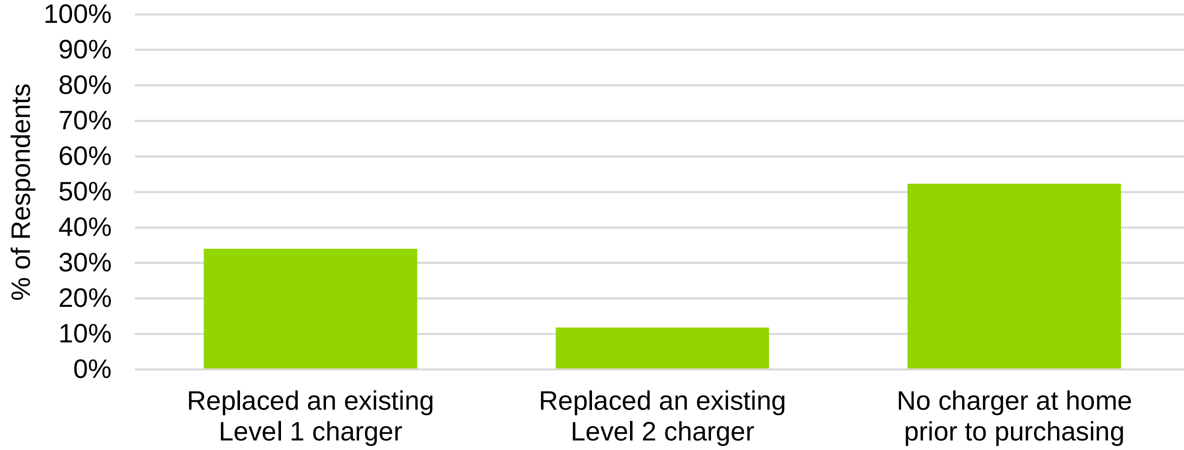
Figure 4-3. Top Motivation for Enrolling (n=206)



Q. What was your top motivation for enrolling in Eversource's ConnectedSolutions Electric Vehicle Home Charger Demand Response Program?
Note: 71 of the 206 survey respondents to the 2021 post-winter participant survey also took the 2020 post-summer participant survey and/or the 2019 participant survey. These respondents were not asked this question again and their response to this question was taken from the first survey that they completed.
Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Respondents with newly purchased home charging stations were asked what type of charger they replaced, if any. As Figure 4-4 shows, 54% of respondents with new chargers did not have a charger at home prior to enrolling in the program, while 34% replaced a Level 1 charger. The vast majority (85%) of those that did not previously have a charger at home have EV models from 2019 or later, suggesting these respondents may not have had an EV until relatively recently.

Figure 4-4. Enrolled EVSE Purchase Context (n=150)



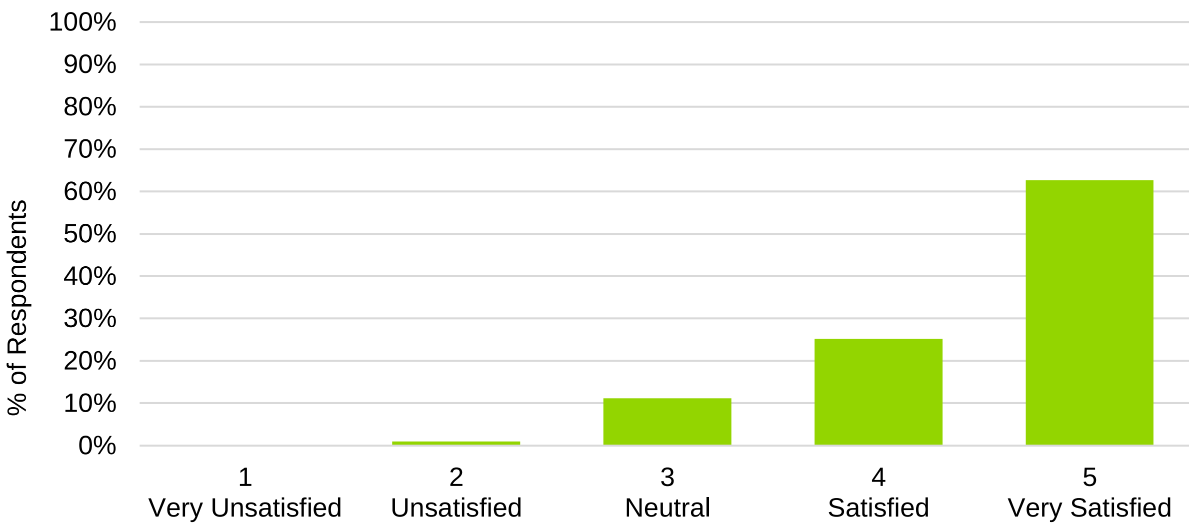
Q. Which of the following best describes the charger that you owned prior to purchasing the Level 2 charger that is currently enrolled in the program?

Source: Guidehouse analysis of 2021 post-winter survey.

The vast majority of respondents (88%) were satisfied with the enrollment process (Figure 4-5). A few respondents to the 2021 post-winter survey encountered some challenges in the enrollment process, as follows:

- No confirmation was provided to indicate that enrollment attempt was successful (5)
- Issues installing or connecting to the EVSE (4)
- Difficulty figuring out how to enroll (3)
- Conflict between Eversource billing account holder name vs. EVSE account holder name (2)

Figure 4-5. Satisfaction with the Enrollment Process (n=206)



Q. Using a scale of 1 to 5, how satisfied were you with the process of enrolling in the program?

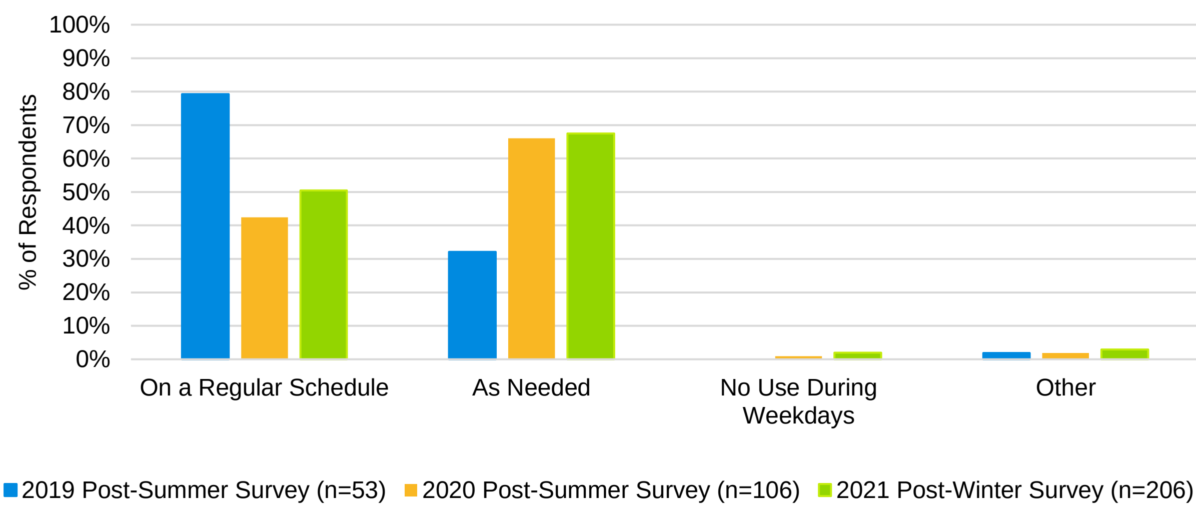
Note: 71 of the 206 survey respondents to the 2021 post-winter participant survey also took the 2020 post-summer participant survey and/or the 2019 participant survey. These respondents were not asked this question again and their response to this question was taken from the first survey that they completed.

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

4.1.2.3 Driving and Charging Behavior

2020 and 2021 impacted how respondents used their EVs on weekdays. Those who used their EV on a regular schedule (e.g., work commuting) during summer months declined from approximately 80% to 40% between the 2019 post-summer and 2020 post-summer surveys, assumed to be due to COVID-19. By the 2021 post-winter survey, roughly 50% of respondents indicated they used their EV on a regular schedule on weekdays during winter 2020/2021.

Figure 4-6. Participants' Use of EVs on Weekdays



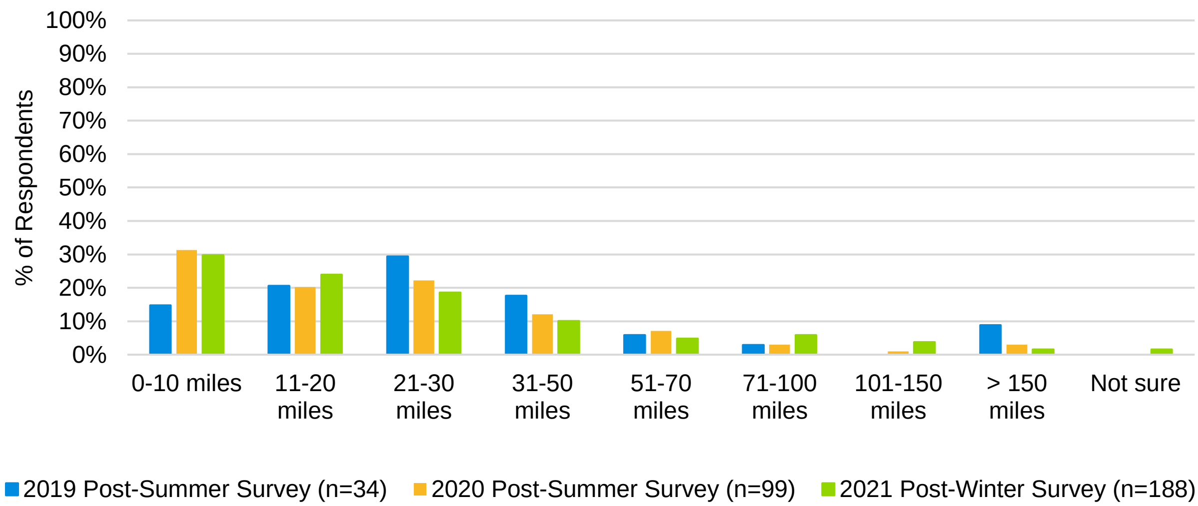
Q. Which of the following best describes how your household typically uses your electric vehicle on weekdays?

Note: In the survey, respondents with more than 1 EV were asked to answer questions about the EV whose driving and charging patterns they were most familiar with.

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

In terms of daily mileage driven in their EV, the percentage of respondents who drove their EV less than 10 miles per day during summer weekdays increased from 15% to approximately 30% between the 2019 post-summer and 2020 post-summer surveys. Of respondents to the 2020 post-summer survey who had their EV in summer 2019, 62% reported driving less during summer weekdays in 2020. Similarly, of respondents to the 2021 post-winter survey who had their EV in winter 2019/2020, 50% reported driving less during winter weekdays in 2020/2021.

Figure 4-7. Average Miles Driven by EV on Typical Weekday



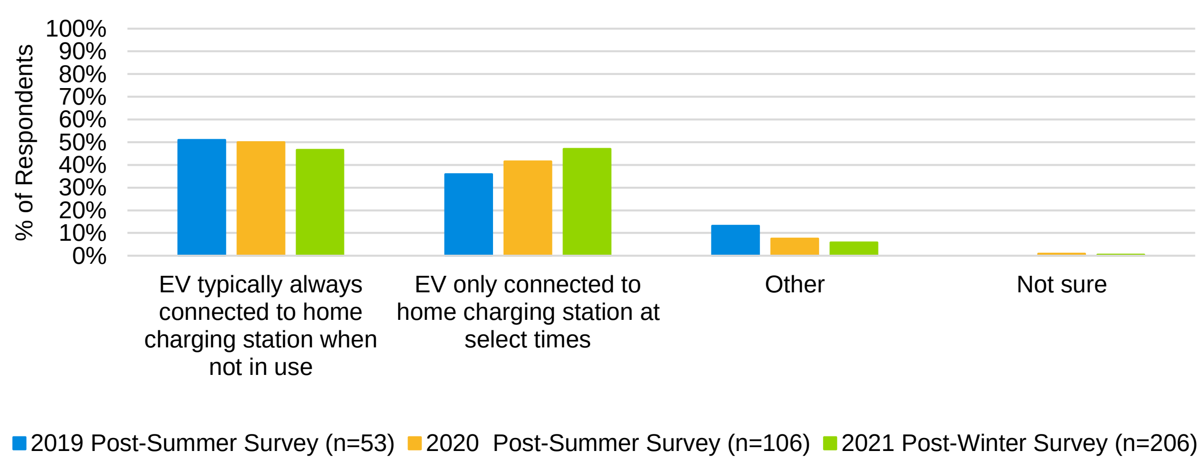
Q. During a typical weekday, on average how many miles was your electric vehicle driven by you and other members of your household?

Note: Respondent population numbers exclude respondents that stated that mileage varied significantly day-to-day. Additionally, in the survey, respondents with more than 1 EV were asked to answer questions about the EV whose driving and charging patterns they were most familiar with.

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Approximately 50% of respondents reported connecting their EV to a charger whenever it is not in use. The slight decrease in this percentage over time may be a reflection of an increased percentage of respondents with high capacity BEVs. 20% of respondents indicated they only connect when the battery is low and another 15% generally have it connected overnight.

Figure 4-8. EV "Connected" Behavior

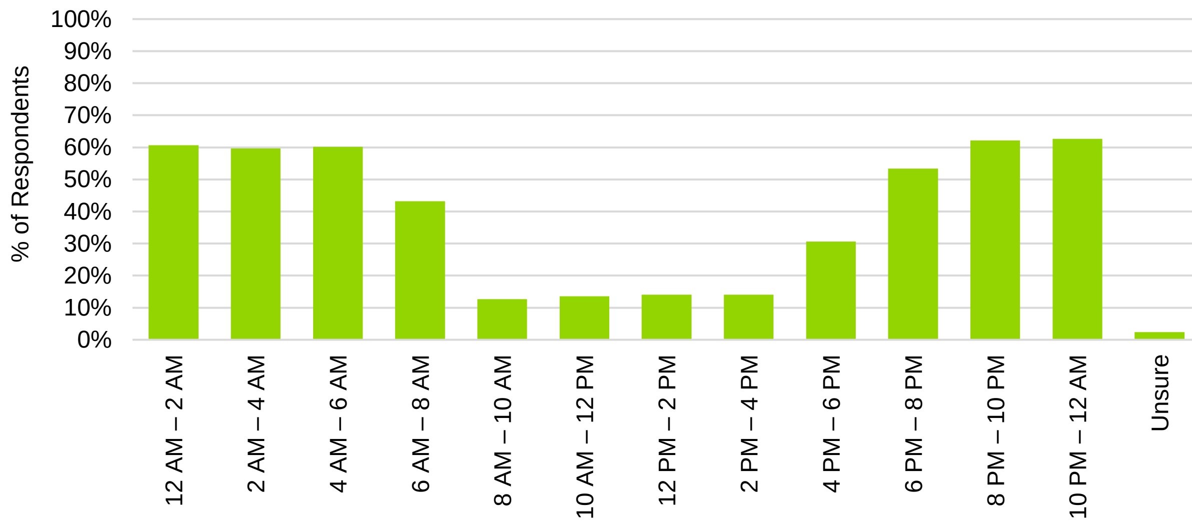


Q. When this electric vehicle was not being used and at home, was it typically connected to your home charging station?

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Consistent across surveys, the most common times for respondents' EVs to be connected to chargers was on weekdays was between 6 p.m. and 6 a.m. For respondents who said their connected times varied significantly from day-to-day, most said they only connected as-needed.

Figure 4-9. Most Common Times Participants Said Their EVs were Connected (n=206)



Q. Please indicate the time ranges during which your electric vehicle was typically connected to your home charging station on weekdays.

Note: Categories not shown in the chart include varied day-to-day and varied depending on week/month.

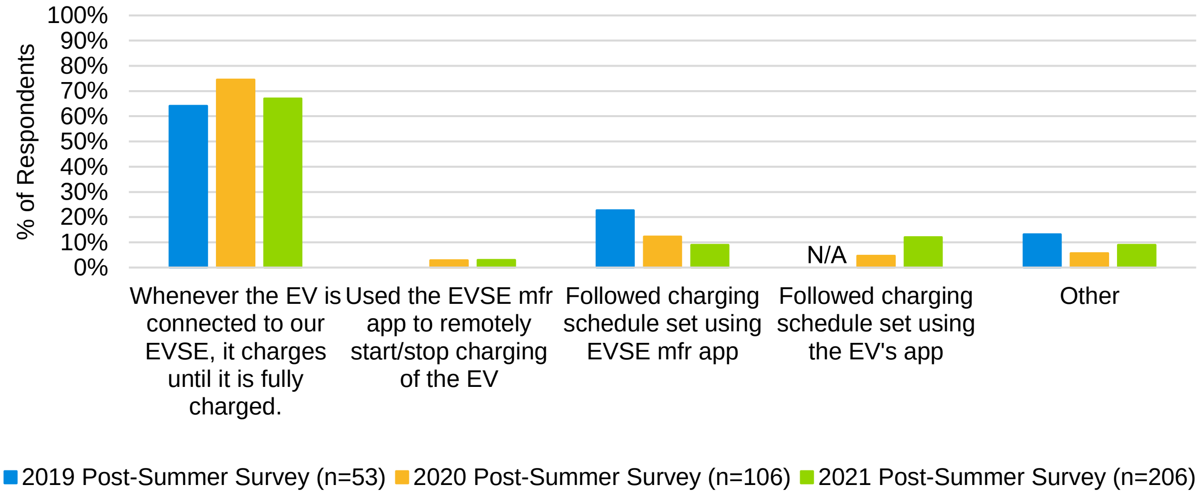
Source: Guidehouse analysis of 2021 post-winter survey.

As Figure 4-10 shows, as of the 2021 post-winter survey, 67% of respondents let their EV fully charge every time it is connected to their home charging station, and 20% of respondents use scheduled charging through an app (the app provided by either their EVSE manufacturer or EV manufacturer). Seven respondents (within "Other") indicated that they charge to a certain battery percentage.

Of the respondents who follow a charging schedule of some kind (42), 37 indicated that they set the schedule themselves while 3 use the default schedule. Common scheduled start times ranged from 9 p.m.–1 a.m. on weekdays.

Notably, 49 of 206 respondents (24%) to the 2021 post-winter survey indicated that the program influenced their charging schedule. As one respondent put it, "The charging station was set to charge the car from 11 p.m.–8 a.m.—we wanted to be consistent with Eversource's program."

Figure 4-10. Use of Home EVSE for Charging



Q. Which of the following best describes your household's use of your home charging station for your electric vehicle?

Note: N/A = response option was not provided in the 2019 participant survey

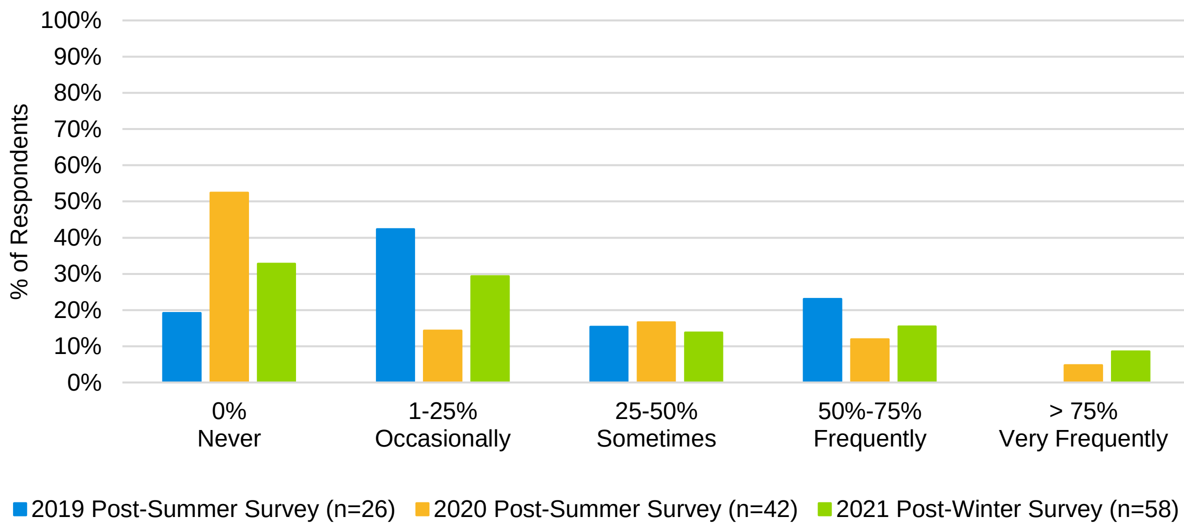
Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Not surprisingly, COVID-19 also appears to have impacted respondents' use of workplace charging. During the 2019 post-summer survey, 19% of those who had access to workplace charging reported never using it, while this increased to 52% in the 2020 post-summer survey, as more respondents worked remotely. There was some indication of respondents beginning to go back to the workplace by the 2021 post-winter survey (with only 33% reporting never using workplace charging).

As of the 2021 post-winter survey, the respondents that charged <50% of the time at work gave the following reasons for doing so:

- Worked remotely some days due to the pandemic (20)
- Charging spots were unavailable or limited (11)
- Charging was not free (3)

Figure 4-11. Percentage of Charging Occurring at a Workplace



Q. Approximately what percentage of your household's electric vehicle charging occurred at a workplace?
Note: Chart reflects only respondents who indicated that they had access to workplace charging.
Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

In addition to home and workplace charging use, surveys asked respondents how much they use public charging stations. As of the 2021 post-winter survey, close to 50% of respondents indicated they never or rarely use public charging stations and another 30% said they use public charging sporadically or about once per month. Self-reported use of public charging stations stayed relatively constant over the three survey efforts.

4.1.2.4 Event and Overall Program Experience

Most respondents to the 2021 post-winter survey were enrolled prior to when the four winter 2021 events were called. However, 30% of respondents did not recall that any events had occurred—these were mostly respondents with EVSEs from vendor B, which did not provide advance notice of events.

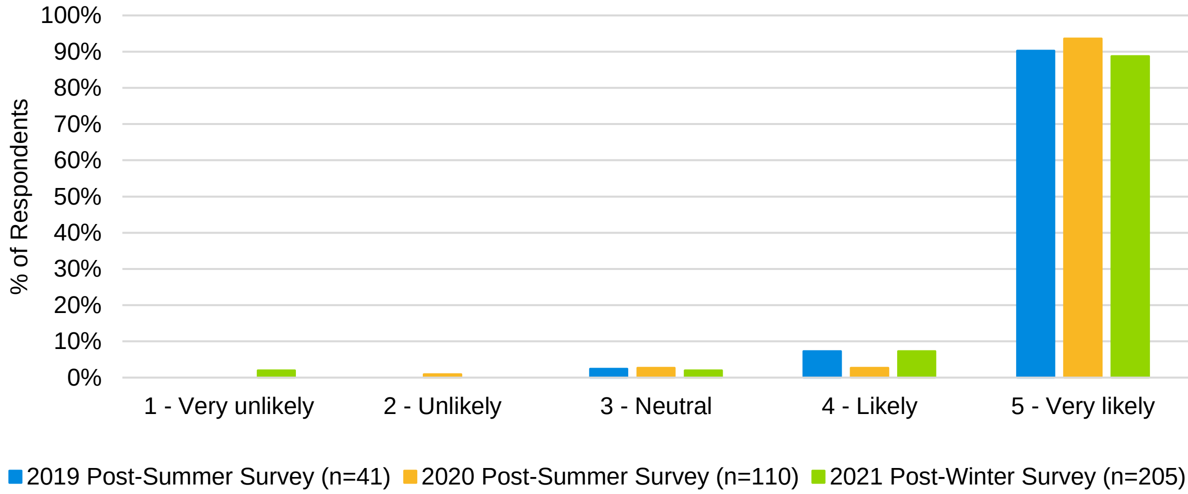
Across all three survey efforts, close to all of respondents who recalled at least one event said the events had no impact on their charging or driving behavior, despite the majority having been connected during at least some event hours. Of those who reported that they did adjust their behavior due to events (eight, during 2021 Post-Winter survey), feedback included:

- "I waited a day to charge. There was no immediate need to charge so I avoided it."
- "Drove somewhere else during the event (not to charge), came back after it was over."

Only three 2021 post-winter survey respondents recalled opting-out or overriding an event (all with EVSEs from vendor A). Two respondents who opted out said they needed their car fully charged quickly. One said they needed a full charge for the next morning.

Satisfaction with the program is very high, with 96% of respondents reporting that they are likely to continue participating in the future (Figure 4-12).

Figure 4-12. Likelihood of Continued Program Participation



Q. How likely are you to continue to participate in Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

Note: Removed DKs, of which there was one for the 2021 survey.

Source: Guidehouse analysis of 2019 post-summer survey, 2020 post-summer survey, and 2021 post-winter survey.

Of those that answered "very unlikely" to participate again, two requested that they be able to temporarily opt-out of an event and then rejoin and one wanted there to be more program-eligible chargers to choose from.

Additionally, in open-ended feedback about their experiences with the program:

- Seven respondents with EVSEs from vendor B expressed confusion around events and event timing due to a lack of notifications.
- Ten respondents recommended additional advertising or awareness to improve the program.
- Seventeen respondents wanted the program to be coupled with pricing changes—i.e., time-of-use (TOU) pricing (nine) or low off-peak rates (eight).

4.2 Assessment of Charging Profiles

The section consists of an assessment of participant charging behaviors during non-DR event periods.

4.2.1 Key Findings

- **Peak charging occured between 5 p.m. and 9 p.m. on weekdays and the maximum peak charging observed was 19% (in 2019).** An average of 16%-19% of EVSEs were simultaneously charging during this period from August 2019–February 2020. The percentage of EVSEs charging during these hours dropped to 8%-9% from March 2020–September 2020 and increased to 11%-13% from October 2020–March 2021. The decreased number of EVs charging on average during evening hours led to fewer potential participants in the two impact analysis periods that occurred during the pandemic.

- Across all three analysis periods, **the single weekday hour with the most energy consumed, on average, was 11 p.m.–12 a.m.**, primarily due to a concentration of scheduled charging sessions starting at 11 p.m.
- **60% of all charging sessions were complete within 2 hours and 89% were complete within 4 hours.** Longer event windows will likely have a negligible impact on the ability for vehicles to finish charging overnight.
- **29% of customers used scheduled charging in some capacity from August 2019–March 2021.** The most frequent start time of scheduled charging sessions was 11 p.m. on weekdays.
- **Enrolled customers decreased their frequency of charging after February 2020, likely due to the COVID-19 pandemic.** Of EVSEs, 50% had two or fewer charging sessions per week from March 2020 to September 2020, compared with 28% before March 2020.
- **Device power draw was not affected by changes in outdoor temperature.** EVSEs that were located outside or in an unheated garage did not have any clear changes in power draw as outdoor temperature changed.

4.2.2 Charging Profile Analysis Results

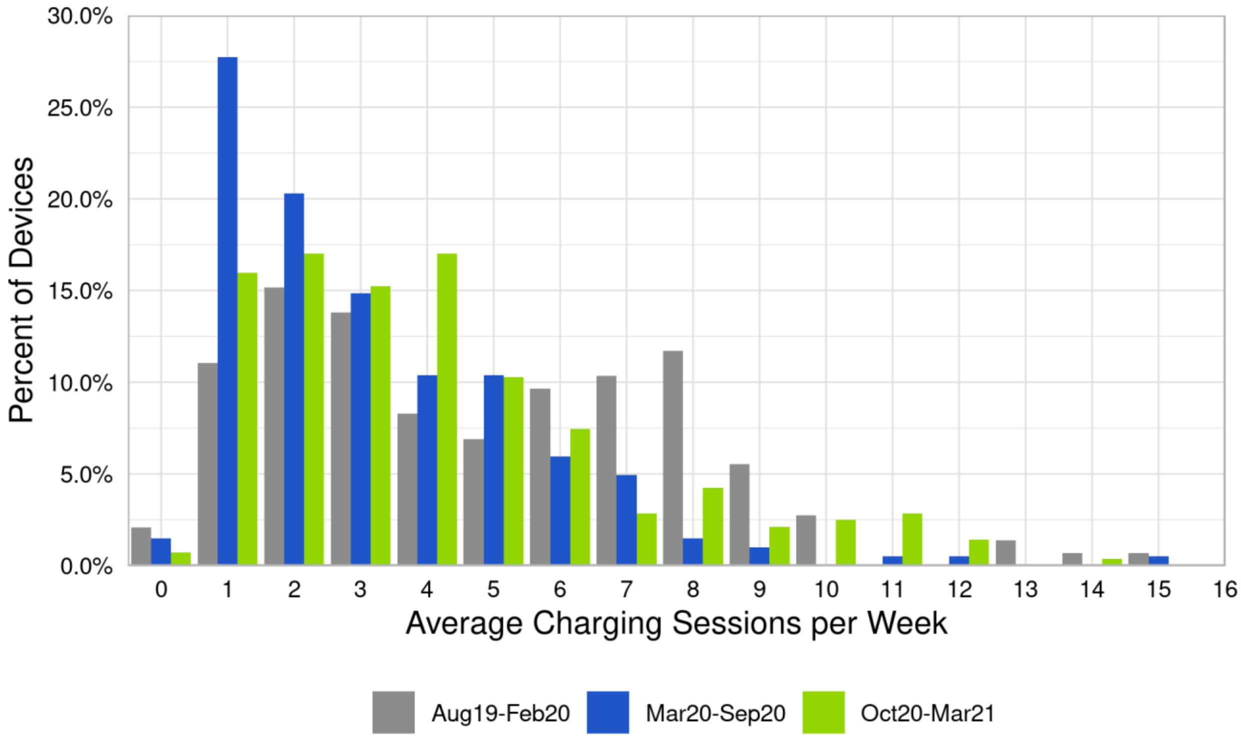
Guidehouse's experience with EVSE data has shown that a breadth of metrics can be helpful in characterizing charging behavior. For instance, understanding when charging sessions occur is relevant to Eversource in knowing how frequently customers are interacting and using their EVSE equipment and for understanding potential DR impacts. Guidehouse investigated the charging behavior of enrolled devices over several time periods. Each of these periods contains one impact analysis period and occurs before (first period) or during (second and third periods) the COVID-19 pandemic. While changes in charging behavior in the second and third periods are likely primarily due to the pandemic, there may also be seasonal effects that cannot be isolated. The number of EVSEs used in the assessment of charging profiles for each time period is shown in Table 4-1.

Table 4-1. Enrolled EVSEs with Data by Charging Analysis Period

Period	Enrolled EVSEs with Data
August 2019 – February 2020	112
March 2020 – September 2020	193
October 2020 – March 2021	287

Figure 4-13 shows the percentage of EVSEs with a given average number of charging sessions per week. Across all three time periods, 42%-64% of all devices charged three or fewer times per week. A low frequency of charging makes it less likely that Eversource's DR event windows will align with a given enrolled customer's charging sessions. During March 2020–September 2020, 50% of EVSEs had two or fewer charging sessions per week, compared with 28% pre-pandemic (before March 2020).[23] The decrease in charging frequency resulted in fewer enrolled customers charging simultaneously and, in turn, lessened the potential impact of DR events.

Figure 4-13. Average Number of Charging Sessions per Week

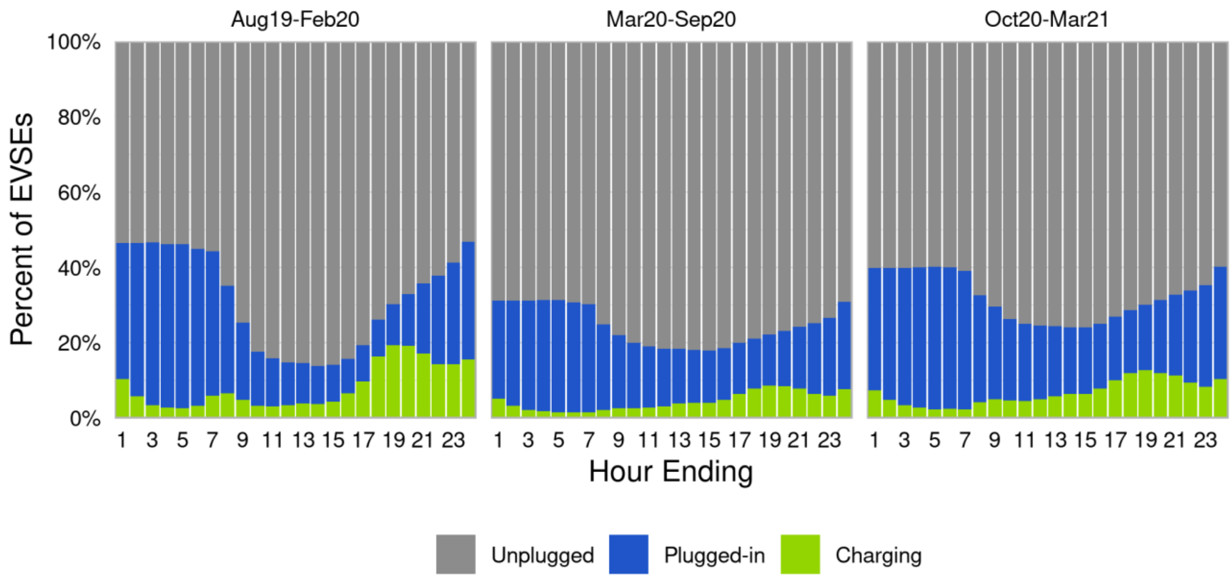


Source: Guidehouse analysis of EVSE vendor data

Figure 4-14 shows a plot of average weekday charger status. Looking across the entire evaluation period (August 2019–March 2021), peak charging occurred from 5 p.m. to 9 p.m. during the pre-pandemic August 2019–February 2020 period. During this time, 16%-19% of enrolled EVSEs, on average, were simultaneously charging. The percent of EVSEs charging during these hours dropped to 8%-9% from March 2020–September 2020 and then increased to 11%-13% for October 2020 to March 2021. The decreased number of EVs charging on average during evening hours led to fewer potential participants in the two impact analysis periods that occurred during the pandemic (i.e., June 2020–September 2020 and October 2020–March 2021).

[23] Also note that the pre-pandemic period includes winter while March-September 2020 does not.

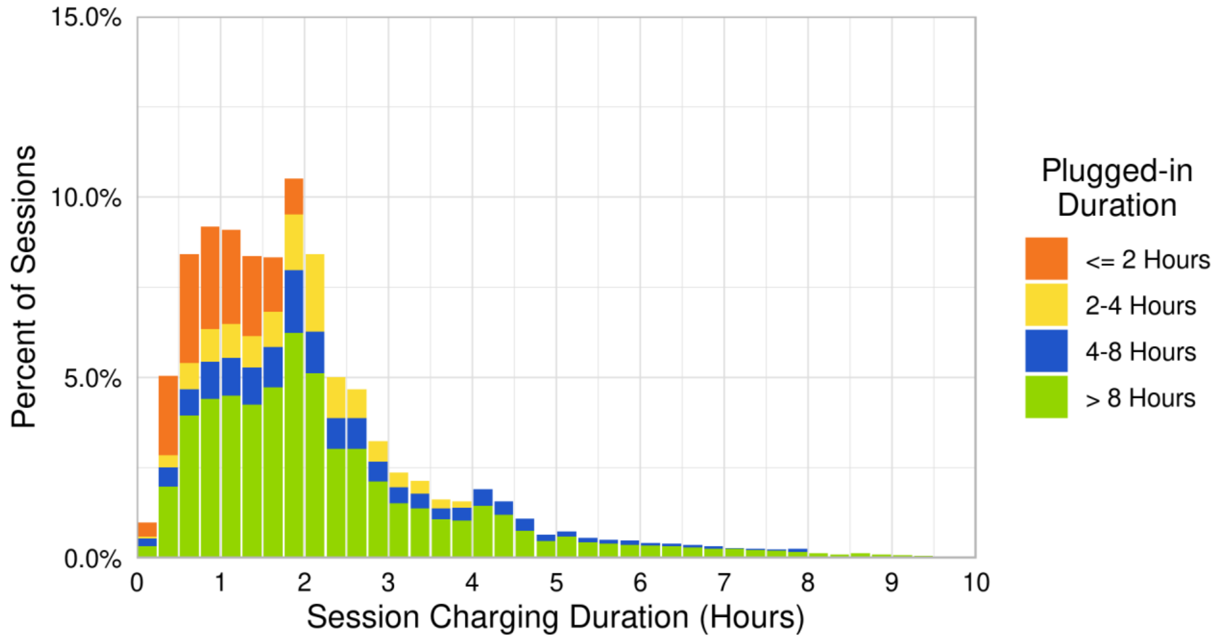
Figure 4-14. Weekday Hourly Average Charger Status



Source: Guidehouse analysis of EVSE vendor data

Figure 4-15 shows approximately 60% of plug-in sessions actively charged the EV for less than 2 hours, and 89% did so for less than 4 hours. This was relatively constant over the three analysis time periods. Out of sessions that actively charged for less than 2 hours, 63% of them were part of a plug-in session that lasted at least 4 hours, with the majority lasting more than 8 hours. The longer plug-in times coupled with shorter charging times indicates that customers often leave their EVSE connected to the EV after charging completes. Due to the brevity of charging sessions, EVs are still likely to get a full charge after being throttled for an evening event.

Figure 4-15. Percent of Sessions by Charging Duration and Plugged-in Duration



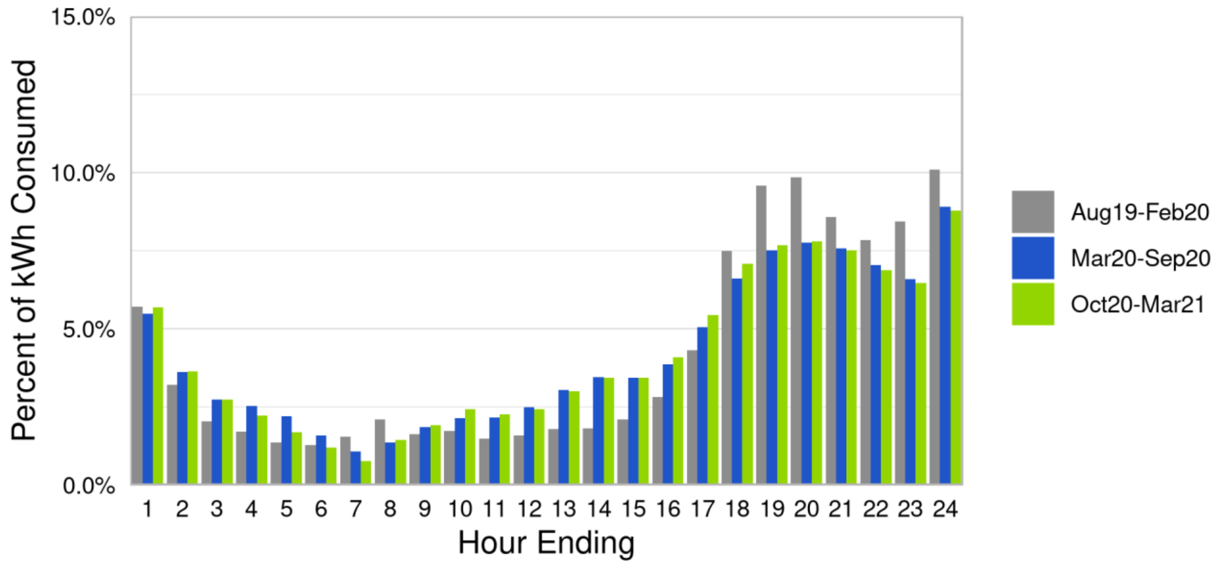
Note: Bars represent 0.25-hour increments.

Source: Guidehouse analysis of EVSE vendor data

Figure 4-16 shows the percent of energy consumed by hour on weekdays. All three periods had the most energy consumed during the 11 p.m.–12 a.m. window, primarily due to a concentration of scheduled charging sessions starting at 11 p.m. While a higher percentage of EVSEs are charging vehicles from 5 p.m.–9 p.m., the sessions are spread out during those hours and have less concentrated charging due to most sessions lasting under two hours. The concentration of charging sessions starting right at 11 p.m. results in a higher first hour energy consumption followed by sharp drops in subsequent hours as there are few vehicles beginning their charge.

Charging sessions from August 2019 to February 2020 had higher energy consumption in the hours following common business hours, with nearly 20% of all energy consumed between 6 p.m. and 8 p.m. The percentage of energy consumed between 6 p.m. and 8 p.m. in March 2020–September 2020 and October 2020–March 2021 was approximately 15% of all daily energy consumed, with a larger percent of energy consumed during midday hours than during the August 2019–February 2020 period.

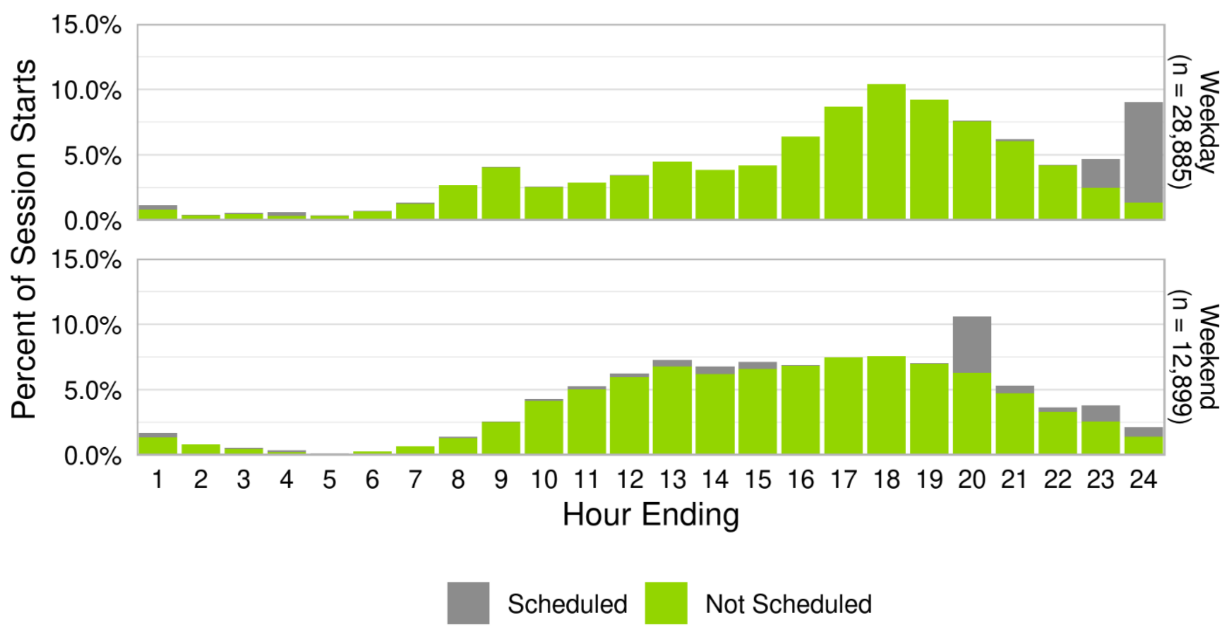
Figure 4-16. Percent of Energy Consumed by Hour on Weekdays



Source: Guidehouse analysis of EVSE vendor data

Approximately 29% of customers scheduled charging sessions in some capacity from August 2019–March 2021. Figure 4-17 shows the percent of charging sessions started in each hour of weekdays and weekends and breaks out the sessions by session type. As Figure 4-16 describes, customers that schedule weekday charging sessions primarily have them begin at 11 p.m. One likely explanation for the 11 p.m. scheduled start time: EVSE vendor A (with the most enrolled EVSEs) had a default start time of 11 p.m. for users scheduling charging sessions in Eversource's service territory.

Figure 4-17. Percent of Charging Session Starts by Session Type



Note: "n = " represents the number of charging sessions.

Source: Guidehouse analysis of EVSE vendor data

Table 4-2 displays monthly averages for several charging characteristics by analysis time period to track differences in charging behavior over time. The average power draw remained relatively constant over the three time periods, while charging duration and consumed energy increased slightly for the October 2020-March 2021 time period. The increases may reflect a combination of factors including changes in pandemic restrictions, increasing battery capacities, and/or seasonal driving patterns. One large change observed was the decrease in charging sessions per enrolled EVSE. From August 2019 to February 2020, there were 20.7 sessions per month. This decreased to 12.5 for March 2020–September 2020 and 15.9 for October 2020–March 2021.

Table 4-2. Average Monthly Charging Statistics

Metric – Monthly Averages	Aug19-Feb20	Mar20-Sep20	Oct20-Mar21	Aug19-Mar21
Charging Sessions *	1,444	1,617	3,276	2,086
Enrolled EVSEs with Data *	70	128	206	134
Charging Sessions per EVSE *	20.7	12.5	15.9	16.2
Avg. Session Charging Duration (hours) *	2.2	2.2	2.4	2.3
Avg. Session Consumed Energy (kWh) *	10.1	10.6	12.0	10.9
Avg. Session Power Draw (kW) *	4.7	4.7	4.8	4.8
Avg. Session Charging Duration by EVSE (hours) **	2.5	2.7	2.9	2.7
Avg. Session Consumed Energy by EVSE (kWh) **	13.0	14.9	16.2	14.7
Avg. Session Power Draw by EVSE (kW) **	5.1	5.3	5.4	5.3

* Averages were calculated by month, and then averaged again across all months in a given period. Session statistics are across all sessions in a given month, and are not first averaged by EVSE

** Averages were calculated by month, and then averaged again across all months in a given period. Session statistics are averaged by EVSE prior to calculating a monthly average.

Source: Guidehouse analysis of EVSE vendor data

Similarly, Table 4-3 compares average daily charging characteristics by time period to track changes in charging behavior after February 2020 likely due to the COVID-19 pandemic. Due to the decreased number of charging sessions after February 2020, the average daily max percentage of EVSEs charging was only 9% from March 2020–September 2020. This is less than half the 19% observed from August 2019–February 2020. The average daily max power draw was similar for the August 2019–February 2020 and March 2020–September 2020 periods (62.9 kW versus 66.9 kW), even though there were more EVSEs enrolled during the latter. The daily maximum power draw increased to 139.2 kW during the October 2020–March 2021 period, primarily due to increased enrollment.

Table 4-3. Average Daily Charging Characteristics

Metric	Aug19-Feb20	Mar20-Sep20	Oct20-Mar21	Aug19-Mar21
Avg. Daily Total Consumed Energy (kWh)	488	588	1,360	787

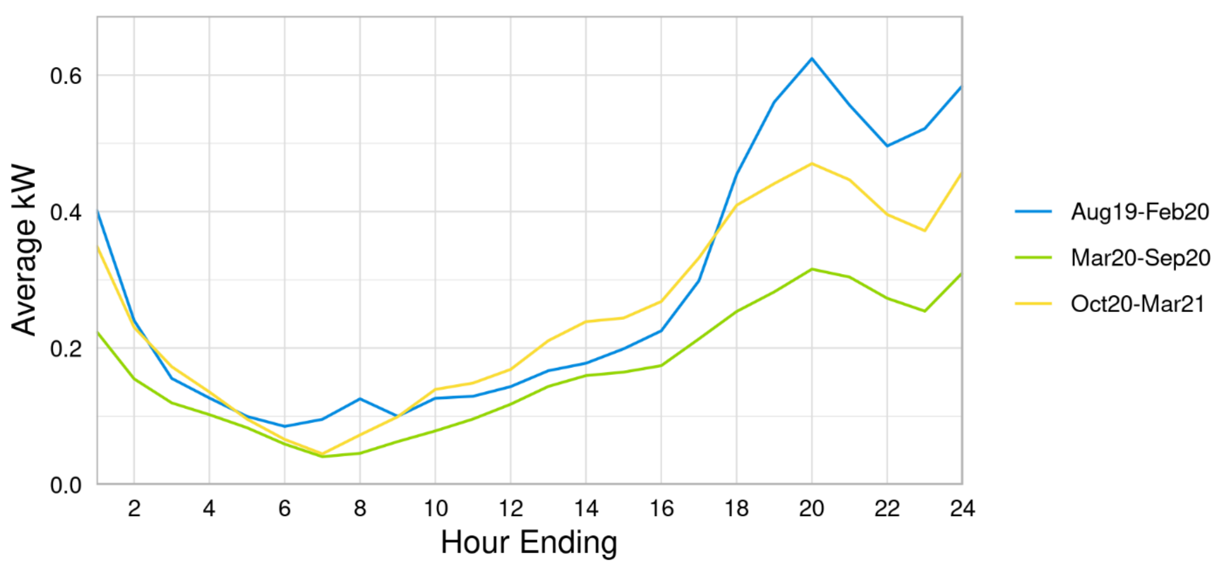
Avg. Daily Max Power Draw (kW)	62.9	66.9	139.2	87.4
Max Power Draw (kW)	144.8	153.7	250.0	250.0
Avg. Daily Max % EVSEs Charging	19%	9%	12%	13%
Avg. Daily Max % EVSEs Plugged-in	48%	33%	42%	41%

Note: Max and total values were calculated per day, and then averaged across all days in the given period.

Source: Guidehouse analysis of EVSE vendor data

Guidehouse also analyzed the hourly average power draw of enrolled EVSEs across time periods to understand when the average power draw per EVSE peaked (Figure 4-18). From August 2019 to February 2020, the average power draw per EVSE on all non-event days (including weekends) peaked at 0.62 kW from 8 p.m.–9 p.m. During the same hour, average power peaked at 0.32 kW from March 2020–September 2020 and 0.47 kW from October 2020–March 2021. This drop in peak average power draw is a result of the changes noted in Table 4-3, as it follows the sharp decline observed in the number of charging sessions per EVSE and average daily max percentage of EVSEs charging.

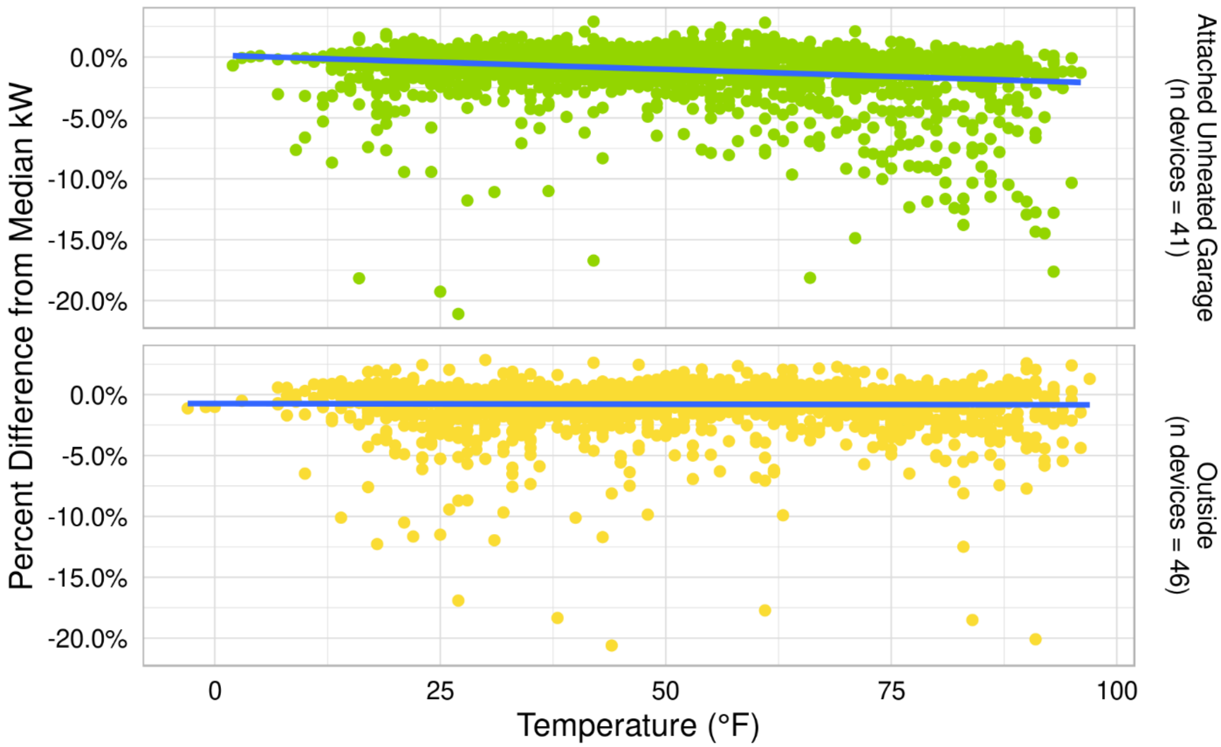
Figure 4-18. Hourly EVSE Average Power Draw on Non-Event Days



Source: Guidehouse analysis of EVSE vendor data

Guidehouse compared power draws of enrolled EVSEs at various temperatures in order to investigate how changes in weather may affect rates of charging. Figure 4-19 shows the relationship between a device's change in power draw (measured as percent difference from the EVSE's median power draw) and outdoor air temperature. This plot only includes survey respondents that stated their EVSE was located in an unheated garage or outside, as those EVSEs could be more susceptible to changes in outdoor temperature. Based on the plot below, there is no evidence that power draw is impacted by outdoor air temperature.

Figure 4-19. Changes in Power Draw by Outdoor Temperature



Source: Guidehouse analysis of EVSE vendor data and weather data

4.3 Assessment of Event Participation

To characterize EVSE-level participation in DR events, Guidehouse analyzed EVSE participation data from each event. Guidehouse categorized all enrolled EVSEs by event into one of five participation status categories. Enrolled customers may be flagged as non-participants for several possible reasons: technical issues, because they were unplugged for the entire event ("Unplugged"), or because they were plugged-in but no charging occurred over the event period ("Not Charging"). Full participants, those that curtailed for the entire event or finished charging during the event, are distinguished from partial participants who plugged-in late or early.

The categories are outlined below:

- **Full Participant:** EVSE was occupied and charging at the start of the event and was not used during the event
- **Partial Participant:** EVSE was occupied and charging at the start of the event but then unplugged during the event, or EVSE was plugged-in after event started.
- **Not Charging:** EVSE was not charging at the start of and throughout the event.
- **Unplugged:** EVSE was not occupied at that start of and throughout the event.

- **Technical Issue or Opt-Out:** EVSE did not participate due to connectivity, failure to receive DR signal, or participant chosing to opt-out of event and charge normally.[24]

4.3.1 Key Findings

- **In all periods and for all events, most devices were unplugged during the event and did not participate.** In all periods, less than 30% of devices on average were fully or partially participating. Participation was lowest in the June–September 2020 impact analysis period, where only 4% of devices on average fully participated compared to 18% in the August–October 2019 impact analysis period and 11% in the October 2020–March 2021 impact analysis period.
- **Events did not prevent participants from reaching a full state of charge.** On non-event weekdays, devices fully charged in slightly over 85% of sessions, compared to 85% of sessions on event days.

4.3.2 Event Participation Results

Figure 4-20 represents the average participation across the three impact analysis periods for the demonstration.

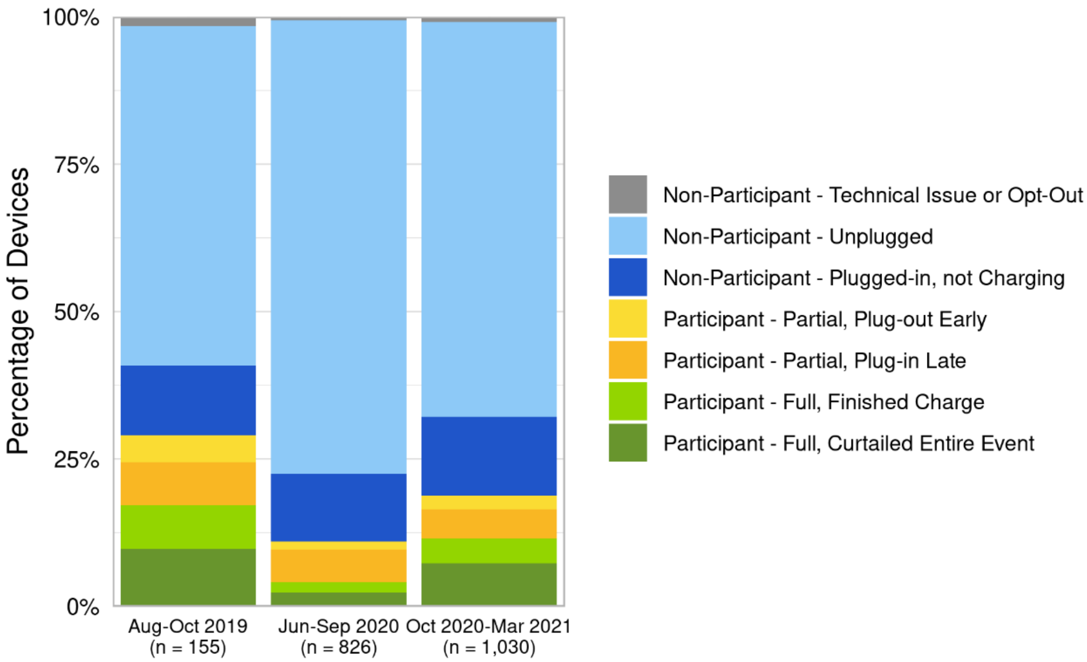
Low participation in the June 2020–September 2020 impact analysis period was likely due to the COVID-19 pandemic and the associated reduction in charging overall and decreased likelihood that devices would be plugged in during event periods. Although full and partial participation increased between the June 2020–September 2020 impact analysis period (4% full and 11% full and partial combined) and the October 2020–March 2021 impact analysis period (11% full and 19% full and partial combined), participation had not returned to August 2019–October 2019 levels (18% full and 30% full and partial combined).

Event participation within each impact analysis period was consistent. The widest range of participation occurred in the August 2019–October 2019 season (18%-31%, across the three events). In the June 2020–September 2020 season, event participation ranged from 9%-13% (across the five events). Similarly, in the October 2020–March 2021 season, participation ranged from 18%-20% (across the four events).

There were differences in event participation between seasons; however, it is more difficult assign causality as events were called at different hours (as early as 4 p.m.-7 p.m. and as late as 8 p.m.-11 p.m.), different days of the week, and lasted for differing amounts of time (either 2 hours or 3 hours). In addition, the different impact analysis periods had different non-event day charging behavior. For example, in the more recent impact analysis periods (June 2020–September 2020 and October 2020–March 2021), fewer devices were charging on average during peak hours, which meant it was less likely they would be plugged in when an event occurred.

[24] From the data, Guidehouse was not able to distinguish opt-outs from EVSEs with technical issues.

Figure 4-20. Participation Status by Impact Analysis Period

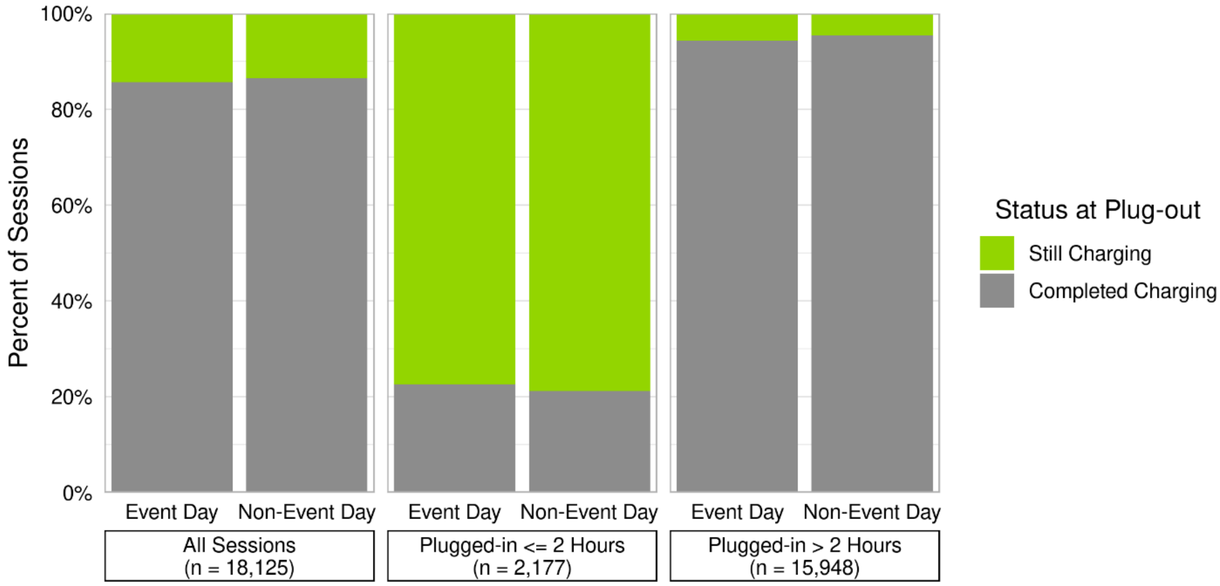


Note: "n = " represents the number of participation statuses across all events.

Source: Guidehouse analysis of EVSE vendor data

As Figure 4-20 shows, events had almost no impact on charging completion. On non-event weekdays, devices fully charged in 87% of sessions, compared to 86% of sessions on event days. Most participants surveyed indicated the event had no effect on their charging and driving behavior.

Figure 4-21. Event Impact on Weekday Charging Completion – August 2019–March 2021



Note: “n = “ represents the number of charging sessions. Sessions were only included if charging occurred during typical event hours: 4-11 p.m.

Source: Guidehouse analysis of EVSE vendor data

4.4 Impact Analysis

This section summarizes key findings related to the impact analysis conducted for this evaluation. Guidehouse assessed impacts and summarized them for the three impact analysis periods, which aligned with periods of time when Eversource may have called events.[25] The impact analysis periods were August 2019–October 2019, June 2020–September 2020, and October 2020–March 2021.

Table 4-4. Event Characteristics by Impact Analysis Period

	August 2019 – October 2019	June 2020 – September 2020	October 2020 – March 2021
Unique Devices Considered in Impact Analysis	60	175	255
Event Timing	7 p.m.-10 p.m. or 8 p.m.-11 p.m.	4 p.m.-7 p.m. or 5 p.m.-7 p.m.	5 p.m.-7 p.m. or 6 p.m.-8 p.m.
Event Day-of-Week	M, T, Th	Mx4, Th	F, M, Tx2

Note: Device count represents the number of devices that had sufficient charging data to evaluate results for at least one event within the season.

Source: Guidehouse

[25] As well as the time periods from which Guidehouse drew for establishing non-event day baselines for the impact analysis.

4.4.1 Key Findings

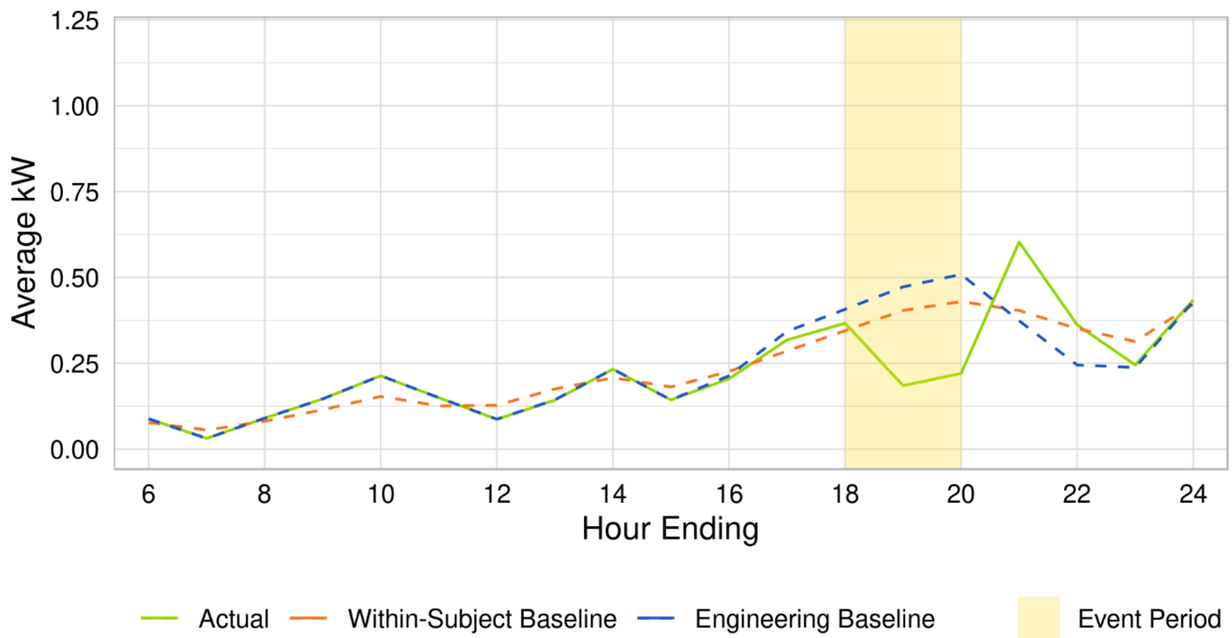
- **Variety in event timing and participation makes it difficult to isolate factors contributing to differences in impacts between impact analysis periods.** As Table 4-4 shows, events were called at different hours, different days of the week, and lasted for differing amounts of time. In addition, there were changes in max observed power draw of participants, non-event day charging behavior, and participation rates during events.
- **Period-average demand impacts for all devices ranged from 0.11 kW to 0.26 kW across the three analysis periods.**[26] The average engineering approach impacts by impact analysis period were 0.26 kW for August 2019–October 2019, 0.11 kW for June 2020–September 2020, and 0.25 kW for October 2020–March 2021.
- **Demand impacts were low during the June 2020–September 2020 impact analysis period due to low participation rates.**
- **Period-average demand impacts for *participating devices* ranged from 0.92 kW to 1.38 kW.** The average engineering approach impacts by impact analysis period for *participating devices only* were 0.92 kW for August 2019–October 2019, 0.99 kW for June 2020–September 2020, and 1.38 kW for October 2020–March 2021.
- **Average impacts among participating devices were highest in the most recent impact analysis period (October 2020–March 2021).** This was in part due to higher maximum observed power draw in the population. The earliest impact analysis period had no participating EVSEs with maximum observed power draw greater than 8 kW, whereas the most recent had five devices.
- If peak charging returns to pre-pandemic level where an average of 19% of users simultaneously charged during peaks, the **potential curtailable load (based on devices enrolled as of March 2021) could be approximately 386 kW for weekday evening events.** If peak charging does not reach or exceeds the pre-pandemic level of 19% of EVSEs charging simultaneously, the potential curtailable load could be approximately 305 kW at 15% or 508 kW at 25%.

4.4.2 Impact Results

Figure 4-22 shows an example baseline for the March 15, 2021 event. Guidehouse calculated demand impacts by comparing the actual charging during the event to a calculated engineering baseline and to a modeled within-subject regression baseline. In Figure 4-22, hour ending 18 to hour ending 20 are shaded to represent the event period

[26] Impacts calculated with the engineering method are highlighted in the key findings section because they are unaffected by non-event day charging, which changed across impact analysis periods due to the COVID-19 pandemic.

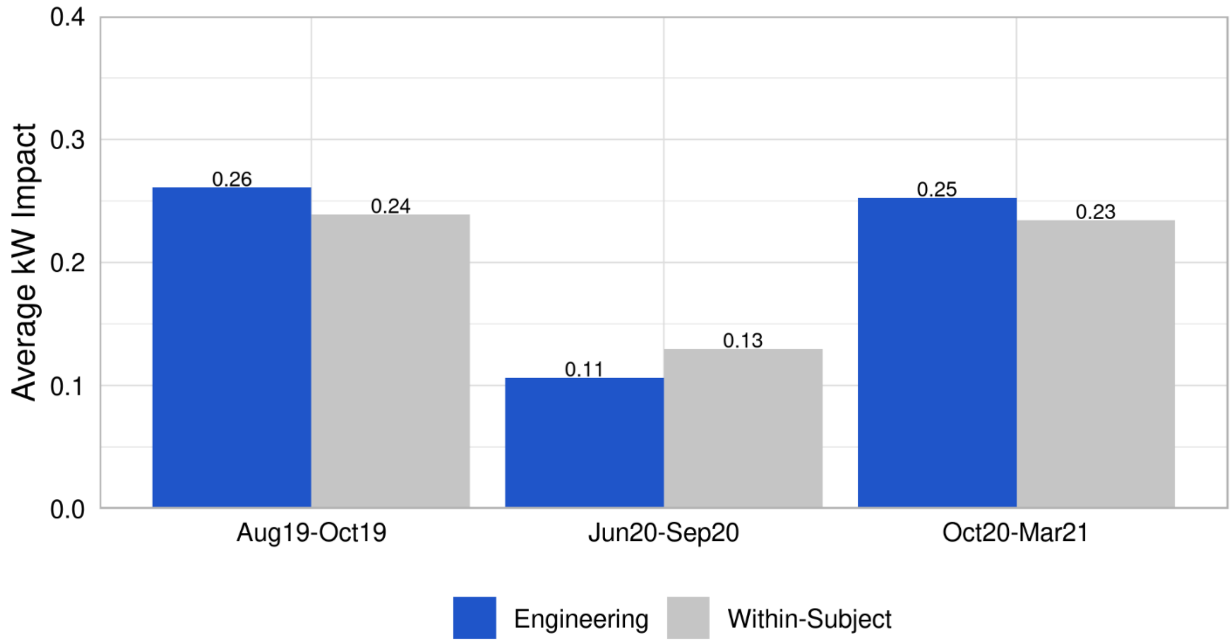
Figure 4-22. Example Baseline for March 15, 2021 Event



Source: Guidehouse analysis of EVSE vendor data

Figure 4-23 shows the average kW impact per enrolled device by evaluation period. For all impact analysis periods, average demand impacts were similar between engineering and within subject approaches. Impacts were highest in the August 2019–October 2019 impact analysis period at 0.24 kW–0.26 kW per device and lowest in the June 2020–September 2020 impact analysis period at 0.11 kW–0.13 kW per device. The October 2020–March 2021 impacts were similar to the August 2019–October 2019 impacts at 0.23 kW-0.25 kW per device.

Figure 4-23. Average kW Impact per Device by Impact Analysis Period



Source: Guidehouse analysis of EVSE vendor data

Table 4-5 shows the demand impacts per device by event. The event with the highest impacts in the engineering (0.32 kW) and within-subject approaches (0.40 kW) was called on October 17, 2019 from 7 p.m. to 10 p.m. This event had similar participation to the event called on August 19, 2021 and has similar engineering impacts. The August 19, 2021 event's within-subject impacts were impacted negatively by the number of devices and availability of non-event day data.

Though differences in event timing make it difficult to compare impacts directly, the March 23, 2021 and March 30, 2021 events were both called on Tuesdays in March 2021 from 6 p.m. to 8 p.m. The events also had similar participation (19% in the March 23, 2021 event compared to 18% in the March 30, 2021 event). Differences may be partially attributed to an anomaly in the March 23, 2021 event where it appeared that 8-10 devices curtailed approximately 15 minutes after the start of the event. The events also had differing levels of participation among EVs with high observed power draw (those that can charge at a rate greater than 8 kW).

Table 4-5. Demand Impacts per Device by Event

Impact Analysis Period	Event Date	Day of Week	Event Start Time	Event End Time	Engineering Impact (kW)	Within-Subject Impact (kW)	Devices with Sufficient Data
August 2019–October 2019	8/19/2019	Monday	8:00 p.m.	11:00 p.m.	0.31	<0.01	29
	10/8/2019	Tuesday	7:00 p.m.	10:00 p.m.	0.15	0.32	59
	10/17/2019	Thursday	7:00 p.m.	10:00 p.m.	0.32	0.40	60
June 2020–	7/9/2020	Thursday	5:00 p.m.	7:00 p.m.	0.10	0.17	163
	7/20/2020	Monday	4:00 p.m.	7:00 p.m.	0.12	0.12	165
	7/27/2020	Monday	4:00 p.m.	7:00 p.m.	0.09	0.11	167

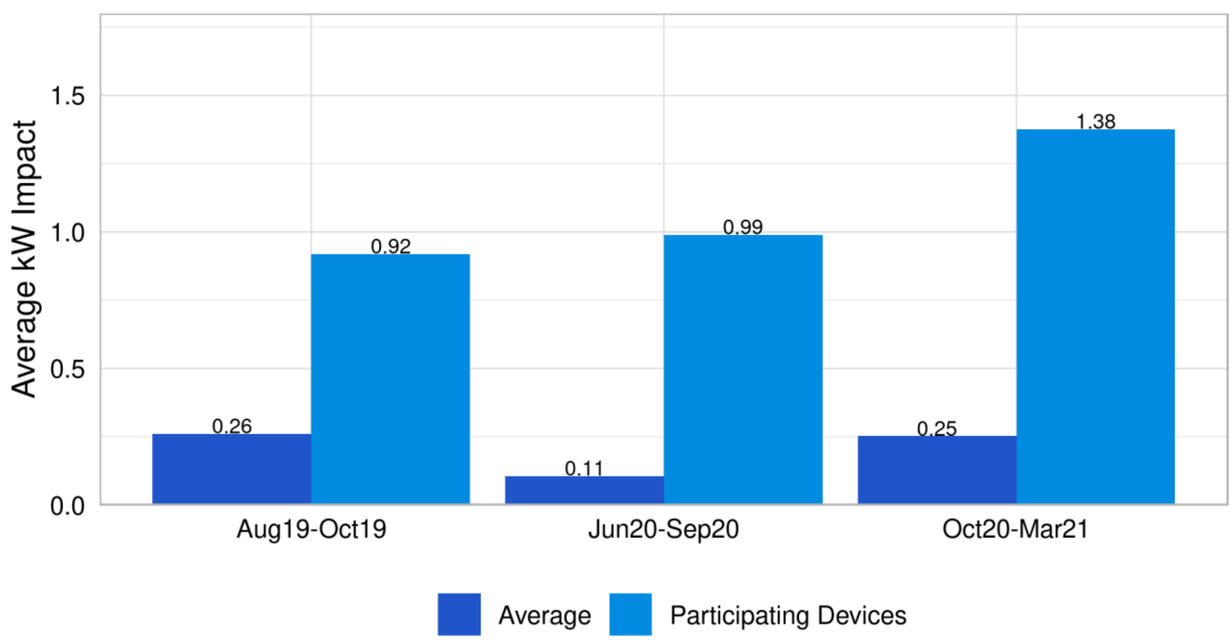
Impact Analysis Period	Event Date	Day of Week	Event Start Time	Event End Time	Engineering Impact (kW)	Within-Subject Impact (kW)	Devices with Sufficient Data
September 2020	8/3/2020	Monday	5:00 p.m.	7:00 p.m.	0.12	0.12	163
	8/24/2020	Monday	4:00 p.m.	7:00 p.m.	0.11	0.12	168
October 2020–March 2021	1/29/2021	Friday	5:00 p.m.	7:00 p.m.	0.32	0.25	246
	3/15/2021	Monday	6:00 p.m.	8:00 p.m.	0.29	0.21	244
	3/23/2021	Tuesday	6:00 p.m.	8:00 p.m.	0.19	0.27	244
	3/30/2021	Tuesday	6:00 p.m.	8:00 p.m.	0.21	0.21	244

Note: For a device to be included in the impact calculation, it must have had sufficient data to be included in the within-subject regression model, meaning that it must have had charging data on at least one event day and must have had charging data in at least 2 months of the evaluation period.

Source: Guidehouse analysis of EVSE vendor data

Figure 4-24 shows the average demand impacts for devices that were fully or partially participating in the events compared to the average impact for all devices. The most recent impact evaluation period had much higher impacts for participating devices at 1.38 kW compared to 0.92 kW and 0.99 kW in the first and second impact analysis periods, respectively. Impacts of participating devices by event are detailed in Appendix E.

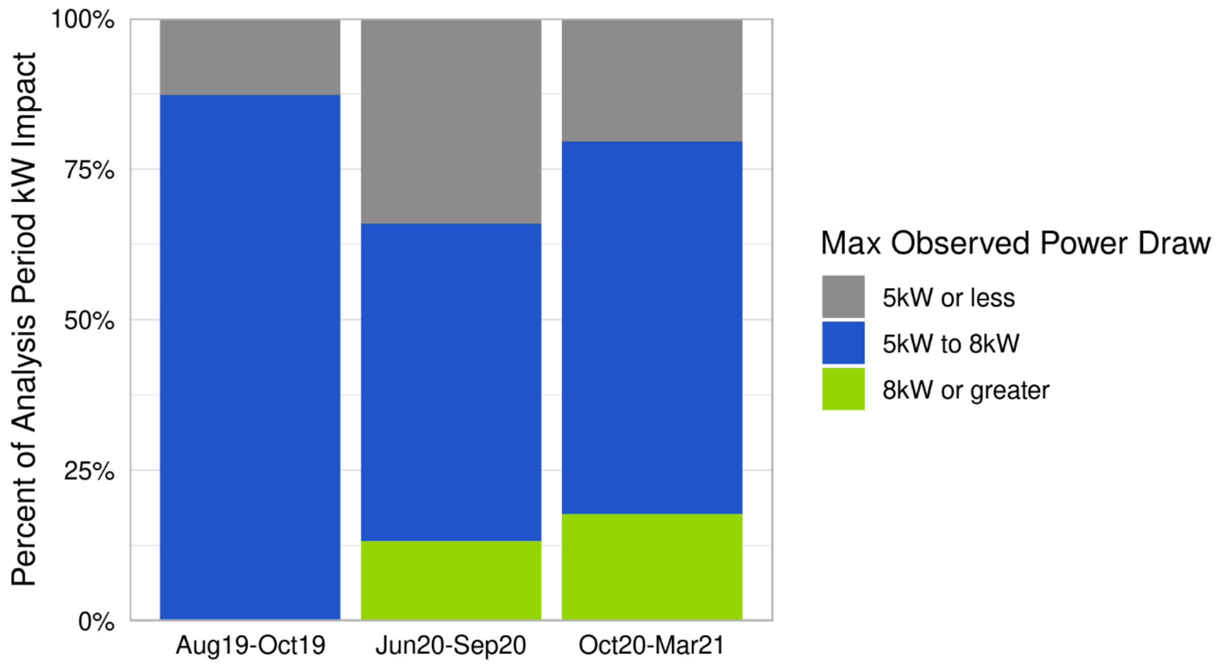
Figure 4-24. Average kW Impact per Device for Participating Devices



Source: Guidehouse analysis of EVSE vendor data

This increase in average impacts is at least partly due to an increase in enrolled EVs with maximum observed power draw of 8 kW or greater. Figure 4-25 shows the share of kW impacts estimated with the engineering approach for participating devices by their observed maximum power draw. In the October 2020–March 2021 impact analysis period, devices with maximum observed power draw greater than 8 kW made up 8% of the participating devices, but 18% of the impacts.

Figure 4-25. Contribution to Demand Impacts by Observed Power Draw



Source: Guidehouse analysis of EVSE vendor data

The proportion of EVSEs with maximum observed power draw greater than 8 kW has increased from each impact analysis period to the next. Table 4-6 shows the percent of EVSEs by observed power draw in a given impact analysis period. 15.3% of EVSEs included in the impact estimates for October 2020–March 2021 had an observed power draw exceeding 8 kW, compared to 5.8% in June 2020–September 2020 and 0% in August 2019–October 2019. While Guidehouse does not have vehicle characterization data for charging sessions, the higher power draws are likely from BEVs with higher battery capacities and acceptance rates. If acceptance rates of BEVs continue to trend upward, potential impacts may also increase. The percent of EVSEs with an observed power draw of 5 kW or less, which is predominantly associated with PHEVs, stayed relatively constant across the three analysis periods (26.0-28.3%).

Table 4-6. Percent of EVSEs by Observed Power Draw per Impact Analysis Period

Max Observed Power Draw	August 2019 – October 2019	June 2020 – September 2020	October 2020 – March 2021
5 kW or Less	28.3%	26.0%	27.8%
5 kW to 8 kW	71.7%	68.2%	56.9%
8 kW or Greater	0.0%	5.8%	15.3%

Note: Devices were only included in a period if they were enrolled on at least one event day and had sufficient data to be included in the impact analysis..

Source: Guidehouse analysis of EVSE vendor data

Eversource's EVSE DLC demonstration has continued to scale since the initial launch in August 2019 and has increased the resulting potential curtailable load. Curtailable load was calculated for each EVSE as its maximum observed power draw minus 1.8 kW, as the events throttle the EVSE's charging to Level 1 rates. For enrolled customers that did not have data, Guidehouse used the average curtailable load of customers with data. As of March 31, 2021, the theoretical curtailable load of all enrolled devices reached 2,033 kW, up from the 242 kW on September 1, 2019. However, as highlighted in the assessment of charging profiles section, the maximum number of enrolled EVSEs that were simultaneously charging on weekdays only averaged 19%. Based on this average percent of EVSEs charging (if peak charging returns to pre-pandemic level), the potential curtailable load could be approximately 386 kW for weekday evening events. If peak charging does not reach or exceeds the pre-pandemic level of 19% of EVSEs charging simultaneously, the potential curtailable load could be approximately 305 kW at 15% or 508 kW at 25%.

4.5 Assessment of Simulated Events

4.5.1 Key Findings

- **Theoretical event impacts decrease after February 2020 because of changes in charging behavior, assumed to be due primarily to the COVID-19 pandemic.** Months with data before and during the pandemic had an average 32% decrease of theoretical impacts year-over-year for events simulated from 5 p.m.–7 p.m.

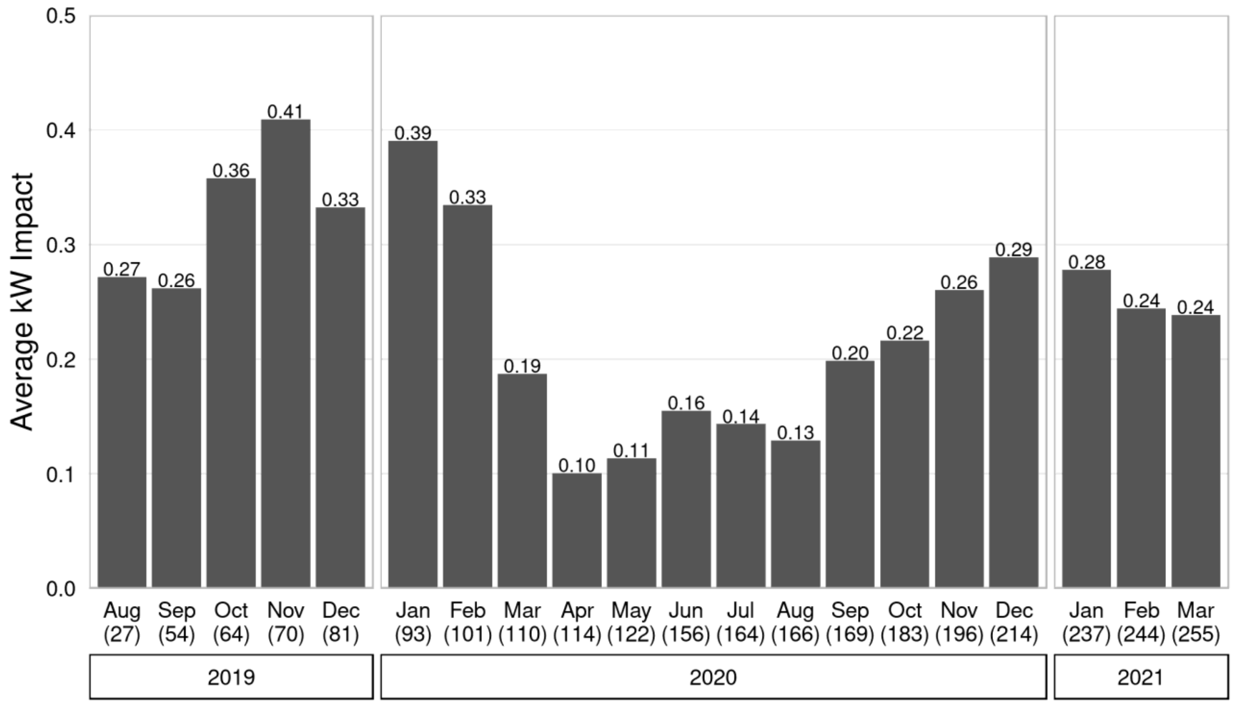
4.5.2 Simulated Impact Results

The three impact analysis periods detailed in Section 4.4 occurred from August 2019 through March 2021, during which time there were large changes in charging behavior that were likely due in large part to the COVID-19 pandemic. However, the impacts of these changes could not be isolated for the twelve demand response events because they had different characteristics such as day of week, event start time, and event duration. In order to quantify the effect of changes in charging behavior on event impacts, Guidehouse simulated hypothetical events on non-event days and estimated average potential impacts using the engineering method.

Guidehouse simulated “events” for all non-event, non-holiday weekdays and impacts per enrolled EVSE were averaged for each month. All EVSEs that were charging during the simulated event window of 5 p.m.–7 p.m. were assumed to curtail to 1.8 kW (the Level 1 charging rate) and continue charging at that rate until one of three things occurred: the event ended, the EVSE consumed the same total amount of energy as the real session, or the EVSE was unplugged.

Figure 4-26 displays the average monthly theoretical impacts calculated using the methodology outlined above. The potential impacts began to decline in March 2020 and bottomed out in April 2020 at an average theoretical impact of 0.10 kW per enrolled device. Average theoretical impacts per EVSE increased after August 2020 and reached 0.29 kW in December 2020, which is still 13% lower than the theoretical impacts estimated for December 2019 (0.33 kW). While the differences in charging behavior are largely assumed to be due to the pandemic, the effect of the pandemic on theoretical impacts over time cannot be entirely isolated from all other factors, such as customers purchasing EVs with higher acceptance rates in more recent months. Also, these theoretical impacts cannot be directly compared to those of the real events, as some customers’ charging behavior may have been affected by the day-ahead or day-of notice sent for real events.

Figure 4-26. Theoretical Event Impacts per Device by Month (Simulated Event Window of 5-7 p.m.)



Note: Numbers in parantheses represent the average number of enrolled EVSEs with telemetry data.

Source: Guidehouse analysis of EVSE vendor data

Guidehouse calculated the percent decrease between theoretical impacts shown in Figure 4-26 for the months with data before and during the pandemic to directly compare changes by month. The months included in this comparison are months from August 2019 to February 2020 and August 2020 to February 2021. The percent decrease of potential impacts from each month's first occurrence in 2019-2020 to its second occurrence in 2020-2021 averaged 32% and ranged from 13-53%.

4.6 Literature Review

This section summarizes key findings related to Guidehouse's literature review for this evaluation. Guidehouse developed an interim memorandum summarizing the results of the 2019 process evaluation, which included secondary research of managed charging programs administered by other utilities.[27] This section describes Guidehouse's interviews with managed charging program managers in December 2020 and January 2021.

Table 4-7 shows that all but one of the managed charging programs described in this section are active/ongoing programs (as of January 2021). The only interview that related to a pilot that was no longer running was that with Potomac Electric Power Company (Pepco).

[27] *2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings*, July 6, 2020. https://ma-eeac.org/wp-content/uploads/2019-Eversource-EVSE-DLC-Process-Evaluation-Memo-2020-07-06-FOR-PUBLICATION.pdf

Table 4-7. Managed Charging Program Manager Interviews

Utility	State	Year(s)	Program Description	Approximate Program Size
Austin Energy	TX	2017-Present	Residential EVSE rebate and EV TOU	100
Potomac Electric Power Company (Pepco)	MD	2014-2016	Residential managed charging programs (EVSE DR and TOU)	100 (35 customers with smart EVSEs)
Green Mountain Power (GMP)	VT	2018-Present	Residential EVSE DR program	400
Massachusetts Municipal Wholesale Electric Company (MMWEC)	MA	2017-Present	Residential EVSE DR program	100
Pacific Gas & Electric Company (PG&E)	CA	2020-Present	Multi-unit dwelling (MUD) and Workplace Charge Network program	200 (35 enrolled in DR portion)

Source: Guidehouse

4.6.1 Key Findings

- Utilities across the US are experimenting with a variety of managed charging solutions (including direct load control and pricing-based solutions) for electric vehicles to achieve goals for peak load reduction or load shifting. **No single program design or technology platform has been identified as the model that will ultimately become the industry favorite.**
- Of the five utilities interviewed, **several offer customers a choice between TOU and active managed charging** program channels for EV load reduction efforts.
- **The interviewed utilities take different approaches to vendor partnerships, with no clear winner.** Equipment choice is influenced by existing systems/platforms at each utility. Submetering EV load allows integration into existing billing systems, charging data collection, EVSE performance validation, and customer education.
- All of the utilities mentioned the importance of **supporting and educating customers** to the program's success.
- The early managed charging pilots and programs administered by the five interviewed utilities have shown potential and achievement of their load reduction goals, but challenges **related to equipment connectivity need to be addressed before these programs can achieve the scale and dispatchability that utilities may ultimately want.**
- Many utilities are planning for, or are deploying, managed charging-capable infrastructure with **the intent of offering future DR programs.**

4.6.2 Literature Review Results

Findings from the interviews conducted with program managers of five managed EV charging programs across the country are broken out into the following topics: program logistics, best practices/lessons learned, program feedback and impacts, and future outlook.

4.6.2.1 Program Logistics

In terms of program offerings, several utilities offer customers a choice between TOU and active managed charging program channels for EV DR participation. Peak load reduction and renewables absorption are some of the primary use cases for managed charging programs among the utilities interviewed.

Table 4-8. Program Options and Use Cases

Utility	Program Options	Managed Charging Use Case
Austin Energy	1. Subscription (flat rate) TOU with on-peak price adder 2. EVSE rebate with 3-year agreement to participate in future managed charging	Peak reduction, absorption of renewables.
Pepco (prior pilot)	1. Whole-Home TOU 2. EV-only TOU, with curtailment events of 80% reduction in charging kW	Peak reduction, combine EV DR with capacity from other DLC technologies for PJM*.
GMP	1. TOU 2. Flat rate for unlimited charging with agreement to participate in managed charging with 100% curtailment (critical peak pricing for opt-outs)	Scheduled around monthly/annual peak transmission events. Considering optimizing on wholesale pricing.
MMWEC	Daily active curtailment to 1.25 kW (3-year commitment)	Peak reduction.
PG&E	Day-ahead TOU with optional enrollment in active managed charging pilot	Day-ahead load management and absorption of renewables.

PJM = regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia.

Source: Interviews with managed charging program managers that took place in December 2020 and January 2021.

The interviewed utilities take different approaches to vendor partnerships, with no clear winner. Equipment choice is influenced by existing systems/platforms at each utility. Submetering EV load allows integration into existing billing systems, charging data collection, EVSE performance validation, customer education.

Table 4-9. Equipment and Vendors Leveraged

Utility	Equipment	Vendor Model
Austin Energy	EVSE plus second meter	• TOU - Utility submeter allows customer to install any L2. • EVSE Rebate – tiered incentive for Wi-Fi vs non-connected charger. • No EVSE vendor, just installation partners.
Pepco (prior pilot)	EVSE plus second meter	Single vendor as aggregator for multiple EVSE.
GMP	EVSE only	EVSE must be compatible with Virtual Peaker DRMS (2 vendors currently).
MMWEC	EVSE only	• Single vendor • Considering future integration with Virtual Peaker to allow multiple vendors and coordination with other DLC technologies.
PG&E	EVSE only	• Multiple EVSE vendors, must be compliant with OpenADR 2.0. • Different approaches to communicating with site host.

Source: Interviews with managed EV charging program managers that took place in December 2020 and January 2021.

The interviewed utilities also take different approaches to event control. Several utilities send event notification 24 hours in advance.

Table 4-10. Event Control

Utility	Control	Event Timing
Austin Energy	N/A	N/A
Pepco (prior pilot)	• Pepco has some control by requiring OCPP* compliant devices. • Events scheduled 24hours in advance with opt-out via button on EVSE or online portal.	Most events were called between 4 p.m. and 6 p.m., but some from 2 p.m. to 6 p.m.
GMP	• GMP schedules events using Virtual Peaker, alongside other DLC resources. • 24-hour notification via text/email.	4-hour events targeted at peak transmission events.
MMWEC	• MMWEC staff uses an EV service provider (EVSP) network to schedule daily events (same staff that schedule other DLC program events). • No notification because of daily events.	Events are called on every non-holiday weekday from 5 p.m. to 9 p.m.
PG&E	PG&E sends day-ahead price signal to EVSPs, EVSPs communicate with site hosts 24 hours in advance (curtailment notice pushed).	N/A

*Note: OCPP = Open Charge Point Protocol.
Source: Interviews with managed charging program managers that took place in December 2020 and January 2021.

4.6.2.2 Best Practices/Lessons Learned

All of the utilities mentioned the importance of supporting and educating customers to the success of the program. Table 4-11 includes these takeaways.

Table 4-11. Best Practices and Lessons Learned

Utility	Key Takeaway	Description
Austin Energy	Focus on communication	• Develop a network of qualified charging station installers (maintain for future program expansion). • Foster good communication with installers and customers to reduce confusion down the line.
Pepco (prior pilot)	Focus on customer feedback	• Educate customers about the peak period, when they should aim to charge their EVs, and the value of EVs in the context of DR. • Pepco created a customer advisory council early on in their DR programs which helped engage customers. • Expand your field of vision into associated policy issues and think through possible side effects when creating a program (interaction with solar stakeholders will occur for any TOU program).
GMP	Be prepared to support customers	• Technical issues will often require utility support and may become time intensive. GMP has used a call center in the past to provide customer support.
MMWEC	Make enrollment and participation clear and easy	• Simplify the enrollment process and participation experience and be clear about program requirements. • Be available to answer customer questions, particularly about enrollment and setting up their charger. MMWEC developed a set of documents to walk customers through the enrollment and installation processes.
PG&E	Focus on user experience	• Explain the program and its benefits in simple and clear terms. • Focus on user experience to make it conducive to changing customer behavior (minimally invasive). • TOU rates are likely the best and easiest way to control charging behavior and encourage customer engagement. A clear price signal provides stability and clarity to the customer.

Source: Interviews with managed charging program managers that took place in December 2020 and January 2021.

The most common technical challenge cited by the utilities interviewed was issues with device connectivity. Table 4-12 notes other challenges.

Table 4-12. Greatest Challenges

Utility	Key Takeaway	Description
Austin Energy	Communication issues	• Found there was lot of early confusion and disconnect between utility, EVSE installers, and customers. Engaging with EVSE installers has been a worthwhile investment.
Pepco (prior pilot)	Connectivity issues and significant data loss	• Faced technical difficulties with their meters and lost a lot of data due to connectivity issues (experimented with Wi-Fi, cellular, Zigbee). • Noted that some locations have less coverage, so meters would randomly disconnect, or data would not load properly to the Cloud.
GMP	Connection issues	• Did not experience many technical issues during events due to 24-hour advanced event scheduling, but they did experience Wi-Fi connection issues frequently (billing is trued up during next billing cycle after EVSE reconnects). • The larger issue is the amount of time used to help customers reconnect.
MMWEC	Connection issues	• Has encountered glitches in customer internet where connection to charging equipment was lost. This has sometimes required the customer to reenroll their charger on the network which requires utility assistance.
PG&E	Enrollment challenges	• Had a difficult time getting customers to understand the program and enroll (hesitation by MUD and workplace site hosts to engage with complex program dashboard). • Scheduling events 24-hour in advance helps mitigate technical issues during event.

Source: Interviews with managed EV charging program managers that took place in December 2020 and January 2021.

4.6.2.3 Program Feedback and Impacts

All of the utilities were able to achieve their load reduction goals.

Table 4-13. Participant Feedback and Impacts

Utility	Feedback/Impact
Austin Energy	• Successfully reduced peak load • 99% of customers complied with the off-peak charging schedule • Customers have been satisfied with the program and there is now a waitlist of over 600 customers

Utility	Feedback/Impact
Pepco (prior pilot)	• Successfully reduced peak load • Most customers did not plug in during peak times regardless of events • Over 90% of customers saved money on charging through the program • Customers responded very positively and liked having a second bill for EV charging so they could see how much money they were saving
GMP	• Successfully reduced load around monthly/annual peak transmission events • Only had a 2% event opt-out rate • Very few customers on the non-managed TOU rate charged during peak periods • Curtailment impacts have generally not exceeded 1.4 kW per charger, and usually about 1.0 kW per charger
MMWEC	• Successfully reduced peak load with daily events • Customers have been satisfied with the program
PG&E	• Unable to evaluate program impacts yet due to the significant impacts of COVID-19

Source: Interviews with managed charging program managers that took place in December 2020 and January 2021.

4.6.2.4 Future Outlook

Utility planning is driven by market conditions, regulatory direction, and early learnings from managed charging programs.

Table 4-14. EV Managing Charging Interviews - Future Outlook

Themes	Future Plans
Leveraging Early Program Experience	Pepco was an early utility to experiment with active managed charging and is rolling out a new and expanded program. Curtailment will be managed in-house using OCPP-compliant EVSE, with ability for full curtailment and throttling to percentage of charger kW. Austin Energy is using submeter data from current subscription program to assess charging baseline and inform future managed charging solutions.
Systems Integration and Control	Pepco is comparing EVSE data with submeter data to assess suitability of EVSE for billing. MMWEC considering use of virtual peaker to manage EV load along with other DLC devices (GMP is already using virtual peaker for EV and other technologies). PG&E relies heavily on EVSPs for customer interaction (enables different business models).
Workplace and MUD	Many of PG&E's EV customers are already on residential EV rate, and current pilot is about optimizing workplace/multi-unit dwelling (MUD) charging. Austin Energy has designed the EVSE rebate program to enable future workplace managed charging and may engage with corporate sustainability staff from participants of rebate program. GMP is pursuing workplace charging programs but will not include managed charging component because timing does not align with system needs (e.g., aligns with solar production).
Altering Rates via Behavior vs. Active Management	Many utilities are deciding whether TOU rate design is sufficient or whether active curtailment yields better results. Navigating regulatory landscape may determine program direction (e.g., stakeholder intervention may differ between TOU and active curtailment programs). Consider alternative program pathways – Pepco received U.S. Department of Energy grant to experiment with public/workplace managed charging outside of programs approved by regulators.

Source: Interviews with managed charging program managers that took place in December 2020 and January 2021.

5. Findings and Considerations

Key findings from each research activity, along with key considerations for the program, are summarized in the tables below.

Table 5-1. Key Findings – Customer Experience Research

Research Category	Findings
Participant EV Characteristics	• **The number of respondents with only EVs for their household increased steadily** between the 2019 post-summer and 2021 post-winter surveys.
	• For all three surveys, a **greater share of respondents had BEVs than PHEVs**.
	• **Respondents' BEVs skew newer than respondents' PHEVs suggesting a trend towards purchase of BEVs.** BEVs generally have higher battery capacities than PHEVs. Additionally, newer EVs tend to have higher battery capacities than older ones.
Motivations and Enrollment	• Helping the environment was the most commonly cited as the primary motivator to purchase an EV, while **program incentives was most commonly cited as the top reason for enrolling in the program**. 88 of 150 respondents (59%) who had purchased a new charger around the time of enrolling in the program became aware of the program before purchasing the new charger. Of the respondents who became aware of the program prior to purchasing a new charger, 84% reported being at least partially influenced by the program to buy the new charger.
	• Over half of respondents who purchased a new charger did not have a charger at home prior to enrolling in the program, likely due to having recently purchased their EV. Another **one-third replaced a Level 1 charger**.
	• The vast majority of respondents were **satisfied with the enrollment process**.
Driving and Charging Behavior	• **Large changes in 2020 also correlated with how respondents used their EVs on weekdays.** Those who used their EV on a regular schedule (e.g., work commuting) during summer months declined from approximately 80% to 40% between the 2019 post-summer and 2020 post-summer surveys. The COVID-19 pandemic is likely a major contributor to this EV usage change.
	• **About half of respondents reported connecting their EV to a charger whenever it is not in use.** Twenty per cent (20%) of respondents indicated they only connect when the battery is low, and another 15% generally have it connected overnight.
	• Consistent across surveys, the **most common times for respondents to have their EVs connected to chargers was on weekdays between 6 p.m. and 6 a.m.**
	• Two-thirds of respondents let their EV fully charge every time it is connected to their home charging station, and **20% reported using scheduled charging through an app**. Common scheduled start times ranged from 9 p.m.–1 p.m. on weekdays.

	• One-quarter of respondents to the 2021 post-winter survey indicated that **the program influenced their charging schedule**, with some choosing to charge during off-peak hours on a regular basis to align with program goals.
	• **It is likely that COVID-19 impacted respondents' use of workplace charging.** During the 2019 post-summer survey, 19% of those who had access to workplace charging reported never using it, while this increased to 52% in the 2020 post-summer survey, as more respondents worked remotely.
Event and Overall Program Experience	• Nearly all of respondents who recalled at least one event said the **events had no impact on their charging or driving behavior. Only three 2021 post-winter survey respondents recalled opting-out or overriding an event**.
	• **Satisfaction with the program is very high**, with 96% of respondents reporting that they are likely to continue participating in the future.

Source: Guidehouse

Table 5-2. Key Findings – Assessment of Charging Profiles

Research Category	Findings
Non-Event Day Charging Behavior	• **Peak charging occurs between 5 p.m. and 9 p.m. on weekdays.** An average of 16%-19% of EVSEs were simultaneously charging during this period from August 2019–February 2020. The percentage of EVSEs charging during these hours dropped to 8%-9% from March 2020–September 2020 and climbed back to 11%-13% from October 2020–March 2021. The decreased number of EVs charging on average during evening hours led to fewer potential participants in the two impact analysis periods that occurred during the pandemic.
	• Across all three analysis periods, **the single weekday hour with the most energy consumed, on average, was 11 p.m.–12 a.m.**, primarily due to a concentration of scheduled charging sessions starting at 11 p.m. One likely explanation for the 11 p.m. scheduled start time: EVSE vendor A (with the most enrolled EVSEs) had a default start time of 11 p.m. for users scheduling charging sessions in Eversource's service territory. **29% of customers used scheduled charging in some capacity from August 2019–March 2021.**
	• **Charging was complete for 60% of charging sessions within 2 hours and 89% were complete within 4 hours.** This translates to the finding that longer event windows will likely have a negligible impact on the ability for vehicles to finish charging overnight.
	• **Enrolled customers decreased their frequency of charging after February 2020, likely largely due to the COVID-19 pandemic.** Of EVSEs, 50% had two or fewer charging sessions per week from March 2020 to September 2020, compared with 28% before March 2020, pre-pandemic winter.
	• **Device power draw was not affected by changes in outdoor temperature.** EVSEs that were located outside or in an unheated garage did not have any clear changes in power draw as outdoor temperature changed

Source: Guidehouse

Table 5-3. Key Findings – Event Behavior & Impacts

Research Category	Findings
Event Participation	• **In all periods and for all events, most devices were unplugged during the event and did not participate.** In all periods, less than 30% of devices on average were fully or partially participating. Participation was lowest in the June–September 2020 impact analysis period, where only 4% of devices on average fully participated compared to 18% in the August–October 2019 impact analysis period and 11% in the October 2020–March 2021 impact analysis period.
	• **Events did not prevent participants from reaching a full state of charge.** On non-event weekdays, devices fully charged in slightly over 85% of sessions, compared to 85% of sessions on event days.
Impacts	• **Variety in event timing and participation makes it difficult to isolate factors contributing to differences in impacts between impact analysis periods.** As Table 4-4 shows, events were called at different hours, different days of the week, and lasted for differing amounts of time. In addition, there were changes in max observed power draw of participants, non-event day charging behavior, and participation rates during events.
	• **Period-average demand impacts for all devices ranged from 0.11 kW to 0.26 kW across the three analysis periods.** The average engineering approach impacts by impact analysis period were 0.26 kW for August 2019–October 2019, 0.11 kW for June 2020–September 2020, and 0.25 kW for October 2020–March 2021.
	• **Demand impacts were low during the June 2020–September 2020 impact analysis period due to low participation rates.**
	• **Period-average demand impacts for *participating devices* ranged from 0.92 kW to 1.38 kW.** The average engineering approach impacts by impact analysis period for *participating devices only* were 0.92 kW for August 2019–October 2019, 0.99 kW for June 2020–September 2020, and 1.38 kW for October 2020–March 2021.
	• **Average impacts among participating devices were highest in the most recent impact analysis period (October 2020–March 2021).** This was in part due to higher maximum observed power draw in the population. The earliest impact analysis period had no participating EVSEs with maximum observed power draw greater than 8 kW, whereas the most recent had five devices.
Potential Curtailable Load	• If peak charging returns to pre-pandemic level where an average of 19% of users simultaneously charged during peaks, the **potential curtailable load (based on devices enrolled as of March 2021) could be approximately 386 kW for weekday evening events.** If peak charging does not reach or exceeds the pre-pandemic level of 19% of EVSEs charging simultaneously, the potential curtailable load could be approximately 305 kW at 15% or 508 kW at 25%.
Simulated Impacts	• **Theoretical event impacts decrease after February 2020 because of changes in charging behavior, assumed to be due primarily to the COVID-19 pandemic.** Months with data before and during the pandemic had an average 32% decrease of theoretical impacts year-over-year for events simulated from 5 p.m.–7 p.m.

Source: Guidehouse

Table 5-4. Key Findings – Literature Review

Research Category	Findings
Managed Charging Offerings	• Utilities across the US are experimenting with a variety of managed charging solutions (including direct load control and pricing-based solutions) to achieve goals for peak load reduction or load shifting. **No single program design or technology platform has been identified as the model that will ultimately become the industry favorite.**
	• Of the five utilities interviewed, **several offer customers a choice between TOU and active managed charging** program channels for EV load reduction efforts.
Vendor Partnerships	• **The interviewed utilities take different approaches to vendor partnerships, with no clear winner.** Equipment choice is influenced by existing systems/platforms at each utility. Submetering EV load allows integration into existing billing systems, charging data collection, EVSE performance validation, and customer education.
Lessons Learned	• All of the utilities mentioned the importance of **supporting and educating customers** to the program's success.
	• The early managed charging pilots and programs administered by the five interviewed utilities have shown potential and achievement of their load reduction goals, but challenges **related to equipment connectivity need to be addressed before these programs can achieve the scale and dispatchability that utilities may ultimately want.**
Future Outlook	• Many utilities are planning for or are deploying managed charging-capable infrastructure with **the intent of offering future DR programs.**

Source: Guidehouse

Table 5-5. Key Findings – Considerations

Research Category	Considerations
Impacts	• **Consideration 1:** When the EVSE DLC demonstration becomes a program and/or in implementing additional managed charging program designs, continue to monitor the effects of the program on participants' charging behavior on all days (not just event days) through surveys and other methods, as possible. Develop a method of evaluating this type of behavioral effect to enable Eversource to claim the savings associated with participants choosing to charge during off-peak hours as a result of their participation in the program.
Program Design	• **Consideration 2:** Consider offering a behavioral program pathway that educates customers about the benefits of charging off-peak and offers a modest incentive to follow an off-peak charging schedule (e.g., default charging schedule on EVSE app that begins at 11 p.m. on weekdays).
Program Design	• **Consideration 3:** Continue to track the use of scheduled charging. Customers using a schedule, who were not influenced to do so by the program, will typically not contribute to peak demand and may be program free riders.
Program Design	• **Consideration 4:** Consider assessing the default charging schedules on EVSE apps may have in the future of creating a smaller secondary peak. Assess whether there should be an effort to change defaults (perhaps random starts between 10 p.m. and 4 a.m.) or an effort to educate customers to change their schedule time as starts between these times but not at the default given in the app.
Impacts	• **Consideration 5:** Develop a framework that establishes baseline charging behavior and how the changes to charging behavior as a result of different programs (e.g., DLC, behavior, rate) should be accounted for.
Program Design	• **Consideration 6:** Depending on Eversource's load management goals, consider changing the program to use longer events (3-4 hours) or shut off charging entirely for a two-hour event window. Most EV charging sessions finish in under two hours and could potentially be throttled more without customer satisfaction issues.
Impacts	• **Consideration 7:** As EVs with high maximum observed power draw (i.e., greater than 8 kW) account for an increasing share of enrolled participants' EVs, average impacts per EVSE are expected to increase. Continue to monitor the observed maximum power draw of enrolled participants through charging telemetry data.
Effects of Seasons	• **Consideration 8:** Consider conducting future research to further explore the effect of seasons on EV charging behavior (e.g., range effects of heating/cooling of the EV, changes in driving behavior due to weather).
Effects of COVID-19	• **Consideration 9:** Continue to track differences in charging behavior, event participation, and impacts across seasons as COVID-19 pandemic and its consequences continue to evolve, including work location, work travel requirements, employment, economy, among others. (Whether to follow-through on this consideration may hinge on assessing the value of doing so versus the costs that would be required.)

Source: Guidehouse

Appendix A. Participant Survey Instruments

A.1 2019 Participant Survey Instrument

[Survey start] Eversource thanks you for participating in ConnectedSolutions EV Home Charger Demand Response Program this year. In an effort to improve the program and its ability to reduce strain on the electricity grid during periods of peak demand, we have some questions related to your experiences in the program and your household's charging and driving behavior in general. If you cannot complete the survey all at one time or you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking on the link from this email.

A.1.1 Enrollment

Q1. What was your top motivation for enrolling in Eversource's ConnectedSolutions Electric Vehicle Home Charger Demand Response Program?

[Response order for options A through D randomized for each respondent]

A. Receive incentives
B. Reduce my/our environmental impact
C. Reduce the need for additional power plants
D. Support my/our community and/or state's energy initiatives
E. Other (please specify)

Q2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? Select all that apply.

A. Eversource email
B. Eversource website
C. Eversource other (please specify)
D. **[EVSE_MANUFACTURER]** email
E. **[EVSE_MANUFACTURER]** website
F. **[EVSE_MANUFACTURER]** app
G. **[DRMS_PROVIDER]** website
H. Friend/family/neighbor
I. Other (please specify)
J. Not sure

Q3. Has enough information been provided to you about the program?

A. Yes, I have received enough information about the program.
B. No, I have not received enough information about the program.

[If Q3 is B, continue. Otherwise, skip to Q5]

Q4. What additional information would you like to see? (open-ended)

Q5. Did you encounter any challenges or difficulties during the enrollment process?

A. Yes, I encountered challenges during the enrollment process.
B. No, I did not encounter any challenges during the enrollment process.

[If Q5 is A, continue. Otherwise, skip to Q7]

Q6. What challenges or difficulties did you encounter during the enrollment process? (open-ended)

Q7. Using a scale of 1 to 5 where 1 indicates “Very Unsatisfied” and 5 indicates “Very Satisfied,” how satisfied were you with the process of enrolling in the program?

a. Very Unsatisfied 1	b. 2	c. 3	d. 4	e. Very Satisfied 5

[If Q7 is A or B (1 or 2), continue. Otherwise, skip to Q8_1]

Q8. What was less than satisfactory about the enrollment experience? (open-ended)

Q8_1. Approximately when did you purchase the charger that you enrolled in the program? (e.g., “May 2019”)

A. Approximate purchase date (prompts entry)
B. Don’t know

Q8_2. Did the program influence your decision to purchase the new charger?

A. Yes, I purchased the new charger because of this program.
B. No, I did not purchase the new charger because of this program.

A.1.2 EV Characteristics and Driving Behavior

Q9_0. How many licensed drivers are there in your household? (open-ended)

Q9. Please indicate the number of each type of vehicle your household owns. Enter 0 if you do not have that type of vehicle.

Vehicle Type	Number in Household
a. Battery electric vehicle (BEV)	**[numeric]**
b. Plug-in hybrid electric vehicle (PHEV)	**[numeric]**
c. Other (including non-plug in hybrid and gasoline consuming vehicles)	**[numeric]**

[If Q9a = 1, continue. Otherwise, skip to Q9_2]

Q9_1. Please provide the make, model, and year for your battery electric vehicle (BEV).

# of Battery electric vehicles (BEV)	Make	Model	Year
BEV #1	**[text]**	**[text]**	**[numeric]**

[If Q9a = 2, continue. Otherwise, skip to Q9_3]

Q9_2. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	Make	Model	Year
BEV #1	**[text]**	**[text]**	**[numeric]**
BEV #2	**[text]**	**[text]**	**[numeric]**

[If Q9a = 3, continue. Otherwise, skip to Q9_4]

Q9_3. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	Make	Model	Year
BEV #1	**[text]**	**[text]**	**[numeric]**
BEV #2	**[text]**	**[text]**	**[numeric]**
BEV #3	**[text]**	**[text]**	**[numeric]**

[If Q9a > 3, continue. Otherwise, skip to Q9_5]

Q9_4. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	**Make**	**Model**	**Year**
BEV #1	**[text]**	**[text]**	**[numeric]**
BEV #2	**[text]**	**[text]**	**[numeric]**
BEV #3	**[text]**	**[text]**	**[numeric]**
BEV #4	**[text]**	**[text]**	**[numeric]**

[If Q9b = 1, continue. Otherwise, skip to Q9_6]

Q9_5. Please provide the make, model, and year for your plug-in hybrid electric vehicle (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make**	**Model**	**Year**
PHEV #1	**[text]**	**[text]**	**[numeric]**

[If Q9b = 2, continue. Otherwise, skip to Q9_7]

Q9_6. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make**	**Model**	**Year**
PHEV #1	**[text]**	**[text]**	**[numeric]**
PHEV #2	**[text]**	**[text]**	**[numeric]**

[If Q9b = 3, continue. Otherwise, skip to Q9_8]

Q9_7. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make**	**Model**	**Year**
PHEV #1	**[text]**	**[text]**	**[numeric]**
PHEV #2	**[text]**	**[text]**	**[numeric]**

PHEV #3	**[text]**	**[text]**	**[numeric]**

[If Q9b > 3, continue. Otherwise, skip to Q9_9]

Q9_8. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make**	**Model**	**Year**
PHEV #1	**[text]**	**[text]**	**[numeric]**
PHEV #2	**[text]**	**[text]**	**[numeric]**
PHEV #3	**[text]**	**[text]**	**[numeric]**
PHEV #4	**[text]**	**[text]**	**[numeric]**

[If Q9a + Q9b > 1, continue. Otherwise, skip to Q10]

Q9_9. Of the electric vehicles you listed, please identify the electric vehicle whose driving and charging schedule you are most familiar with. **[PIPED IN RESPONSE OPTIONS BASED ON PREVIOUS QUESTIONS, REQUIRED]**

Please answer the remaining questions thinking about this electric vehicle.

Q10. Does your electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the summer (June through August)?

A. Yes
B. No

Q11. What was your household's top motivation for buying the electric vehicle?

[Response order for options A through F randomized for each respondent]

A. We/I wanted to save money
B. We/I wanted to help the environment
C. There were rebates available (please specify)
D. We/I wanted the latest technology
E. It fits with my/our lifestyle
F. For comfort reasons
G. Other (please specify)

Q13. Which of the following best describes how your household *typically* uses your electric vehicle on weekdays (M-F) during the summer (June through August)? Select all that apply.

A. I or another member of my household uses it on a regular schedule (e.g., to and from work)
B. I or another member of my household uses it as needed (e.g., to complete errands)
C. No one from my household uses it on weekdays
D. Other (please describe)

Q14. Ignoring short-term vacations (< 2 weeks), is the total distance (miles) your electric vehicle is driven by you and other household members relatively constant across summer weekdays (M-F) or does it vary?

A. The distance that our electric vehicle is driven is relatively constant from day-to-day across summer weekdays (M-F)
B. The distance that our electric vehicle is driven varies depending on the particular weekday
C. The distance that our electric vehicle is driven varies depending on the month
D. Other (please describe)

[If Q14 is A, continue. Otherwise, skip to Q16]

Q15. During a *typical* summer weekday (M-F), on average, how many miles is your electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for miles driven per day.

A. 0-10 miles
B. 11-20 miles
C. 21-30 miles
D. 31-50 miles
E. 51-70 miles
F. 71 to 100 miles
G. 101 to 150 miles
H. More than 150 miles

[If Q14 is B, continue. Otherwise, skip to Q17]

Q16. During a *typical* summer week, on average, how many miles is your electric vehicle driven by you and other members of your household on each weekday? Don't worry about being exact – just provide your best estimate for miles driven per day.

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
a. 0-10 miles b. 11-20 miles c. 21-30 miles d. 31-50 miles e. 51-70 miles f. 71-100 miles	a. 0-10 miles b. 11-20 miles c. 21-30 miles d. 31-50 miles e. 51-70 miles f. 71-100 miles	a. 0-10 miles b. 11-20 miles c. 21-30 miles d. 31-50 miles e. 51-70 miles f. 71-100 miles	a. 0-10 miles b. 11-20 miles c. 21-30 miles d. 31-50 miles e. 51-70 miles f. 71-100 miles	a. 0-10 miles b. 11-20 miles c. 21-30 miles d. 31-50 miles e. 51-70 miles f. 71-100 miles

g. 101-150 miles h. > 150 miles	g. 101-150 miles h. > 150 miles	g. 101-150 miles h. > 150 miles	g. 101-150 miles h. > 150 miles	g. 101-150 miles h. > 150 miles

[If Q14 is C, continue. Otherwise, skip to Q18]

Q17. Please describe how the miles your electric vehicle is driven by you and other members of your household varies by month during the summer. (open-ended)

A.1.3 Charging Behavior

Q19. When your electric vehicle is home and is not being used, is it typically connected to your home charging station?

A. Yes, I/we typically always have the electric vehicle connected to home charging station when not using the electric vehicle
B. No, I/we only connect the electric vehicle to home charging station at select times. (please describe)
C. Other (please specify)
D. Not sure

Q20. Which of the following best describes your household's use of your home charging station for your electric vehicle?

A. Whenever the electric vehicle is connected to our home charging station, it charges until it is fully charged.
B. I/We use the **[EVSE_MANUFACTURER]** app to remotely start and stop charging of the electric vehicle.
C. I/We follow a charging schedule that I/we have set using the **[EVSE_MANUFACTURER]** app.
D. Other (please specify)

Q22. Below, please indicate the time ranges during which your electric vehicle is typically connected to your *home charging station* on weekdays (M-F) during the summer. For each day, select all the time ranges that apply. As an example, if on Mondays, you typically disconnect your EV at 8:30 AM to go to work and then you connect your EV again when you return home at 6:30 PM (leaving it connected until the following morning), you would select the ranges 12 AM – 3 AM, 3 AM – 6 AM, 6 AM – 9 AM, 6 PM – 9 PM, 9 PM – 12 AM in the Monday row.

A. [Table]

Monday	Tuesday	Wednesday	Thursday	Friday
1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use home charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use home charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use home charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use home charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use home charger on this day

B. It varies depending on the month
C. Not sure

Q22_1. Do you or other members of your household have access to charging at a workplace?

A. Yes
B. No
C. Not applicable / don't work

[If Q22_1 is A, continue. Otherwise, skip to Q24]

Q23_0. Approximately what percentage of your household's EV charging occurs at a workplace?

A. 0%
B. 1-25%
C. 25-50%
D. 50%-75%
E. >75%

[If Q23_0 is A, continue. Otherwise, skip to Q23]

Q23_00. Why isn't your household's EV ever charged at a workplace? (open-ended)

[If Q23_0 is not A, continue. Otherwise, skip to Q24]

Q23. Below, please indicate when your electric vehicle is typically connected to a workplace charging station on weekdays (M-F) during the summer. For each day, select all the time ranges that apply. As an example, if on Mondays, you typically connect your EV to a workplace charging station around 3 pm and disconnect when you leave to return home at 5:30 PM, you would select the range 3 PM – 6 PM in the Monday column.

A. [Table]

Monday	Tuesday	Wednesday	Thursday	Friday
1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use workplace charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use workplace charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use workplace charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use workplace charger on this day	1. 12 AM – 3 AM 2. 3 AM – 6 AM 3. 6 AM – 9 AM 4. 9 AM – 12 PM 5. 12 PM – 3 PM 6. 3 PM – 6 PM 7. 6 PM – 9 PM 8. 9 PM – 12 AM 9. Do not use workplace charger on this day

B. It varies depending on the month
C. Not sure
D. Not applicable

[If Q23 is not ALWAYS 9 (“do not use”) or Q23 is not D, continue. Otherwise, skip to Q24]

Q23_1. What are your motivations for using *workplace charging stations*? (open-ended)

Q23_2. Are they any barriers for you or your household members to use *workplace charging stations* to charge your electric vehicle? (open-ended, optional)

Q24. Please briefly describe how frequently and for how long you typically use *public charging stations* during the typical summer weekday (e.g., twice per week for about an hour each time)?

A. Please describe
B. I rarely/never use public charging stations on weekdays during the summer

A.1.4 Behavior During Events

[If the enroll date is before the most recent event, continue. Otherwise, skip to Q44.]

Q25_A. The Eversource ConnectedSolutions EV Home Charger Demand Response Program rewards you for using less energy during periods of peak demand, when others are using more (aka “Events”). During Events, Eversource makes slight adjustments to decrease your charger’s energy use. Your vehicle charges more slowly, but you stay in control. How many events do you recall since enrolling? (open-ended)

[If Q25_A > 0, continue. Otherwise, skip to Q41]

Q25_B. Since enrolling, did you ever receive advance notifications about Events?

A. Yes
B. No

[If Q25_B is A, continue. Otherwise, skip to Q25]

Q25_C. How were you notified in advance that an Event was going to occur? Select all that apply.

A. Email
B. **[EVSE_MANUFACTURER]** app
C. Other (please specify)
D. Don't know

Q25_D. Are there ways that Event notification could be improved? (open-ended, optional)

Q25. Since enrolling, for the Events you can recall, how often was your BEV/PHEV connected to your home charging station during Event hours?

A. Connected for all Event hours
B. Connected for most Event hours
C. Connected for some Event hours
D. Never connected during Event hours
E. Don't know

Q26. Please indicate how the Events affected your normal charging and/or driving behavior. Select all that apply.

A. No impacts
B. Had to modify charging schedule to make sure my vehicle was charged for when it was needed (please specify)
C. Went elsewhere during the event to charge my BEV/PHEV (e.g., public or workplace charging)
D. Had to defer or reschedule activities so we/I could wait to charge the BEV/PHEV after the Event
E. Other (please specify)
F. Don't know

Q27. Did your household take any other actions in response to being notified that an Event was going to occur? (open-ended, optional)

Q28. On Event days, did you ever "opt-out" or override your home charger setting to stop the program from adjusting your charging during the Event (either through the app or on the device itself)?

A. Yes
B. No
C. Don't know

[If Q28 is A, continue. Otherwise, skip to Q35]

Q29. How often would you say you chose to override the scheduled Event charging setting once the Event was in-progress? Would you say…

A. Every Event
B. Most Events
C. Some Events
D. Rarely
E. Never
F. Unsure/Don't know

[If Q28 is A and Q29 is not E, continue. Otherwise, skip to Q35]

Q31. For what reason(s) did you opt-out or override the charging setting during the Event(s)? (open-ended)

Q32. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override Events?

A. Very Difficult or Confusing	B.	C. Neutral	D.	E. Very Easy	F. Don't know

[If Q32 is A or B (1 or 2), continue. Otherwise, skip to Q35]

Q33. What issues did you encounter when trying to opt-out or override a scheduled Event(s)? (open-ended)

A.1.5 Program Satisfaction

Q35. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the following aspects of the Eversource ConnectedSolutions EV Home Charger Demand Response Program to-date?

	A. Very Dissatisfied	B.	C. Neutral	D.	E. Very Satisfied	F. Don't know
	1	2	3	4	5	
35b. Number of Events						
35c. Length of Events						
35d. Timing of Events (i.e., what period during the day events occurred)						

[If Q35b is A or B (1 or 2), continue. Otherwise, skip to Q37]

Q36. Please let us know why you are not satisfied with the number of Events. (open-ended)

[If Q35c is A or B (1 or 2), continue. Otherwise, skip to Q38]

Q37. Please let us know why you are not satisfied with the length of Events. (open-ended)

[If Q35d is A or B (1 or 2), continue. Otherwise, skip to Q40]

Q38. Please let us know why you are not satisfied with the timing of Events. (open-ended)

Q40. How likely are you to continue to participate in the Eversource ConnectedSolutions EV Home Charger Demand Response Program, on a scale of 1-5, where 1 is “Very Unlikely” and 5 is “Very Likely”?

A. Very Unlikely 1	B. 2	C. 3	D. 4	E. Very Likely 5

[If Q40 is A or B (1 or 2), continue. Otherwise, skip to Q42]

Q41. What change(s) to the Eversource ConnectedSolutions EV Home Charger Demand Response Program would encourage you to continue participating? (open-ended, optional)

[If Q40 is C-E (3-5), continue. Otherwise, skip to Q43]

Q42. What recommendations would you make to help improve the Eversource ConnectedSolutions EV Home Charger Demand Response Program going forward? (open-ended, optional)

A.1.6 Closing

Q43. We have reached the end of the survey. Do you have any additional comments regarding the Eversource ConnectedSolutions EV Home Charger Demand Response Program? (open-ended, optional)

Q44. Thank you for taking the time to fill out this survey for the Eversource ConnectedSolutions EV Home Charger Demand Response Program! Please provide your email address so we may email you a $25 Amazon eGift Card.

A. Email (prompts entry)
B. I prefer not to provide my email address

[Survey close] Thanks again!

A.2 2020 Participant Survey Instrument

[Survey start] Eversource thanks you for participating in ConnectedSolutions EV Home Charger Demand Response Program this year. In an effort to improve the program and its ability to reduce strain on the electricity grid during periods of peak demand, we have some questions related to your experiences in the program and your household's charging and driving behavior in general. If you cannot complete the survey all at one time or you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking on the link from this email.

A.2.1 Enrollment

[If PAST RESPONDENT = 0, continue. Otherwise, skip to E10_1]

E1. What was your top motivation for enrolling in Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

[Response order for options A through E randomized for each respondent]

A. Receive incentives
B. Reduce my/our environmental impact
C. Reduce the need for additional power plants
D. Support my/our community and/or state's energy initiatives
E. Get a charger that charges my car more quickly
F. Other, please specify

E2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? Select all that apply.

A. Eversource email
B. Eversource website
C. Eversource other (please specify)
D. **[EVSE_MANUFACTURER]** email
E. **[EVSE_MANUFACTURER]** website
F. **[EVSE_MANUFACTURER]** app
G. **[DRMS_PROVIDER]** website
H. Friend/family/neighbor
I. Other (please specify)
J. Not sure

E3. Has enough information been provided to you about Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

A. Yes, I have received enough information about the program.
B. No, I have not received enough information about the program.

[If E3 is B, continue. Otherwise, skip to E5]

E4. What additional information would you like to see? (open-ended)

E5. Did you encounter any challenges or difficulties during the enrollment process?
A. Yes, I encountered challenges during the enrollment process.
B. No, I did not encounter any challenges during the enrollment process.

[If E5 is A, continue. Otherwise, skip to E7]

E6. What challenges or difficulties did you encounter during the enrollment process? (specify)

E7. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program?

a. Very Unsatisfied 1	**b. 2**	**c. 3**	**d. 4**	**e. Very Satisfied 5**

[If E7 is A or B, continue. Otherwise, skip to E9]

E8. What was less than satisfactory about the enrollment experience? (specify)

E9. Approximately when did you purchase the charger that you enrolled in Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (e.g., "May 2019")

A. Approximate purchase date (specify Month and Year)
B. Don't know

[If NEW CHARGER incentive or E9 > May 2019, continue. Otherwise, skip to EV1]

E10_1. At what point did you become aware of Eversource's ConnectedSolutions EV Home Charger Demand Response Program?
A. I became aware of the program *before* purchasing the charger.
B. I became aware of the program *during* the process of purchasing the charger.
C. I became aware of the program *after* purchasing the charger.

[If E10_1 is A, continue. Otherwise, skip to E11]

E10. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your decision to purchase the new charger?
A. Yes, I purchased the new charger because of this program.
B. Yes, I purchased the new charger in part because of this program.
C. No, I did not purchase the new charger because of this program.

E11. Which of the following best describes the charger that you owned prior to purchasing the Level 2 charger that is currently enrolled in program?

A. The enrolled charger replaced an existing Level 1 charger (i.e., a charger that plugged into a standard 120-volt outlet)
B. The enrolled charger replaced an existing Level 2 charger (i.e., a charger that plugged into a high-output 220/240-volt outlet)
C. I did not have a charger for use at home prior to purchasing the enrolled charger

A.2.2 EV Characteristics and Driving Behavior

EV1. How many licensed drivers are there in your household? (specify a number)

EV2. Please indicate the number of each type of vehicle your household owns. Enter 0 if you do not have that type of vehicle.

Vehicle Type	Number in Household
A. Battery electric vehicle (BEV)	**[numeric]**
B. Plug-in hybrid electric vehicle (PHEV)	**[numeric]**
C. Other (including non-plug in hybrid and gasoline consuming vehicles)	**[numeric]**

[If EV2A = 1, continue. Otherwise, skip to EV4]

EV3. Please provide the make, model, and year for your battery electric vehicle (BEV).

# of Battery electric vehicles (BEV)	Make and Model	Year
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a = 2, continue. Otherwise, skip to QEV5]

EV4. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	Make and Model	Year
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**
BEV #2	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a ≥ 3, continue. Otherwise, skip to QEV6]

EV5. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	**Make and Model**	**Year**
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**
BEV #2	**[DROP DOWN]**	**[DROP DOWN]**
BEV #3	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b = 1, continue. Otherwise, skip to QEV7]

EV6. Please provide the make, model, and year for your plug-in hybrid electric vehicle (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b = 2, continue. Otherwise, skip to QEV8]

EV7. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #2	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b ≥ 3, continue. Otherwise, skip to QEV9]

EV8. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #2	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #3	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a + EV2b > 1, continue. Otherwise, skip to EV10]

EV9. Of the electric vehicles you listed, please identify the electric vehicle whose driving and charging schedule you are most familiar with. **[PIPED IN RESPONSE OPTIONS BASED ON PREVIOUS QUESTIONS, REQUIRED]**

[If EV2a + EV2b > 1, display the text. Otherwise, skip to EV10]

Please answer the remaining questions thinking about this electric vehicle.

EV10. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the winter 2020-2021 (November 2020 through March 2021)?

A. Yes
B. No
C. No applicable (i.e., purchased the EV after August 2020)

EV11. What was your household's top motivation for buying the electric vehicle?

[Response order for options A through H randomized for each respondent]

A. We/I wanted to save money
B. We/I wanted to help the environment
C. There were rebates available (please specify)
D. We/I wanted the latest technology
E. It fits with my/our lifestyle
F. For comfort reasons
G. Fuel independence
H. Convenience (not having to stop at gas station)
I. Other (please specify)

[If EV10 is A or B, continue. Otherwise, skip to ET1]

We now have some questions about how your household used the electric vehicle during the summer. Please answer the questions thinking about *this past summer – i.e., June through August 2020.*

EV12. Which of the following best describes how your household *typically* used this electric vehicle on weekdays (Monday through Friday) during the summer 2020 (June through August)? Select all that apply.

A. I or another member of my household used it on a regular schedule (e.g., to and from work)
B. I or another member of my household used it as needed (e.g., to complete errands)
C. No one from my household used it on weekdays
D. Other (please describe how your vehicle was typically used on weekdays)

EV13. During a *typical* summer 2020 weekday (Monday through Friday), on average, how many miles was this electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for the total miles driven on a typical summer weekday for 2020.

A. 0-10 miles
B. 11-20 miles
C. 21-30 miles
D. 31-50 miles
E. 51-70 miles
F. 71 to 100 miles
G. 101 to 150 miles
H. > 150 miles
I. It varied significantly day-to-day or depending on the day of the week (please describe)
J. It varied significantly depending on the week or month (please describe)
K. Not sure

A.2.3 Charging Behavior

We now have some questions about how your household *charged* this electric vehicle during the summer. Please answer the questions thinking about *this past summer – i.e., June through August 2020.*

CB1. During summer 2020, when this electric vehicle was not being used and at home, was it typically connected to your home charging station?

A. Yes, I/we typically always had the EV connected to home charging station when not using the EV.
B. No, I/we only connected the EV to home charging station at select times. Please describe (e.g., when the EV battery had a certain % charge remaining).
C. Other (please specify)
D. Not sure

CB2. During winter 2020-2021, which of the following best describes your household's use of your home charging station for this electric vehicle?

A. Whenever the EV was connected to our home charging station, it charged until it was fully charged.
B. I/We used the **[EVSE_MANUFACTURER]** app to remotely start and stop charging of the EV.
C. I/We followed a charging schedule that I/we set using the **[EVSE_MANUFACTURER]** app.
D. I/We followed a charging schedule that I/we set using the EV's app.
E. Other (please specify)

[IF CB2 is C or D, continue. Otherwise, skip to CB3]

CB2_a. When was this electric vehicle's charging typically scheduled to start and end on weekdays in winter 2020-2021? (open-ended)

CB2_b. How was this electric vehicle's charging schedule determined?
A. I/We selected it
B. It's the default schedule
C. Don't know

CB3. Below, please indicate the time ranges during which this electric vehicle was typically <u>connected</u> to your *home charging station* on weekdays (Monday through Friday) during summer 2020 (June through August). Select all the time ranges that apply. As an example, if you typically disconnected this electric vehicle at 7:30 AM to go to work and then you connected this electric vehicle again when you returned home at 5:30 PM (leaving it connected until the following morning), you would select all ranges between 12 AM and 8 AM, and between 4 PM and 12 AM.
A. 12 AM – 2 AM
B. 2 AM – 4 AM
C. 4 AM – 6 AM
D. 6 AM – 8 AM
E. 8 AM – 10 AM
F. 10 AM – 12 PM
G. 12 PM – 2 PM
H. 2 PM – 4 PM
I. 4 PM – 6 PM
J. 6 PM – 8 PM
K. 8 PM – 10 PM
L. 10 PM – 12 AM
M. It varied significantly day-to-day or depending on the day of the week (M-F) (please describe)
N. It varied significantly depending on the week or month (please describe)
O. Not sure

CB4. Do you or other members of your household have access to charging at a workplace? Please answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it.

A. Yes
B. No
C. Not applicable (e.g., full-time remote, retired)

[If CB4 is A, continue. Otherwise, skip to CB10]

CB5. Approximately what percentage of this electric vehicle's charging during winter 2020-2021 (November through March) occurred at a workplace?

A. 0% (Never charge at work)
B. 1-25% (Occasionally charge at work)
C. 25-50% (Sometimes charge at work)
D. 50%-75% (Frequently charge at work)
E. >75% (Very frequently charge at work)

[If CB5 is A, continue. Otherwise, skip to CB7]

CB6. Why wasn't your household's electric vehicle ever charged at a workplace during summer 2020 (June through August)?

A. Didn't go into work / worked remotely during summer 2020
B. Other (please describe)

[If CB5 is not A, continue. Otherwise, skip to CB10]

CB7. Below, please indicate when this electric vehicle was typically <u>connected</u> to a *workplace charging station* on weekdays (Monday through Friday) during the summer 2020 (June through August). As an example, if you typically connected this electric vehicle to a workplace charging station around 3 PM and disconnected when you left to return home at 5:30 PM, you would select all ranges between 2 PM and 6 PM. Select all the time ranges that apply.

A. 12 AM – 2 AM
B. 2 AM – 4 AM
C. 4 AM – 6 AM
D. 6 AM – 8 AM
E. 8 AM – 10 AM
F. 10 AM – 12 PM
G. 12 PM – 2 PM
H. 2 PM – 4 PM
I. 4 PM – 6 PM
J. 6 PM – 8 PM
K. 8 PM – 10 PM
L. 10 PM – 12 AM
M. It varied significantly day-to-day or depending on the day of the week (M-F). Please describe.
N. It varied significantly depending on the week or month. Please describe.
O. Not sure

CB8. What are your main motivations for using *workplace charging stations*? (open-ended, optional)

CB9. If there are any barriers for you or your household members to use *workplace charging stations* to charge this electric vehicle, please describe them. (open-ended, optional)

CB10. How frequently did you typically use *public charging stations* for this vehicle during the typical weekday (Monday through Friday) in summer 2020 (June through August) (e.g., twice per week for about an hour each time)?

A. Please describe
B. I rarely/never used public charging stations on weekdays during the summer 2020

A.2.4 Changes Since Summer 2019

Now we have some questions about how driving and charging changed, if at all, between *summer 2019 and summer 2020*.

CS1. Compared to your household's use of this electric vehicle in the summer of 2019, did the typical miles per day that this electric vehicle was driven on weekdays change in summer 2020?

A. Yes, we drove the EV more on weekdays in 2020
B. Yes, we drove the EV less on weekdays in 2020
C. No / Not significantly
D. We bought the EV after the summer of 2019

[If CS1 is not D, continue. Otherwise, skip to ET1]

CS2. Compared to your household's use of your electric vehicle in the summer of 2019, did the timing of when your electric vehicle was typically driven on weekdays change in summer 2020 (e.g., shifted from morning and early evening to scattered throughout the day)?

A. Yes
B. No / Not significantly

[If CS2 is A, continue. Otherwise, skip to CS3]

CS2_a. Please describe how the timing of when your electric vehicle was typically driven on weekdays changed in summer 2020 compared to summer 2019. ______________ [open ended]

CS3. Compared to your household's use of your home charging station in the summer of 2019, did the amount of time your electric vehicle was typically connected to your home charging station on weekdays change in 2020?

A. Yes, the EV was connected more in 2020
B. Yes, the EV was connected less in 2020
C. No / Not significantly

CS4. Compared to your household's use of your home charging station in the summer of 2019, did the timing of when your electric vehicle was typically connected to your home charging station on weekdays change in summer 2020 (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)?

A. Yes
B. No / Not significantly

[If CS4 is A, continue. Otherwise, skip to CS5]

CS4_a. Please describe how the timing of when your electric vehicle was typically connected to your home charging station on weekdays changed in summer 2020 compared to summer 2019. (open-ended)

CS5. What, if any, additional observations do you have to share related to how your household's use of your electric vehicle and/or home charging station changed between summer 2019 and summer 2020? (open-ended, optional)

A.2.5 Behavior During Events

[If the enroll date is before August 24, 2020, continue. Otherwise, skip to S5.]

ET1. The Eversource ConnectedSolutions EV Home Charger Demand Response Program rewards you for using less energy during periods of peak demand, when others are using more (aka “Events”). During Events, Eversource makes slight adjustments to decrease your charger’s energy use. Your vehicle charges more slowly, but you stay in control. How many events do you recall in summer 2020 (June – August)? If you enrolled during this timeframe, provide the number you recall since you enrolled. (open-ended)

[If ET1 > 0, continue. Otherwise, skip to S5]

ET2. Do you recall ever receiving advance notifications about Events?

A. Yes
B. No

[If ET2 is A, continue. Otherwise, skip to ET5]

ET3. How were you notified in advance that an Event was going to occur? Select all that apply.

A. Email
B. **[EVSE_MANUFACTURER]** app
C. Other (please specify)
D. Don’t know

ET4. Are there ways that Event notification could be improved?

A. Yes (please specify)
B. No

ET5. For the Events you can recall during summer 2020, how often was your electric vehicle connected to your home charging station during Event hours?

A. Connected for all Event hours
B. Connected for most Event hours
C. Connected for some Event hours
D. Never connected during Event hours
E. Don’t know

ET6. Please indicate how the Events affected your normal charging and/or driving behavior during summer 2020. Select all that apply.

[Response order for options A through D randomized for each respondent]

A. No impacts
B. Had to modify charging schedule to make sure my vehicle was charged for when it was needed (please specify)
C. Went elsewhere during the event to charge my EV (e.g., public or workplace charging)
D. Had to defer or reschedule activities so we/I could wait to finish charging the EV since charging was slower during the Event
E. Other (please specify)
F. Don't know

ET7. Did your household take any other actions in response to being notified that an Event was going to occur? (open-ended, optional)

ET8. On Event days in summer 2020, did you ever "opt-out" or override your home charging station setting to stop the program from adjusting your charging during the Event (either through the app or on the device itself)?

A. Yes, through the home charging station app
B. Yes, through the home charging station itself
C. No
D. Don't know

[If ET8 is A or B, continue. Otherwise, skip to S1]

ET9. How often would you say you chose to override the scheduled Event charging setting once the Event was in-progress? Would you say…

A. Every Event
B. Most Events
C. Some Events
D. Rarely
E. Never
F. Unsure/Don't know

[If ET8 is A or B and ET9 is not E, continue. Otherwise, skip to S1]

ET10. For what reason(s) did you opt-out or override the charging setting during the Event(s)? (open-ended)

ET11. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override Events?

A. Very Difficult or Confusing	B.	C. Neutral	D.	E. Very Easy	F. Don't know

[If ET11 is A or B (1 or 2), continue. Otherwise, skip to S1]

ET12. What issues did you encounter when trying to opt-out or override a scheduled Event(s)? (open-ended)

A.2.6 Program Satisfaction

S1. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the following aspects of Eversource's ConnectedSolutions EV Home Charger Demand Response Program to-date?

	A. Very Dissatisfied	B.	C. Neutral	D.	E. Very Satisfied	F. Don't know
	1	2	3	4	5	
S1b. Number of Events						
S1c. Length of Events						
S1d. Timing of Events (i.e., what period during the day events occurred)						

[If S1b is A or B (1 or 2), continue. Otherwise, skip to S3]

S2. Please let us know why you are not satisfied with the <u>number</u> of Events. (open-ended)

[If S1c is A or B (1 or 2), continue. Otherwise, skip to S4]

S3. Please let us know why you are not satisfied with the <u>length</u> of Events. (open-ended)

[If S1d is A or B (1 or 2), continue. Otherwise, skip to S5]

S4. Please let us know why you are not satisfied with the <u>timing</u> of Events. (open-ended)

S5. How likely are you to continue to participate in Eversource's ConnectedSolutions EV Home Charger Demand Response Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"?

A. Very Unlikely 1	B. 2	C. 3	D. 4	E. Very Likely 5

[If S5 is A or B (1 or 2), continue. Otherwise, skip to S7]

S6. What change(s) to Eversource's ConnectedSolutions EV Home Charger Demand Response Program, if any, would encourage you to continue participating? (open-ended, optional)

[IF S5 is C-E (3-5), continue. Otherwise, skip to D1]

S7. What recommendations would you make, if any, to help improve Eversource's ConnectedSolutions EV Home Charger Demand Response Program going forward? (open-ended, optional)

A.2.7 Demographics

You're almost done! We just have a few more questions.

D1. Which of the following best describes the property type where your home charging station is located?

A. Single family home
B. Multi-family home (2-4 units)
C. Multi-family home (5+ units)
D. Mobile home
E. Not a residence (business, workshop or other)
F. Other (please describe)

D2. Which of the following age categories do you fall into?

A. 18-24
B. 25-34
C. 35-44
D. 45-54
E. 55-64
F. 65 or over
G. Prefer not to provide

D3. What is the last grade of school you completed?

A. Grade school or less (1-8)
B. Some high school (9-11)
C. Graduated high school (12)
D. Vocational/technical school
E. Some college (1-3 years)
F. Graduated college (4 years)
G. Post graduate education
H. Prefer not to provide

D4. Which category best describes your gender?

A. Male
B. Female
C. Other
D. Prefer not to provide

D5. Please indicate which range best describes the annual income of your entire household (everyone living in your home).

A. Under $24,999
B. $25,000 to 39,999
C. $40,000 to 59,999
D. $60,000 to $74,999
E. $75,000 to $84,999
F. $85,000 to $99,999
G. $100,000 to $124,999
H. $125,000 to $149,999
I. $150,00 to 199,999
J. $200,000 to $224,999
K. $225,000 to $249,999
L. $250,00 to 299,999
M. $300,000 or more
N. Prefer not to provide

A.2.8 Closing

C1. We have reached the end of the survey. Do you have any additional comments regarding the Eversource ConnectedSolutions EV Home Charger Demand Response Program?

A. Yes (please describe)
B. None

C2. Thank you for taking the time to fill out this survey for the Eversource ConnectedSolutions EV Home Charger Demand Response Program! Please provide your email address so we may email you a $10 eGift Card redeemable at a number of retailers including Amazon.com and Visa (to see your options, visit https://www.rewardsgenius.com/reward-catalog).

A. Email (prompts entry)
B. I prefer not to provide my email address

[Survey close] We thank you for your time spent taking this survey. Your response has been recorded.

A.3 2021 Participant Survey Instrument

[Survey start] Eversource thanks you for participating in ConnectedSolutions EV Home Charger Demand Response Program this year. In an effort to improve the program and its ability to reduce strain on the electricity grid during periods of peak demand, we have some questions related to your experiences in the program and your household's charging and driving behavior in general. If you cannot complete the survey all at one time or you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking on the link from this email.

A.3.1 Enrollment

[If PAST RESPONDENT = 0, continue. Otherwise, skip to E10_1]

E1. What was your top motivation for enrolling in Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

[Response order for options A through E randomized for each respondent]

A. Receive incentives
B. Reduce my/our environmental impact
C. Reduce the need for additional power plants
D. Support my/our community and/or state's energy initiatives
E. Get a charger that charges my car more quickly
F. Other, please specify

E2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (select all that apply)

A. Eversource email
B. Eversource website
C. Eversource other (please specify)
D. **[EVSE_MANUFACTURER]** email
E. **[EVSE_MANUFACTURER]** website
F. **[EVSE_MANUFACTURER]** app
G. **[DRMS_PROVIDER]** website
H. Friend/family/neighbor
I. Other (please specify)
K. Not sure

E3. Has enough information been provided to you about Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

A. Yes, I have received enough information about the program.
B. No, I have not received enough information about the program.

[If E3 is B, continue. Otherwise, skip to E5]

E4. What additional information would you like to see? (open-ended)

E5. Did you encounter any challenges or difficulties during the enrollment process?

A. Yes, I encountered challenges during the enrollment process.
B. No, I did not encounter any challenges during the enrollment process.

[If E5 is A, continue. Otherwise, skip to E7]

E6. What challenges or difficulties did you encounter during the enrollment process? (specify)

E7. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program?

a. Very Unsatisfied 1	b. 2	c. 3	d. 4	e. Very Satisfied 5

[If E7 is A or B, continue. Otherwise, skip to E9]

E8. What was less than satisfactory about the enrollment experience? (specify)

E9. Approximately when did you purchase the charger that you enrolled in Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (e.g., "May 2019")

A. Approximate purchase date (specify Month and Year)
B. Don't know

E10_1. At what point did you become aware of Eversource's ConnectedSolutions EV Home Charger Demand Response Program?

A. I became aware of the program before purchasing the charger.
B. I became aware of the program during the process of purchasing the charger.
C. I became aware of the program *after* purchasing the charger.

[If E10_1 is A or B, continue. Otherwise, skip to E11]

E10. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your decision to purchase the new charger?

A. Yes, I purchased the new charger because of this program.
B. Yes, I purchased the new charger in part because of this program.
C. No, I did not purchase the new charger because of this program.

E11. Which of the following best describes the charger that you owned prior to purchasing the Level 2 charger that is currently enrolled in program?

A. The enrolled charger replaced an existing Level 1 charger (i.e., a charger that plugged into a standard 120-volt outlet)
B. The enrolled charger replaced an existing Level 2 charger (i.e., a charger that plugged into a high-output 220/240-volt outlet)
C. I did not have a charger for use at home prior to purchasing the enrolled charger

A.3.2 EV Characteristics and Driving Behavior

EV1. How many licensed drivers are there in your household? (specify a number)

EV2. Please indicate the number of each type of vehicle your household owns. Enter 0 if you do not have that type of vehicle.

Vehicle Type	Number in Household
A. Battery electric vehicle (BEV)	**[numeric]**
B. Plug-in hybrid electric vehicle (PHEV)	**[numeric]**
C. Other (including non-plug in hybrid and gasoline consuming vehicles)	**[numeric]**

[If EV2A = 1, continue. Otherwise, skip to EV4]

EV3. Please provide the make, model, and year for your battery electric vehicle (BEV).

# of Battery electric vehicles (BEV)	Make and Model	Year
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a = 2, continue. Otherwise, skip to QEV5]

EV4. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	Make and Model	Year
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**
BEV #2	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a ≥ 3, continue. Otherwise, skip to QEV6]

EV5. Please provide the make, model, and year for your battery electric vehicles (BEV).

# of Battery electric vehicles (BEV)	**Make and Model**	**Year**
BEV #1	**[DROP DOWN]**	**[DROP DOWN]**
BEV #2	**[DROP DOWN]**	**[DROP DOWN]**
BEV #3	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b = 1, continue. Otherwise, skip to QEV7]

EV6. Please provide the make, model, and year for your plug-in hybrid electric vehicle (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b = 2, continue. Otherwise, skip to QEV8]

EV7. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #2	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2b ≥ 3, continue. Otherwise, skip to QEV9]

EV8. Please provide the make, model, and year for your plug-in hybrid electric vehicles (PHEV).

# of Plug-in hybrid electric vehicles (PHEV)	**Make and Model**	**Year**
PHEV #1	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #2	**[DROP DOWN]**	**[DROP DOWN]**
PHEV #3	**[DROP DOWN]**	**[DROP DOWN]**

[If EV2a + EV2b > 1, continue. Otherwise, skip to EV10]

EV9. Of the electric vehicles you listed, please identify the electric vehicle whose driving and charging schedule you are most familiar with. **[PIPED IN RESPONSE OPTIONS BASED ON PREVIOUS QUESTIONS, REQUIRED]**

[If EV2a + EV2b > 1, display the text. Otherwise, skip to EV10]
Please answer the remaining questions thinking about this electric vehicle.

EV10. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the winter 2020-2021 (November 2020 through March 2021)?

A. Yes
B. No

EV11. What was your household's top motivation for buying the electric vehicle?

[Response order for options A through H randomized for each respondent]

A. We/I wanted to save money
B. We/I wanted to help the environment
C. There were rebates available (please specify)
D. We/I wanted the latest technology
E. It fits with my/our lifestyle
F. For comfort reasons
G. Fuel independence
H. Convenience (not having to stop at gas station)
I. Other (please specify)

We now have some questions about how your household used the electric vehicle whose driving and charging schedule you are most familiar with during the winter. Please answer the questions thinking about *this past winter – i.e., November 2020 through March 2021.*

EV12. Which of the following best describes how your household *typically* used this electric vehicle on weekdays (Monday through Friday) during the winter 2020-2021 (November through March)? Select all that apply.

A. I or another member of my household used it on a regular schedule (e.g., to and from work)
B. I or another member of my household used it as needed (e.g., to complete errands)
C. No one from my household used it on weekdays
D. Other (please describe how your vehicle was typically used on weekdays)

EV13. During a *typical* winter 2020-2021 weekday (Monday through Friday), on average, how many miles was this electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for the total miles driven on a typical winter weekday for 2020-2021.

A. 0-10 miles
B. 11-20 miles
C. 21-30 miles
D. 31-50 miles
E. 51-70 miles
F. 71 to 100 miles
G. 101 to 150 miles
H. >150 miles
I. It varied significantly day-to-day or depending on the day of the week (please describe)
J. It varied significantly depending on the week or month (please describe)
K. Not sure

A.3.3 Charging Behavior

Still thinking about the electric vehicle whose driving and charging schedule you are most familiar with; we now have some questions about how your household charged this electric vehicle during the winter. Please answer the questions thinking about this past winter – i.e., November 2020 through March 2021.

CB1. During winter 2020-2021, when this electric vehicle was not being used and at home, was it typically connected to your home charging station?

A. Yes, I/we typically always had the EV connected to home charging station when not using the EV.
B. No, I/we only connected the EV to home charging station at select times. Please describe (e.g., when the EV battery had a certain % charge remaining).
C. Other (please specify)
D. Not sure

CB2. During winter 2020-2021, which of the following best describes your household's use of your home charging station for this electric vehicle?

A. Whenever the EV was connected to our home charging station, it charged until it was fully charged.
B. I/We used the **[EVSE_MANUFACTURER]** app to remotely start and stop charging of the EV.
C. I/We followed a charging schedule that I/we set using the **[EVSE_MANUFACTURER]** app.
D. I/We followed a charging schedule that I/we set using the EV's app.
E. Other (please specify)

[IF CB2 is C or D, continue. Otherwise, skip to CB2_c]

CB2_a. When was this electric vehicle's charging typically scheduled to start and end on weekdays in winter 2020-2021? (open-ended)

CB2_b. How was this electric vehicle's charging schedule determined?

A. I/We selected it
B. It's the default schedule
C. Don't know

CB2_c. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your choice of charging schedule at all?

A. Yes (please describe)
B. No
C. Don't know

CB3. Below, please indicate the time ranges during which this electric vehicle was typically <u>connected</u> (regardless of charging or not) to your *home charging station* on weekdays (Monday through Friday) during winter 2020-2021 (November through March). Select all the time ranges that apply.

As an example, if you typically disconnected this electric vehicle at 7:30 AM to go to work and then you connected this electric vehicle again when you returned home at 5:30 PM (leaving it connected until the following morning), you would select all ranges between 12 AM and 8 AM, and between 4 PM and 12 AM.

A. 12 AM – 2 AM
B. 2 AM – 4 AM
C. 4 AM – 6 AM
D. 6 AM – 8 AM
E. 8 AM – 10 AM
F. 10 AM – 12 PM
G. 12 PM – 2 PM
H. 2 PM – 4 PM
I. 4 PM – 6 PM
J. 6 PM – 8 PM
K. 8 PM – 10 PM
L. 10 PM – 12 AM
M. It varied significantly day-to-day or depending on the day of the week (M-F) (please describe)
N. It varied significantly depending on the week or month (please describe)
O. Not sure

CB4_a. Compared to your household's use of your home charging station on weekdays, was the amount of time this electric vehicle was typically connected to your home charging station in winter 2020-2021 different on weekends?

A. Yes, the EV was connected more on weekends
B. Yes, the EV was connected less on weekends
C. No / Not significantly

CB4_b. Compared to your household's use of your home charging station on weekdays, was the timing of when this electric vehicle was typically connected to your home charging station in winter 2020-2021 different on weekends (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)?

A. Yes. Please describe [open ended]
B. No / Not significantly

CB4. Is this electric vehicle driven to a workplace that has workplace charging available? Please answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it.

A. Yes
B. No
C. Not applicable (e.g., full-time remote, retired)

[If CB4 is A, continue. Otherwise, skip to CB10]

CB5. Approximately what percentage of this electric vehicle's charging during winter 2020-2021 (November through March) occurred at a workplace?

A. 0% (Never charge at work)
B. 1-25% (Occasionally charge at work)
C. 25-50% (Sometimes charge at work)
D. 50%-75% (Frequently charge at work)
E. >75% (Very frequently charge at work)

[If CB5 is A, B, or C, continue. Otherwise, skip to CB7]

CB6. What was the reason(s) you did not charge at the workplace more frequently during winter 2020-2021 (November through March)? (open-ended)

[If CB5 is not A, continue. Otherwise, skip to CB10]

CB7. Below, please indicate when this electric vehicle was typically connected to a *workplace charging station* on weekdays (Monday through Friday) during the winter 2020-2021 (November through March). As an example, if you typically connected this electric vehicle to a workplace charging station around 3 PM and disconnected when you left to return home at 5:30 PM, you would select all ranges between 2 PM and 6 PM. Select all the time ranges that apply.

A. 12 AM – 2 AM
B. 2 AM – 4 AM
C. 4 AM – 6 AM
D. 6 AM – 8 AM
E. 8 AM – 10 AM
F. 10 AM – 12 PM
G. 12 PM – 2 PM
H. 2 PM – 4 PM
I. 4 PM – 6 PM
J. 6 PM – 8 PM
K. 8 PM – 10 PM
L. 10 PM – 12 AM
M. It varied significantly day-to-day or depending on the day of the week (M-F). Please describe.
N. It varied significantly depending on the week or month. Please describe.
O. Not sure

CB8. What are your main motivations for using workplace charging stations? (select all that apply)

A. My workplace charging is free
B. My workplace charging is cheaper than charging at home
C. Workplace charging is convenient
D. Workplace charging allows me to commute fully in electric mode
E. I charge at my workplace in preparation for demand response events
F. Other (please specify)

CB9. Are there are any barriers for you or your household members to use workplace charging stations to charge this electric vehicle? (select all that apply)

A. There is limited availability of workplace chargers
B. Workplace charging station time limits are a barrier
C. I have not experienced any barriers to use workplace charging stations
D. Other (please specify)

CB10. How frequently did you typically use public charging stations for this vehicle during the typical weekday (Monday through Friday) in winter 2020-2021 (November through March)?

A. More than 3 times a week
B. 2-3 times a week
C. Once a week
D. 2-3 times a month
E. Once a month
F. Very sporadically when it was available
G. I rarely/never used public charging stations on weekdays during the winter 2020-2021
H. Other (please specify)

CB11. How long was your typical charging session at public charging stations during the typical weekday (Monday through Friday) in winter 2020-2021 (November through March)?

A. Less than 30 minutes
B. 30-60 minutes
C. 1-2 hours
D. 2-3 hours
E. 3+ hours
F. I rarely/never used public charging stations on weekdays during the winter 2020-2021
G. Other (please specify)

A.3.4 Changes Since Winter 2019-2020

Now we have some questions about how driving and charging changed, if at all, for the electric vehicle you are most familiar with between winter 2019-2020 and winter 2020-2021.

CS1. Compared to your household's use of this electric vehicle in the winter of 2019-2020, did the typical miles per day that this electric vehicle was driven on weekdays change in winter 2020-2021?

A. Yes, we drove the EV more on weekdays in winter 2020-2021
B. Yes, we drove the EV less on weekdays in winter 2020-2021
C. No / Not significantly
D. We bought the EV after the winter of 2019-2020

[If CS1 is not D, continue. Otherwise, skip to CS6]

CS2. Compared to your household's use of this electric vehicle in the winter of 2019-2020, did the timing of when this electric vehicle was typically driven on weekdays change in winter 2020-2021 (e.g., shifted from morning and early evening to scattered throughout the day)?

A. Yes
B. No / Not significantly

[If CS2 is A, continue. Otherwise, skip to CS3]

CS2_a. Please describe how the timing of when this electric vehicle was typically driven on weekdays changed in winter 2020-2021 compared to winter 2019-2020. (open-ended)

CS3. Compared to your household's use of your home charging station in the winter of 2019-2020, did the amount of time this electric vehicle was typically connected to your home charging station on weekdays change in winter 2020-2021?

A. Yes, the EV was connected more in winter 2020-2021
B. Yes, the EV was connected less in winter 2020-2021
C. No / Not significantly

CS4. Compared to your household's use of your home charging station in the winter of 2019-2020, did the timing of when this electric vehicle was typically connected to your home charging station on weekdays change in winter 2020-2021 (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)?

A. Yes
B. No / Not significantly

[If CS4 is A, continue. Otherwise, skip to CS5]

CS4_a. Please describe how the timing of when this electric vehicle was typically connected to your home charging station on weekdays changed in winter 2020-2021 compared to winter 2019-2020. (open-ended)

CS5. What, if any, additional observations do you have to share related to how your household's use of this electric vehicle and/or home charging station changed between winter 2019-2020 and winter 2020-2021?

A. Please describe (open-ended)
B. No additional observations

[If EV2a + EV2b > 1, continue. Otherwise, skip to ET1]

CS6. Thank you for answering the previous questions thinking about the electric vehicle whose driving and charging schedule you are most familiar with. You indicated that your household has more than one EV. Please describe how your household uses the additional electric vehicle(s) in winter 2020-2021 (e.g., driven approximately 5 miles per weekday, on average, mostly after 4 pm). (open-ended, optional)

CS7. Additionally, please describe how your household charges the additional electric vehicle(s). How do you manage home charging between EVs? (open-ended, optional)

A.3.5 Behavior During Events

[If the enroll date is before March 30, 2021, continue. Otherwise, skip to S5.]

ET1. The Eversource ConnectedSolutions EV Home Charger Demand Response Program rewards you for using less energy during periods of peak demand, when others are using more (aka “Events”). During Events, Eversource makes slight adjustments to decrease your charger’s energy use. Your vehicle charges more slowly, but you stay in control. How many events do you recall in winter 2020-2021 (November through March)? If you enrolled during this timeframe, provide the number you recall since you enrolled. (open-ended)

[If ET1 > 0, continue. Otherwise, skip to S5]

ET2. Do you recall ever receiving advance notifications about Events?

A. Yes
B. No

[If ET2 is A, continue. Otherwise, skip to ET5]

ET3. How were you notified in advance that an Event was going to occur? (select all that apply)

A. Email
B. [EVSE_MANUFACTURER] app
C. Other (please specify)
D. Don’t know

ET4. Are there ways that Event notification could be improved?

A. Yes (please specify)
B. No

ET5. For the Events you can recall during winter 2020-2021, how often was your electric vehicle connected to your home charging station during Event hours?

A. Connected for all Event hours
B. Connected for most Event hours
C. Connected for some Event hours
D. Never connected during Event hours
E. Don’t know

ET6. Please indicate how the Events affected your normal charging and/or driving behavior during winter 2020-2021. (select all that apply)

[Response order for options A through E randomized for each respondent]

A. No impacts
B. Had to modify charging schedule to make sure my vehicle was charged for when it was needed (please specify)
C. Went elsewhere during the event to charge my EV (e.g., public or workplace charging)
D. Had to defer or reschedule activities so we/I could wait to finish charging the EV since charging was slower during the Event
E. I had to disconnect my vehicle before it was fully charged.
F. Other (please specify)
G. Don’t know

ET7. Did your household take any other actions in response to being notified that an Event was going to occur? (open-ended, optional)

ET8. On Event days in winter 2020-2021, did you ever “opt-out” or override your home charging station setting to stop the program from adjusting your charging during the Event (either through the app or on the device itself)?

A. Yes, through the home charging station app
B. Yes, through the home charging station itself
C. No
D. Don’t know

[If ET8 is A or B, continue. Otherwise, skip to S1]

ET9. How often would you say you chose to override the scheduled Event charging setting once the Event was in-progress? Would you say…

A. Every Event
B. Most Events
C. Some Events
D. Rarely
E. Never
F. Unsure/Don’t know

[If ET8 is A or B and ET9 is not E, continue. Otherwise, skip to S1]

ET10. For what reason(s) did you opt-out or override the charging setting during the Event(s)? (open-ended)

ET11. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override Events?

A. Very Difficult or Confusing	B.	C. Neutral	D.	E. Very Easy	F. Don't know

[If ET11 is A or B (1 or 2), continue. Otherwise, skip to S1]

ET12. What issues did you encounter when trying to opt-out or override a scheduled Event(s)? (open-ended)

A.3.6 Program Satisfaction

S1. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the following aspects of Eversource's ConnectedSolutions EV Home Charger Demand Response Program to-date?

	A. Very Dissatisfied	B.	C. Neutral	D.	E. Very Satisfied	F. Don't know
	1	2	3	4	5	
S1b. Number of Events						
S1c. Length of Events						
S1d. Timing of Events (i.e., what period during the day events occurred)						

[If S1b is A or B (1 or 2), continue. Otherwise, skip to S3]

S2. Please let us know why you are not satisfied with the <u>number</u> of Events. (open-ended)

[S1c is A or B (1 or 2), continue. Otherwise, skip to S4]

S3. Please let us know why you are not satisfied with the <u>length</u> of Events. (open-ended)

[S1d is A or B (1 or 2), continue. Otherwise, skip to S5]

S4. Please let us know why you are not satisfied with the <u>timing</u> of Events. (open-ended)

S5. How likely are you to continue to participate in Eversource's ConnectedSolutions EV Home Charger Demand Response Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"?

A. Very Unlikely 1	B. 2	C. 3	D. 4	E. Very Likely 5

[If S5 is A or B (1 or 2), continue. Otherwise, skip to S7]

S6. What change(s) to Eversource's ConnectedSolutions EV Home Charger Demand Response Program, if any, would encourage you to continue participating? (open-ended, optional)

[If S5 is one of C-E (3-5), continue. Otherwise, skip to D1]

S7. What recommendations would you make, if any, to help improve Eversource's ConnectedSolutions EV Home Charger Demand Response Program going forward? (open-ended, optional)

A.3.7 Demographics

You're almost done! We just have a few more questions.

D1. Which of the following best describes the property type where your home charging station is located?

A. Single family home
B. Multi-family home (2-4 units)
C. Multi-family home (5+ units)
D. Mobile home
E. Not a residence (business, workshop or other)
F. Other (please specify)

D1_a. Which of the following best describes the location of your home charging station?

A. In a heated garage
B. In an attached garage with no heat
C. In an unattached heated garage
D. In an unattached garage with no heat
E. Outside
F. Other (please specify)

D2. Which of the following age categories do you fall into?

A. 18-24
B. 25-34
C. 35-44
D. 45-54
E. 55-64
F. 65 or over
G. Prefer not to provide

D3. What is the last grade of school you completed?

A. Grade school or less (1-8)
B. Some high school (9-11)
C. Graduated high school (12)
D. Vocational/technical school
E. Some college (1-3 years)
F. Graduated college (4 years)
G. Post graduate education
H. Prefer not to provide

D4. Which category best describes your gender?

A. Male
B. Female
C. Other
D. Prefer not to provide

D5_a. **[RESTRICT RESPONSE OPTIONS TO 2 DIGITS]** How many people occupied your home this winter 2020-2021? Enter zero if appropriate. (open-ended)

Occupant Type	**Number of Occupants**
Children, under 18	**[numeric]**
Adults, 18 to 65	**[numeric]**
Adults, 65 and older	**[numeric]**

D5. **[USE TABLE PROVIDED IN EXCEL FILE TO PROVIDE RANGES BASED ON RESPONSE TO D5_a. AS AN EXAMPLE, IF THE SUM OF D5_a=1 (SINGLE HOUSEHOLD MEMBER), SHOW THE FOLLOWING]** What was your estimated total annual household income in winter 2020-2021 before taxes (in other words, your gross household income)?

A. Less than $19,600
B. $19,601 - $39,100
C. $39,101 - $45,600
D. $45,601 - $52,100
E. $52,101 - $58,700
F. $58,701 - $65,200
G. $65,201 - $71,700
H. $71,701 - $78,200
I. $78,201 - $97,800
J. $97,801 - $130,400
K. Greater than $130,400
L. Prefer not to answer

A.3.8 Closing

C1. We have reached the end of the survey. Do you have any additional comments regarding the Eversource ConnectedSolutions EV Home Charger Demand Response Program?

A. Yes (please describe)
B. None

C2. Thank you for taking the time to fill out this survey for the Eversource ConnectedSolutions EV Home Charger Demand Response Program! Please provide your email address so we may email you a $10 eGift Card redeemable at a number of retailers including Amazon.com and Visa (to see your options, visit https://www.rewardsgenius.com/reward-catalog).

A. Email (prompts entry)
B. I prefer not to provide my email address

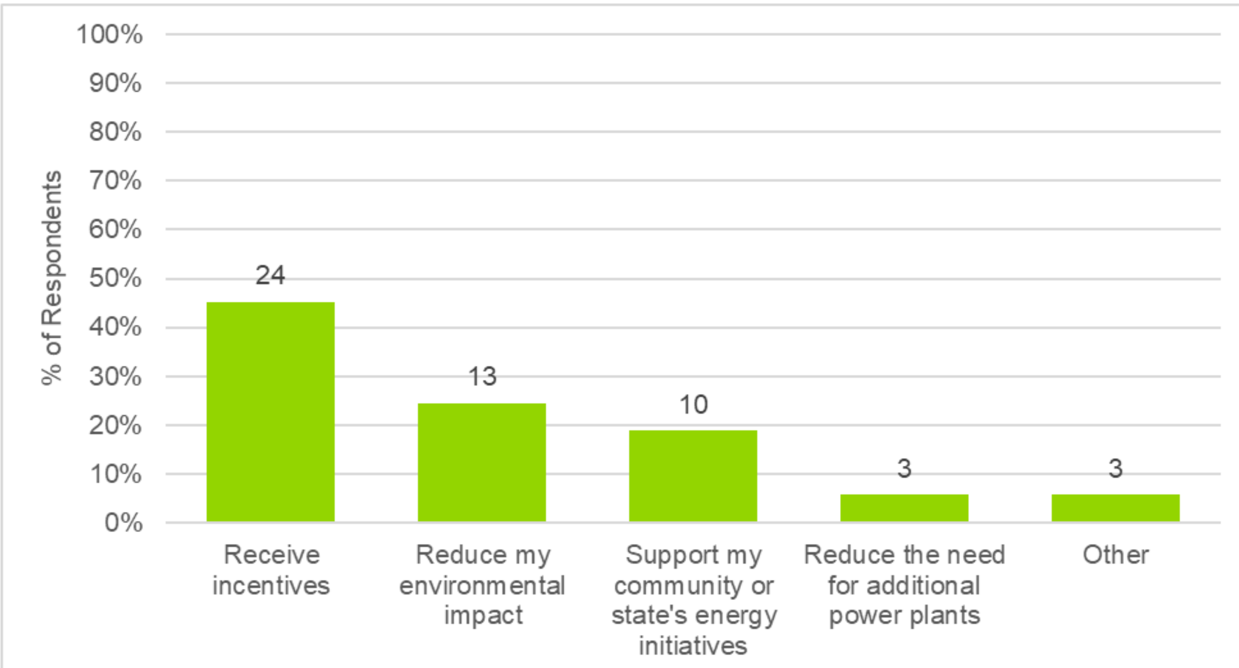
[Survey close] We thank you for your time spent taking this survey. Your response has been recorded.

Appendix B. Participant Survey Output

B.1 2019 Participant Survey Output

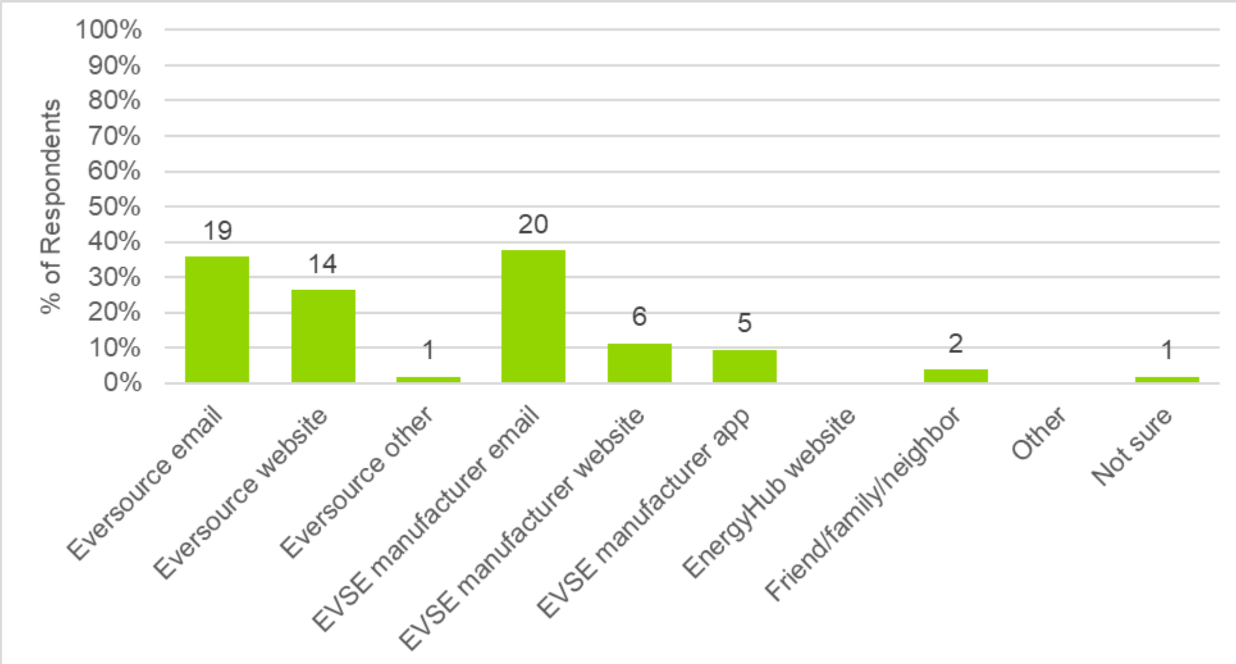
B.1.1 Enrollment

Q1. What was your top motivation for enrolling in Eversource's ConnectedSolutions Electric Vehicle Home Charger Demand Response Program? (n=53)



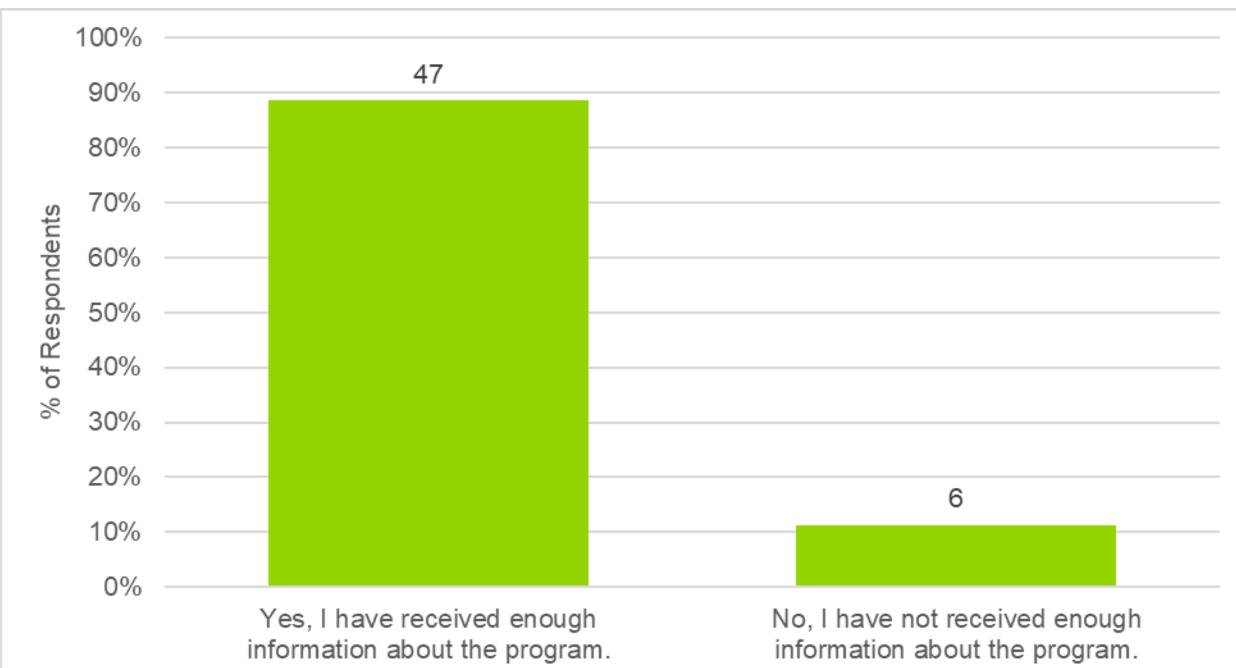
Source: Guidehouse

Q2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? Select all that apply. (n=53)



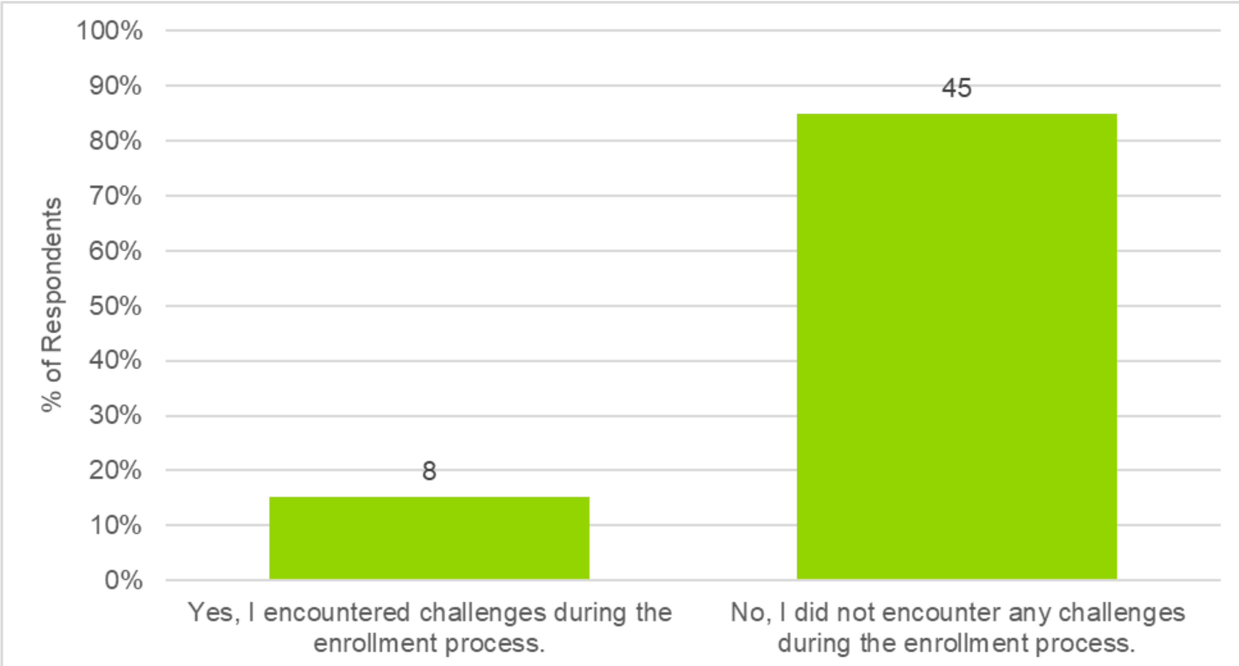
Source: Guidehouse

Q3. Has enough information been provided to you about the program? (n=53)



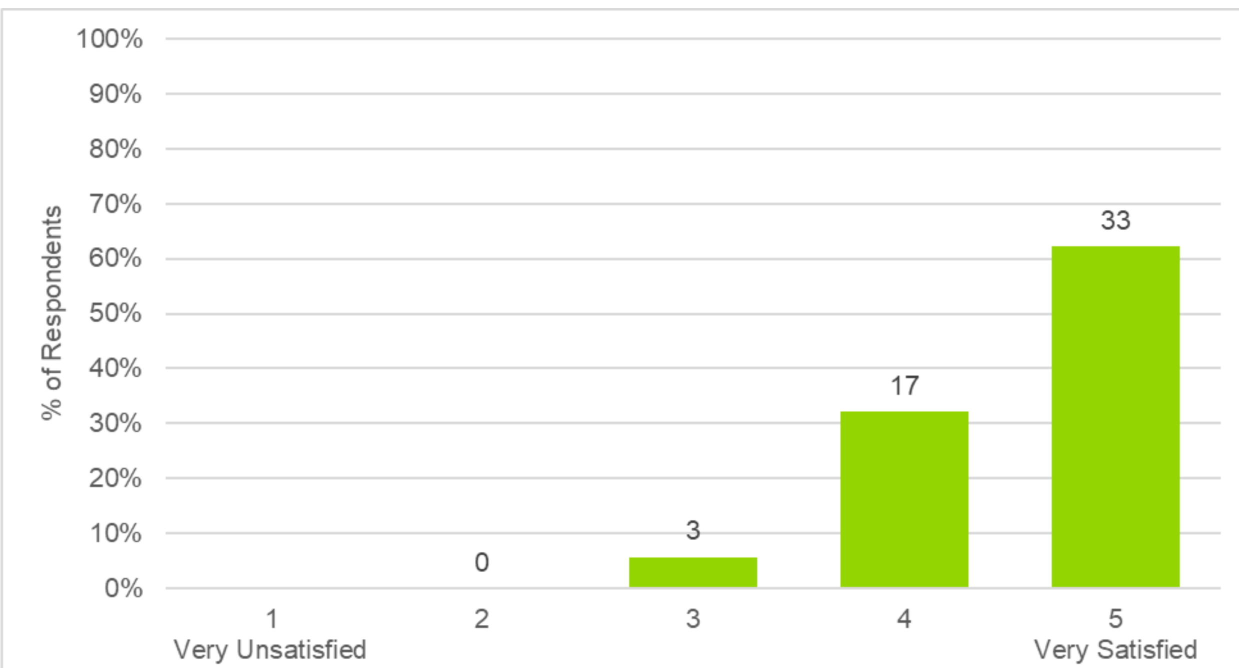
Source: Guidehouse

Q5. Did you encounter any challenges or difficulties during the enrollment process? (n=53)



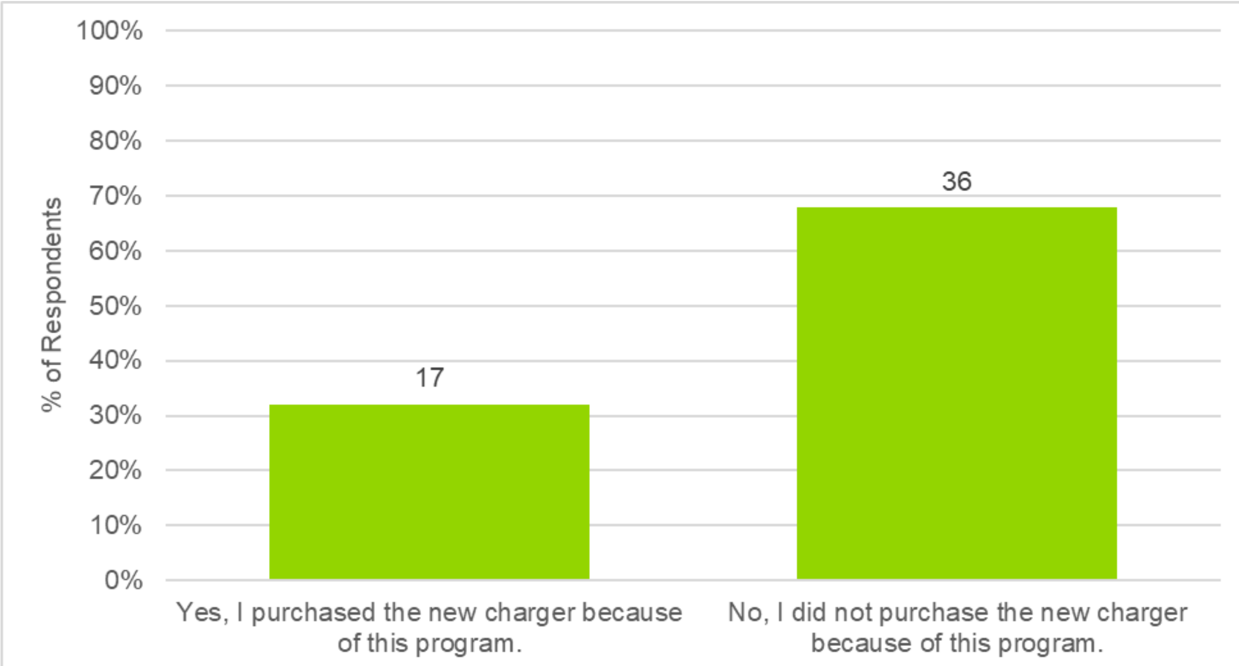
Source: Guidehouse

Q7. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program? (n=53)



Source: Guidehouse

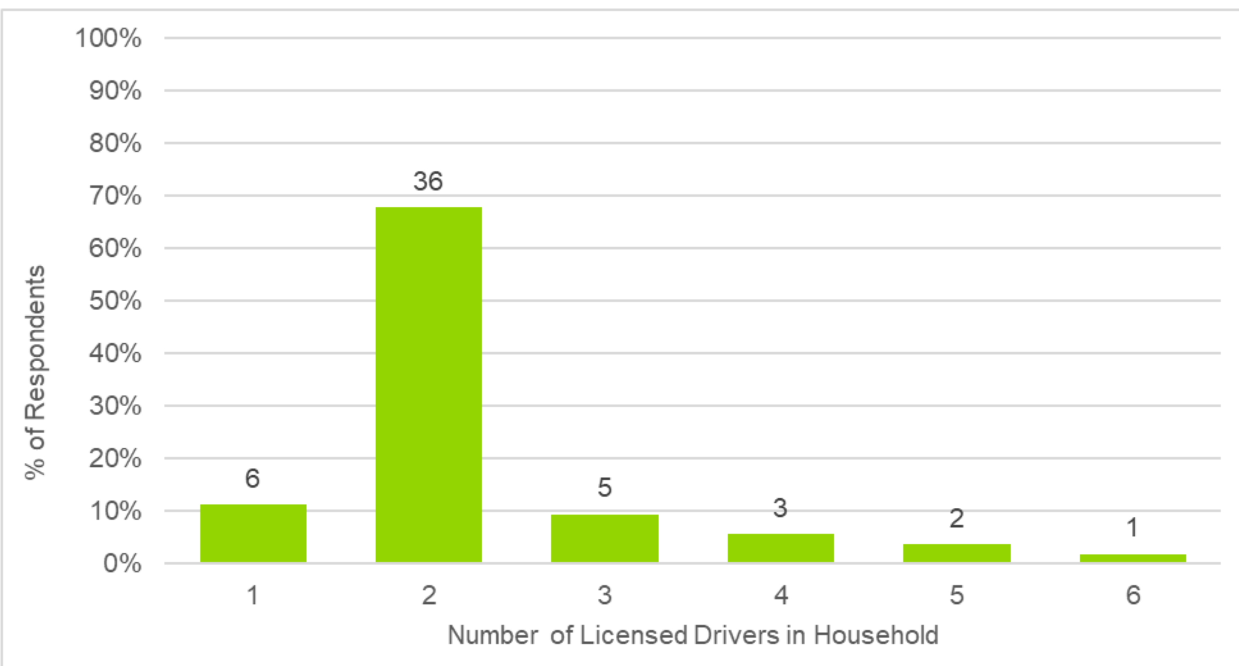
Q8_2. Did the program influence your decision to purchase the new charger? (n=53)



Source: Guidehouse

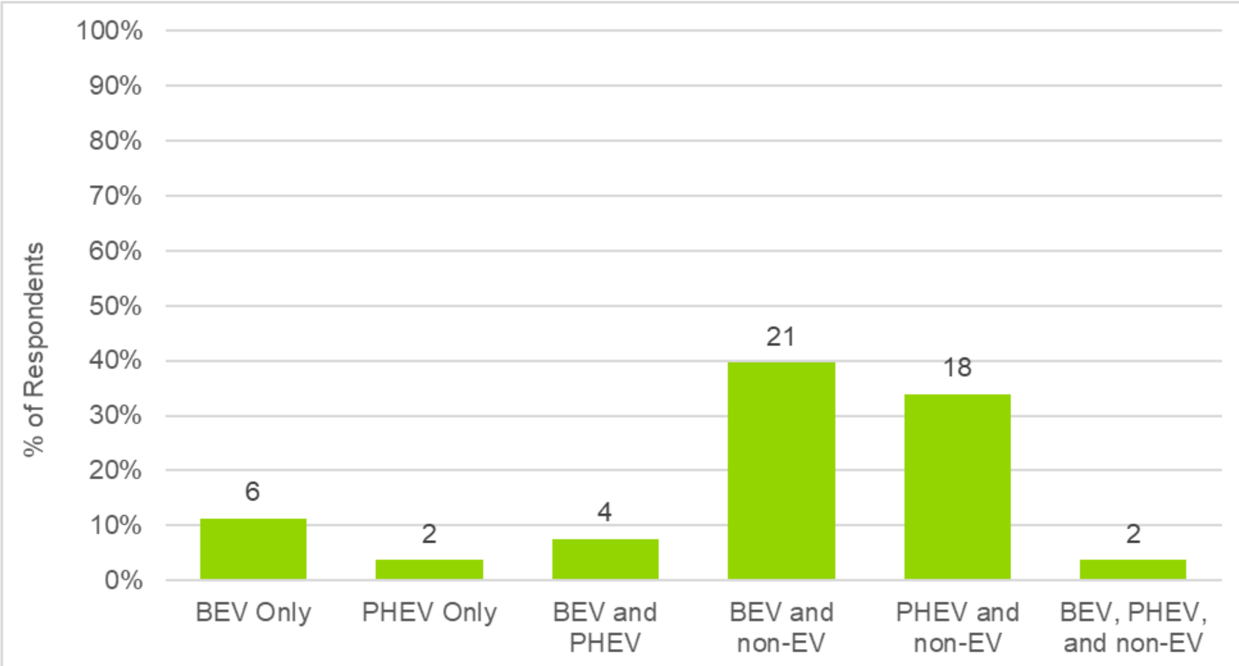
B.1.2 EV Charactersitcs and Driving Behavior

Q9_0. How many licensed drivers are there in your household? (n=53)



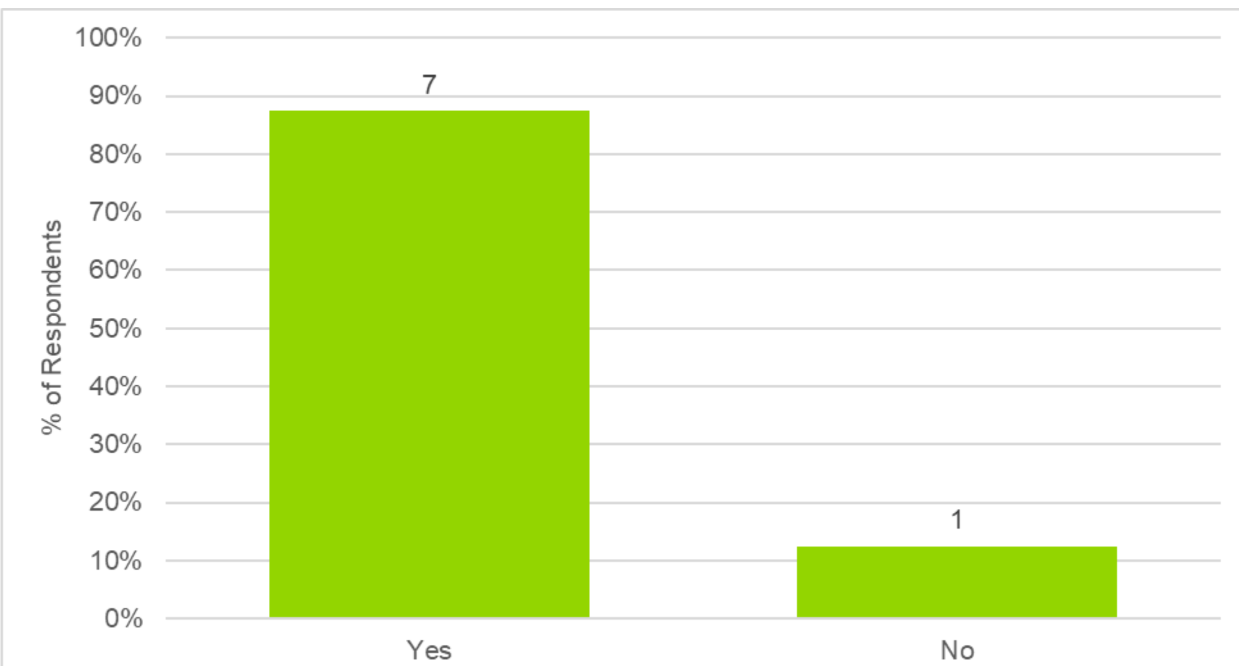
Source: Guidehouse

Q9. Please indicate the number of each type of vehicle your household owns. (n=53)



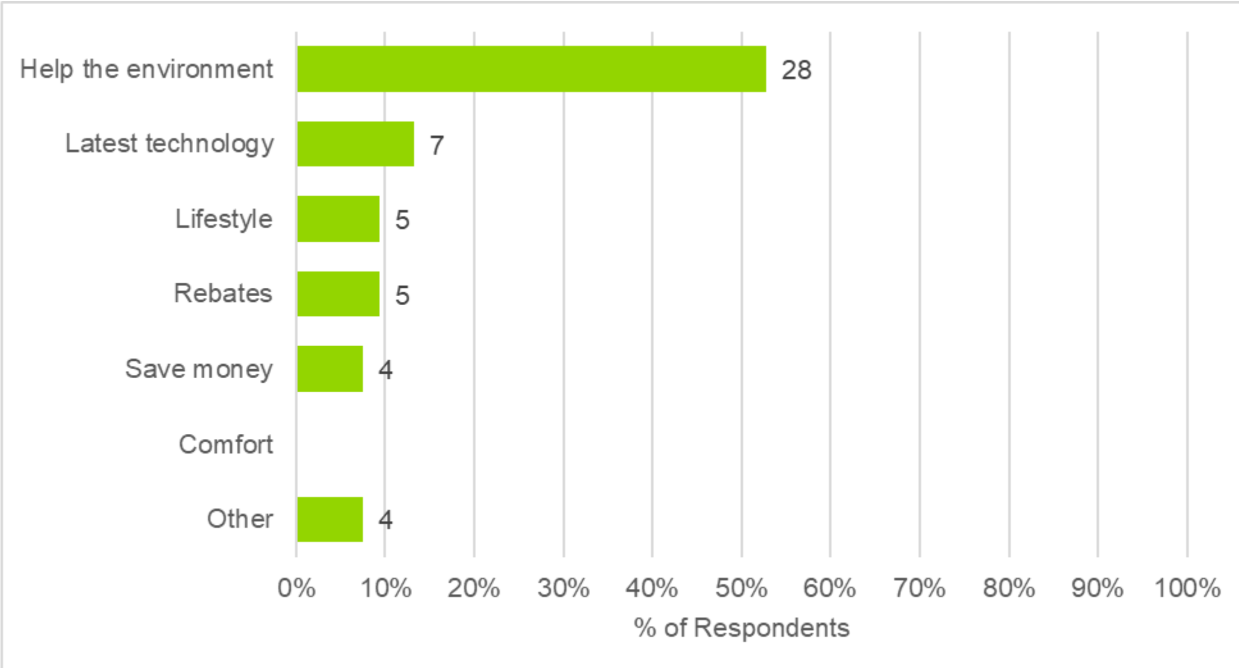
Source: Guidehouse

Q10. Does your electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the summer (June through August)? (n=8)



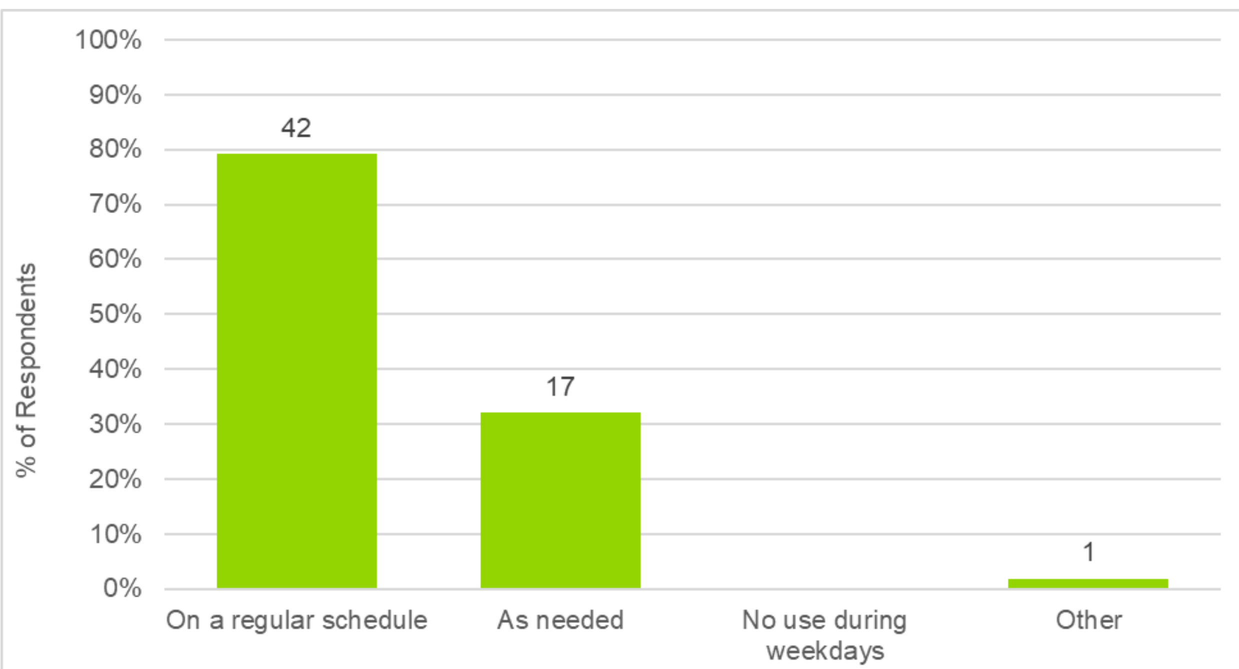
Source: Guidehouse

Q11. What was your household's top motivation for buying the electric vehicle? (n=53)



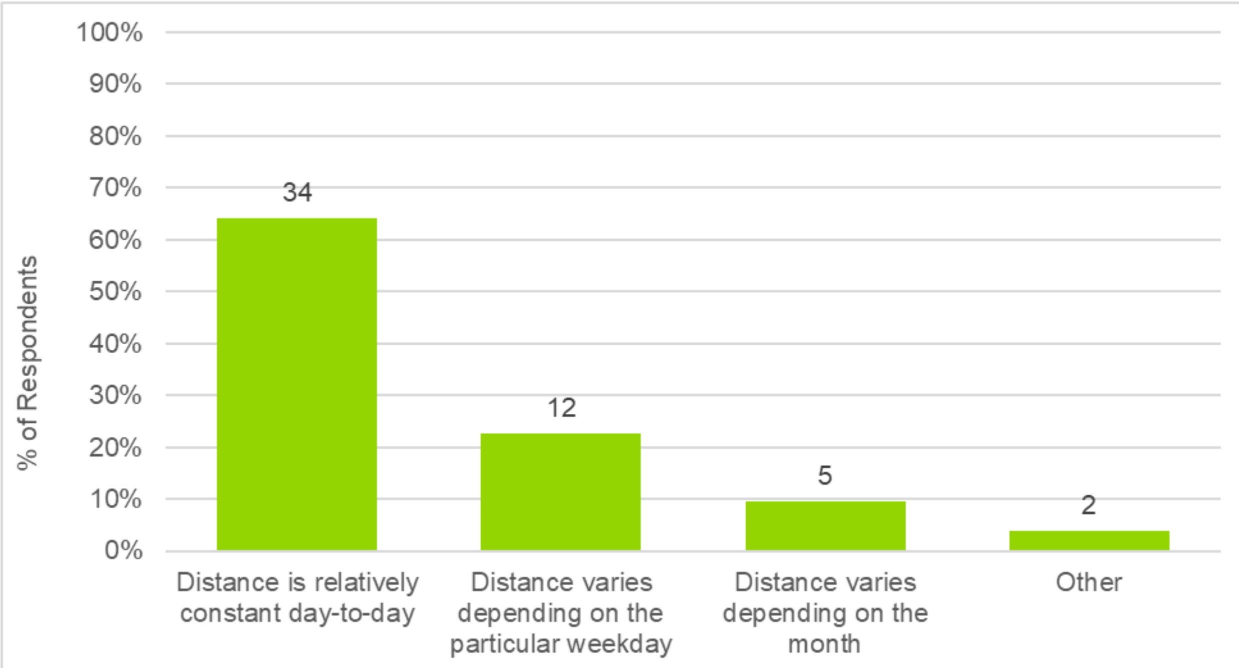
Source: Guidehouse

Q13. Which of the following best describes how your household typically uses your electric vehicle on weekdays (M-F) during the summer (June through August)? Select all that apply. (n=53)



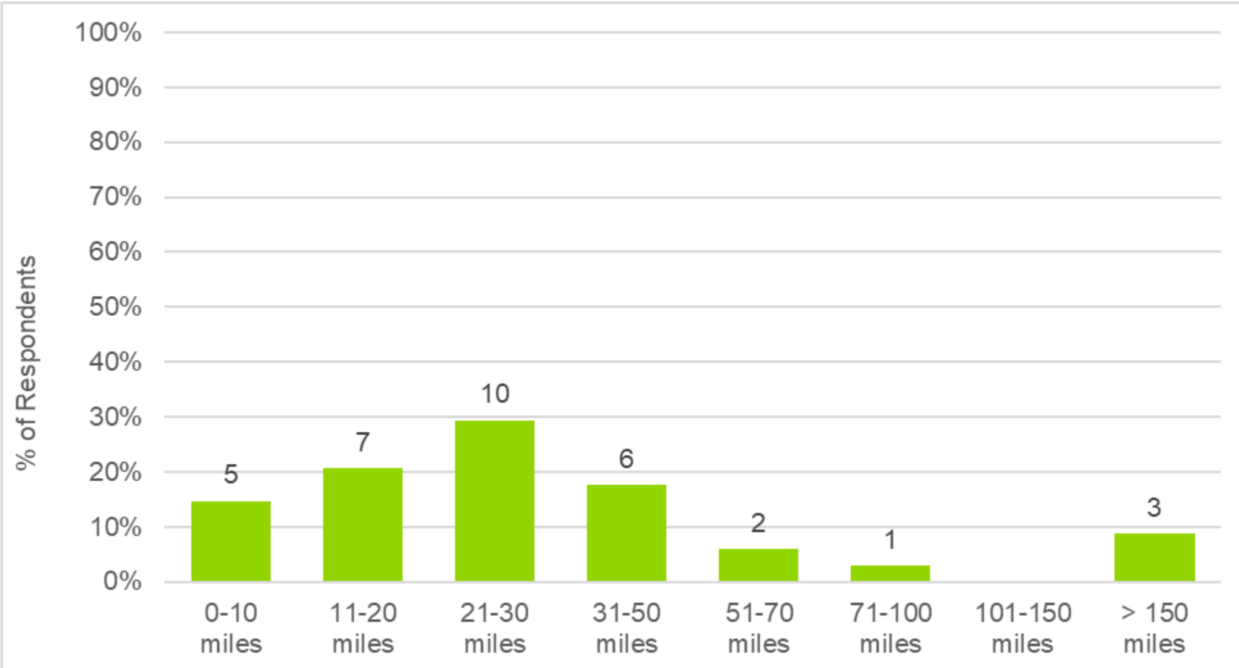
Source: Guidehouse

Q14. Ignoring short-term vacations (< 2 weeks), is the total distance (miles) your electric vehicle is driven by you and other household members relatively constant across summer weekdays (M-F) or does it vary? (n=53)



Source: Guidehouse

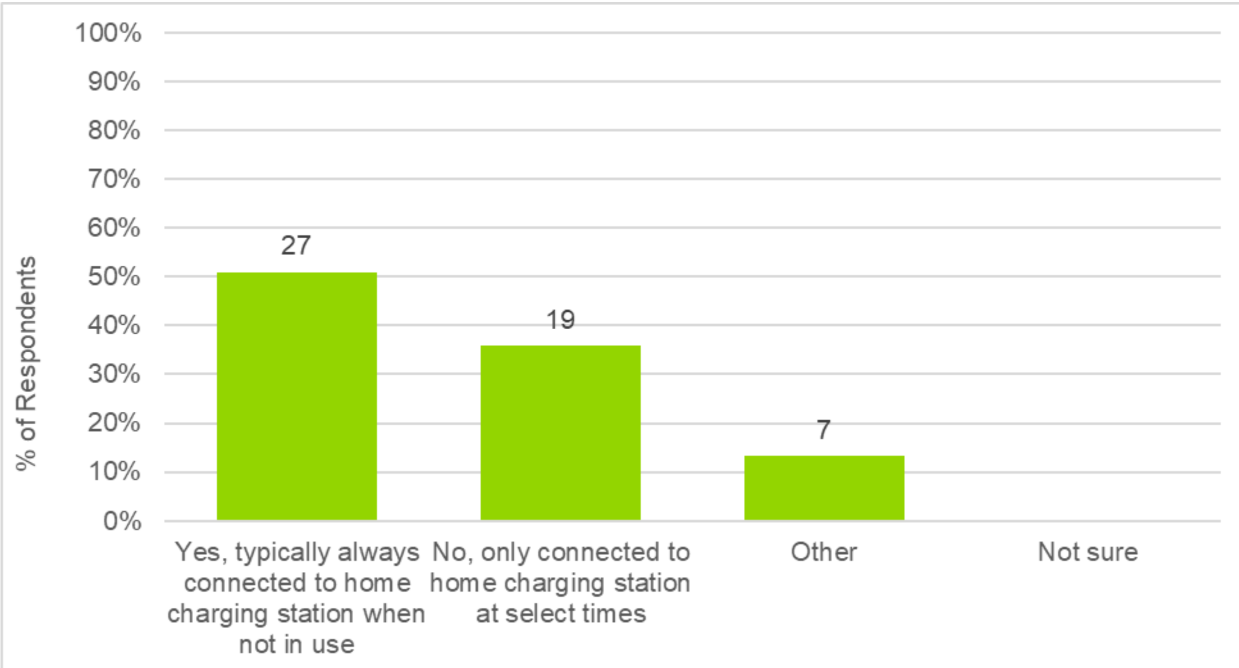
Q15. During a typical summer weekday (M-F), on average, how many miles is your electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for miles driven per day. (n=34)



Source: Guidehouse

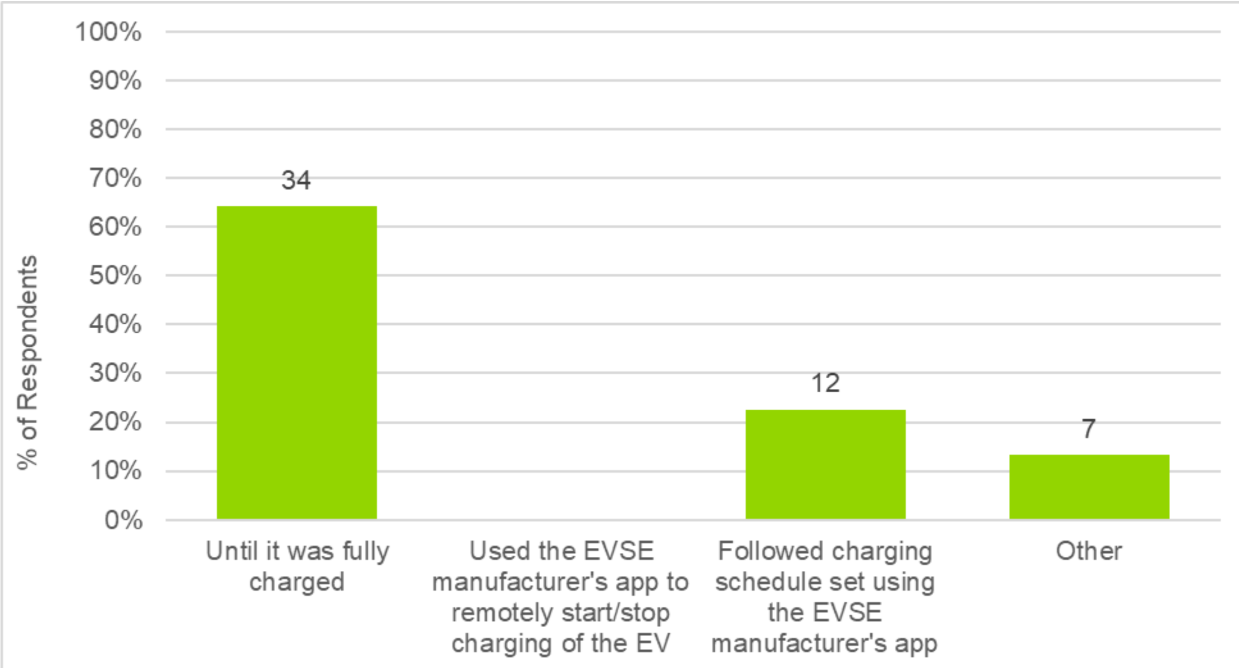
B.1.3 Charging Behavior

Q19. When your electric vehicle is home and is not being used, is it typically connected to your home charging station? (n=53)



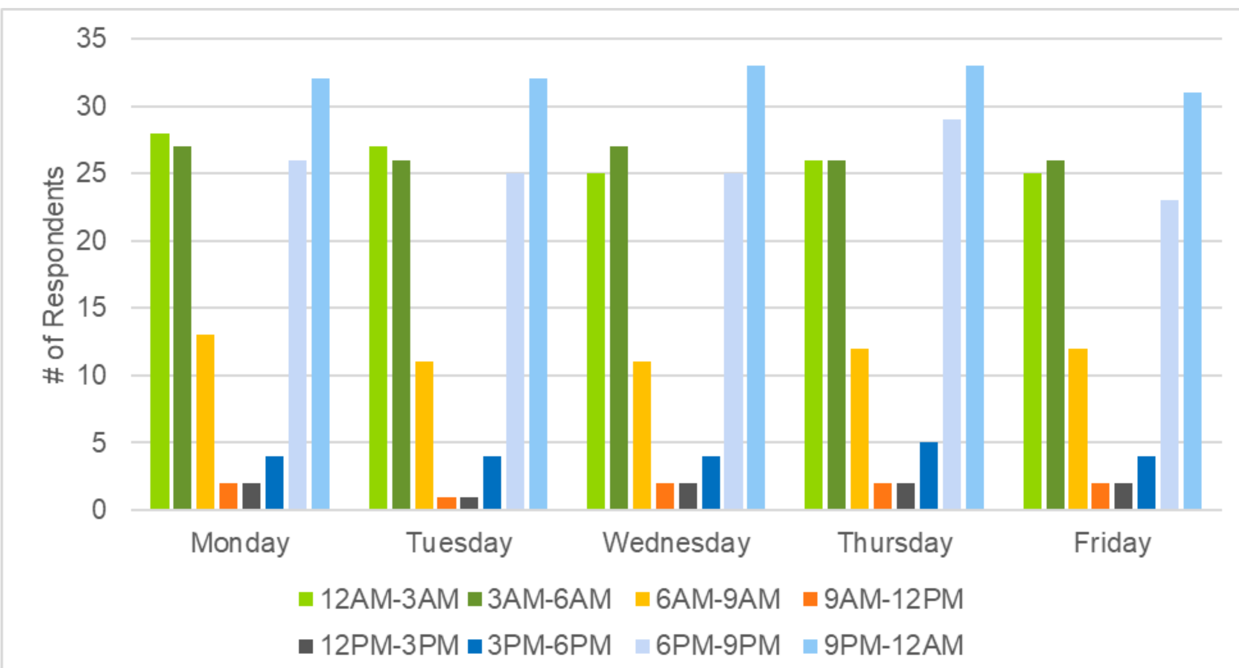
Source: Guidehouse

Q20. Which of the following best describes your household's use of your home charging station for your electric vehicle? (n=53)



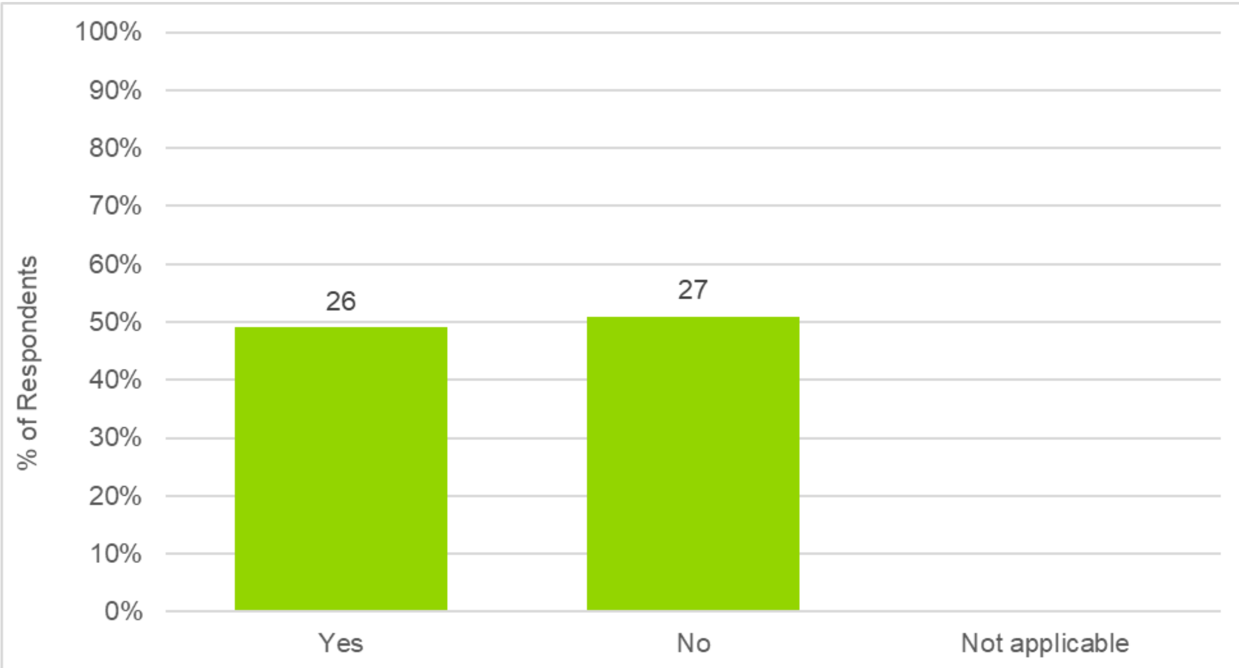
Source: Guidehouse

Q22. Please indicate the time ranges during which your electric vehicle is typically connected to your home charging station on weekdays (M-F) during the summer. Select all the time ranges that apply.



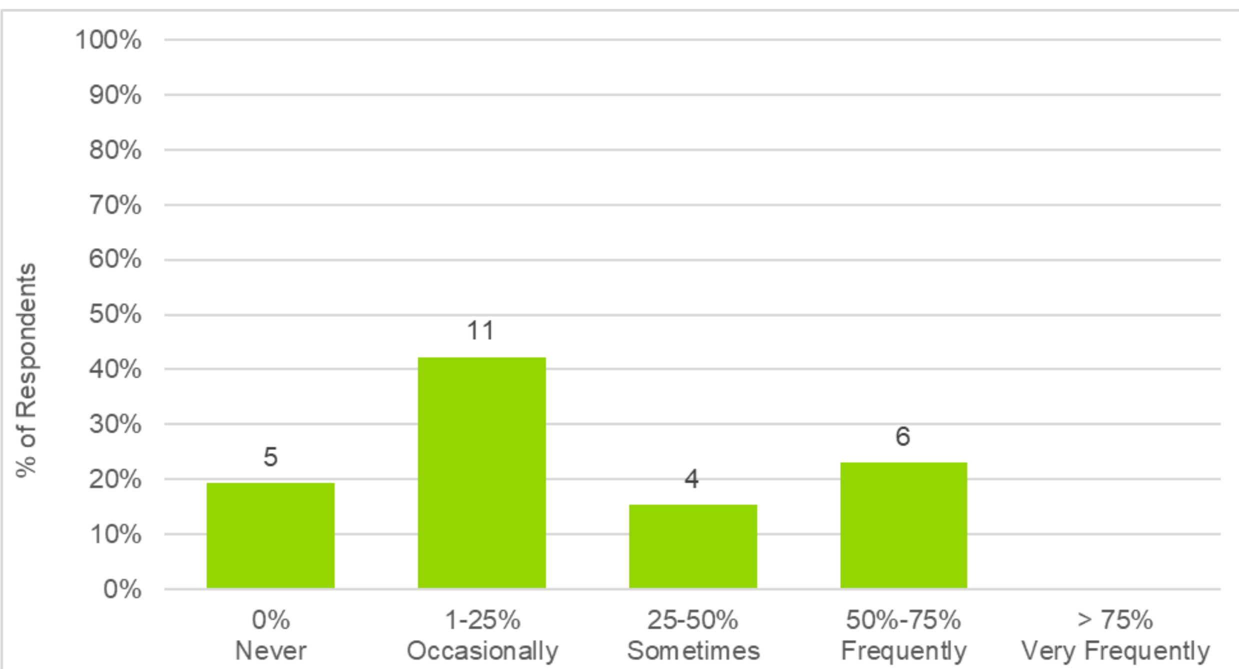
Source: Guidehouse

Q22_1. Do you or other members of your household have access to charging at a workplace? (n=53)



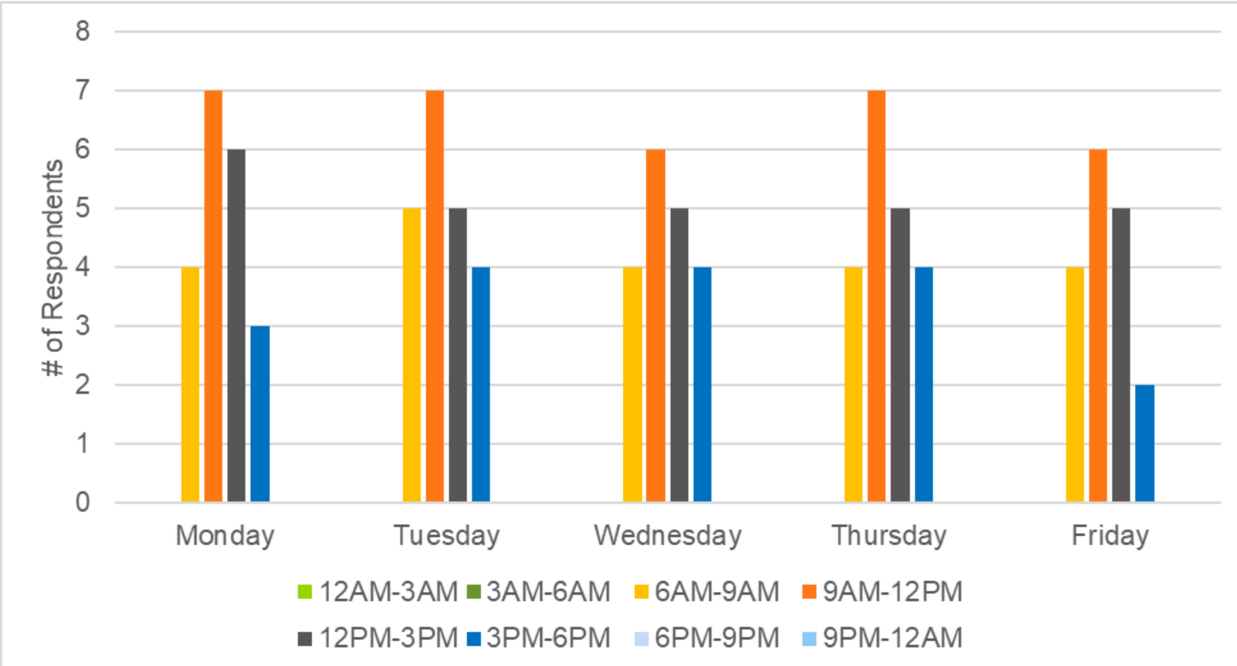
Source: Guidehouse

Q23_0. Approximately what percentage of your household's EV charging occurs at a workplace? (n=26)



Source: Guidehouse

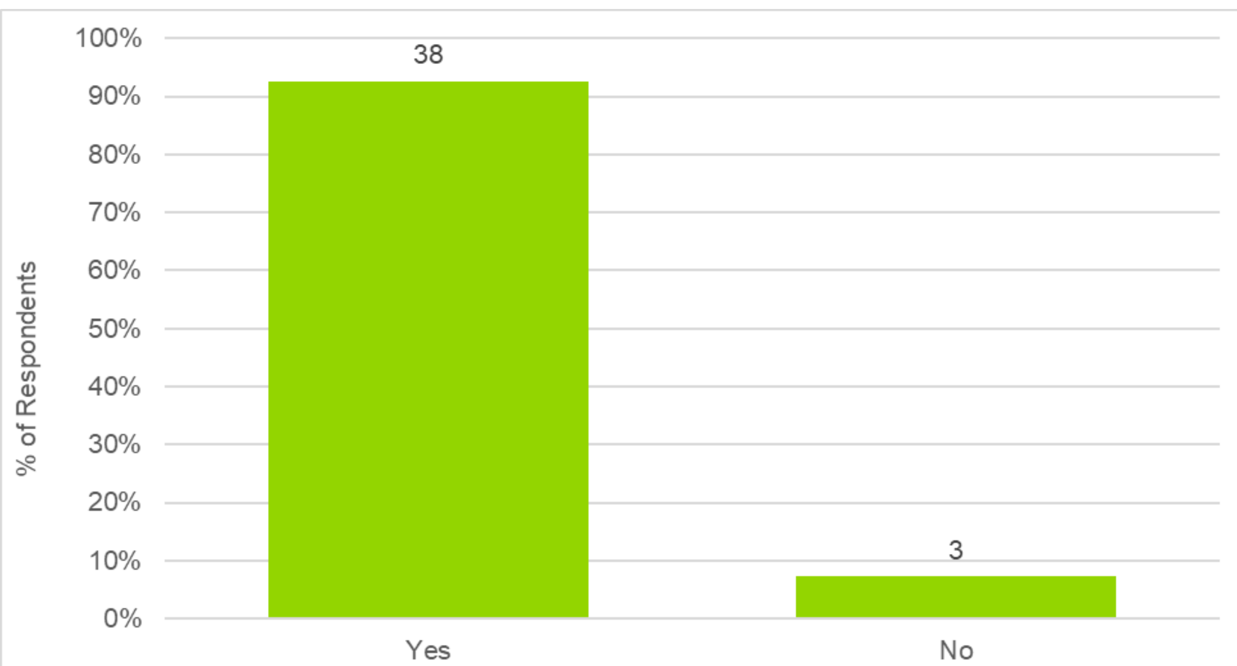
Q23. Please indicate when your electric vehicle is typically connected to a workplace charging station on weekdays (M-F) during the summer. Select all the time ranges that apply.



Source: Guidehouse

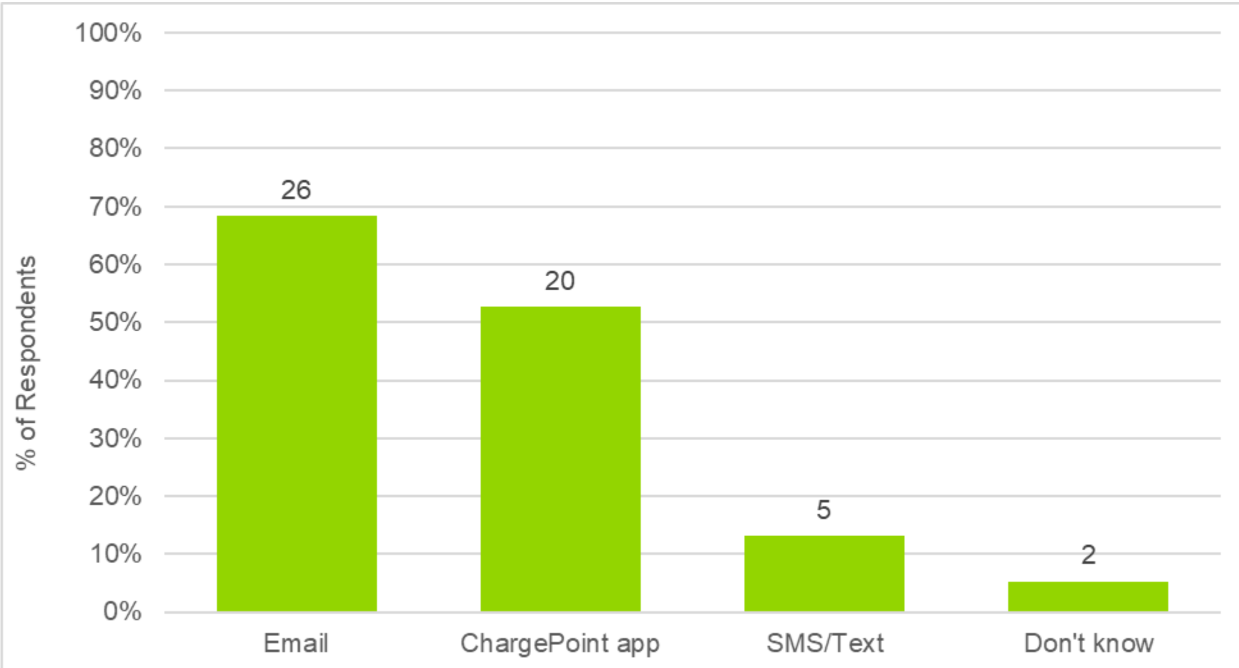
B.1.4 Behavior During Events

Q25_B. Since enrolling, did you ever receive advance notifications about Events? (n=41)



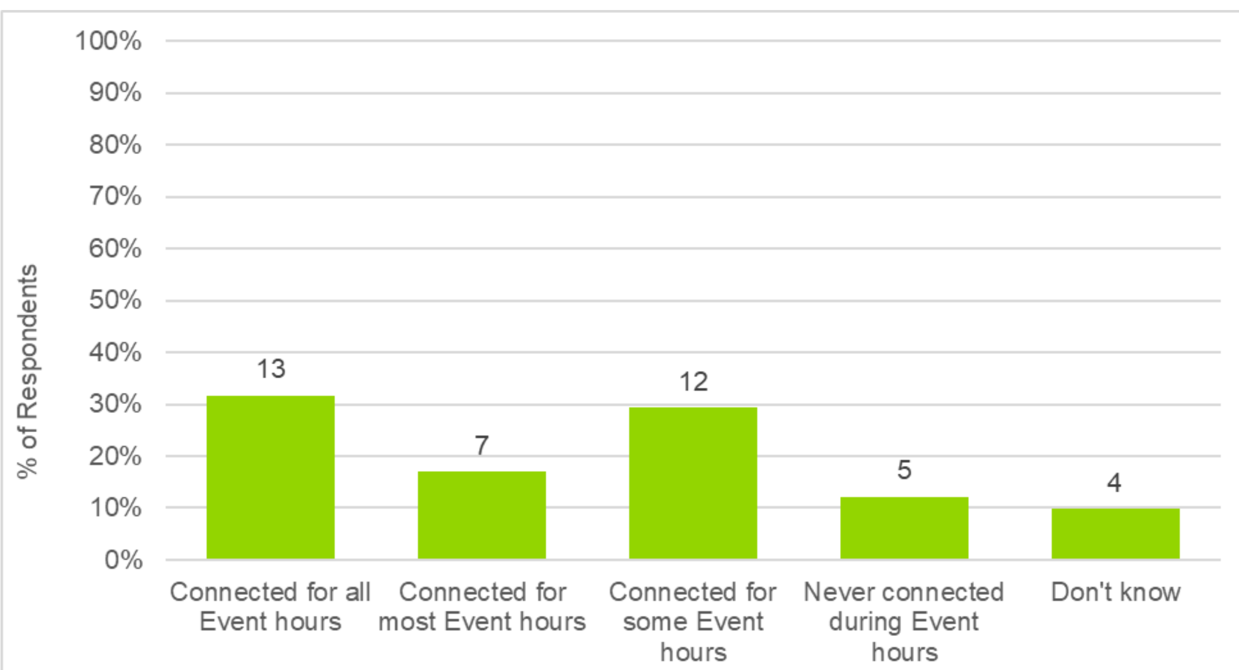
Source: Guidehouse

Q25_C. How were you notified in advance that an Event was going to occur? Select all that apply. (n=38)



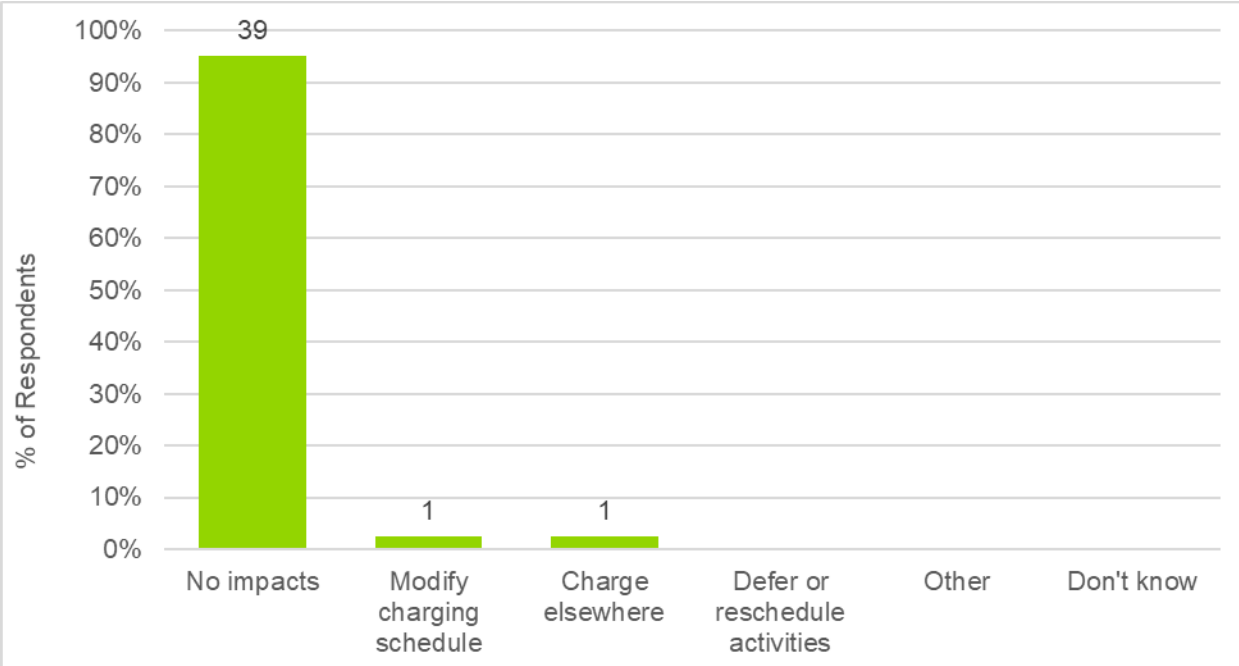
Source: Guidehouse

Q25. Since enrolling, for the Events you can recall, how often was your BEV/PHEV connected to your home charging station during Event hours? (n=41)



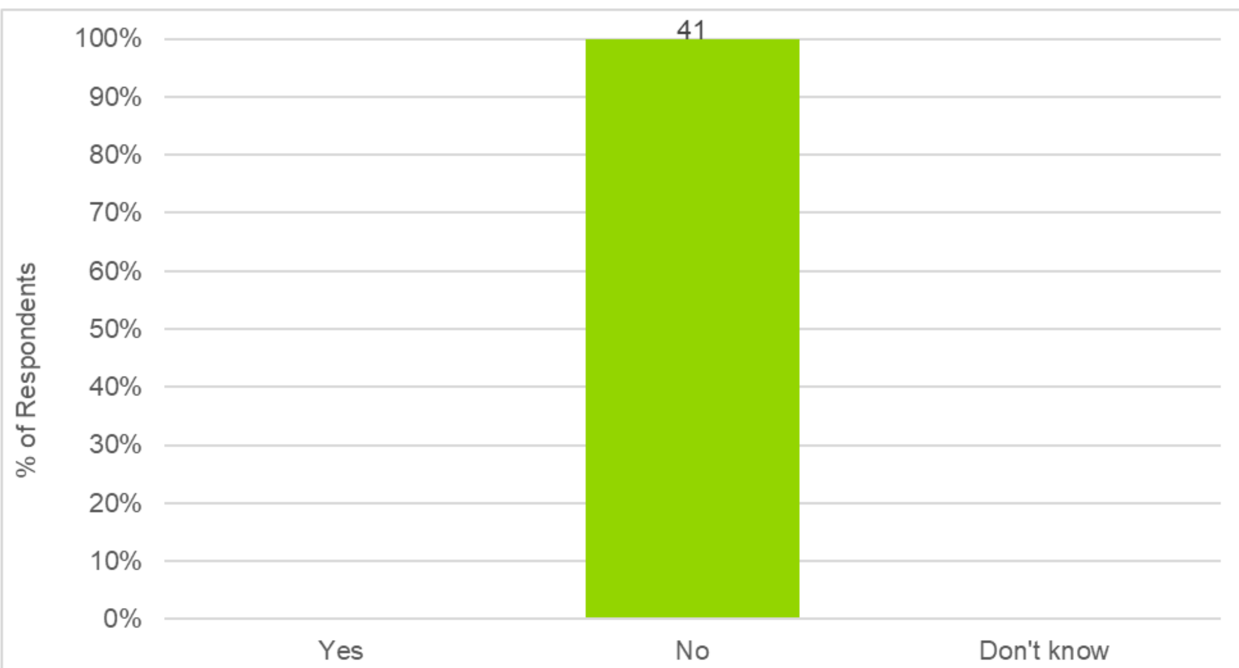
Source: Guidehouse

Q26. Please indicate how the Events affected your normal charging and/or driving behavior. Select all that apply. (n=41)



Source: Guidehouse

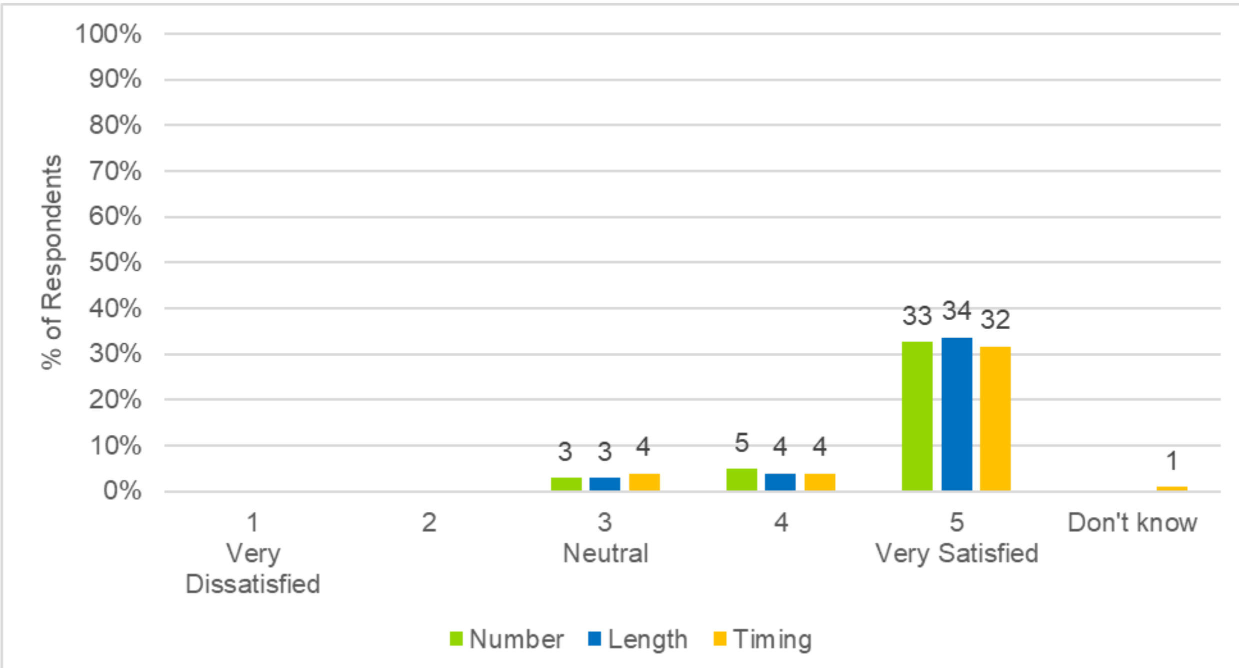
Q28. On Event days, did you ever “opt-out” or override your home charger setting to stop the program from adjusting your charging during the Event (either through the app or on the device itself)? (n=41)



Source: Guidehouse

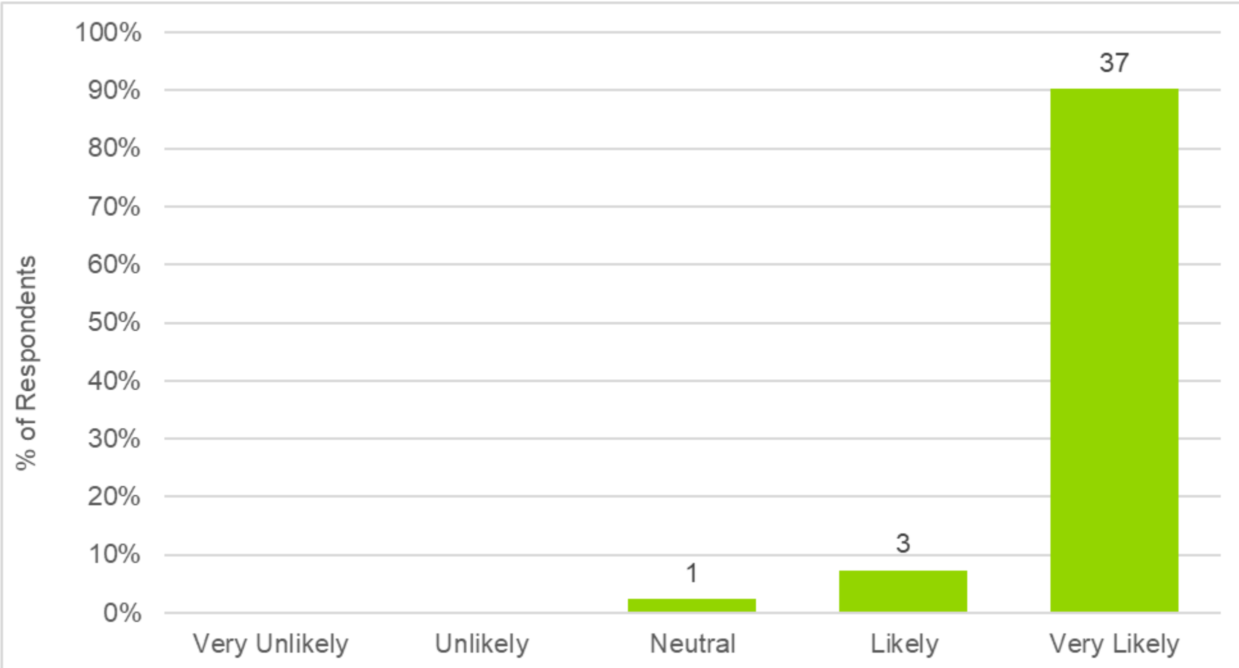
B.1.5 Program Satisfaction

Q35. On a scale of 1 through 5, where 1 is “Very dissatisfied” and 5 is “Very satisfied”, how would you rate your satisfaction with the following aspects of the Eversource ConnectedSolutions EV Home Charger Demand Response Program to-date?



Source: Guidehouse

Q40. How likely are you to continue to participate in the Eversource ConnectedSolutions EV Home Charger Demand Response Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? (n=41)



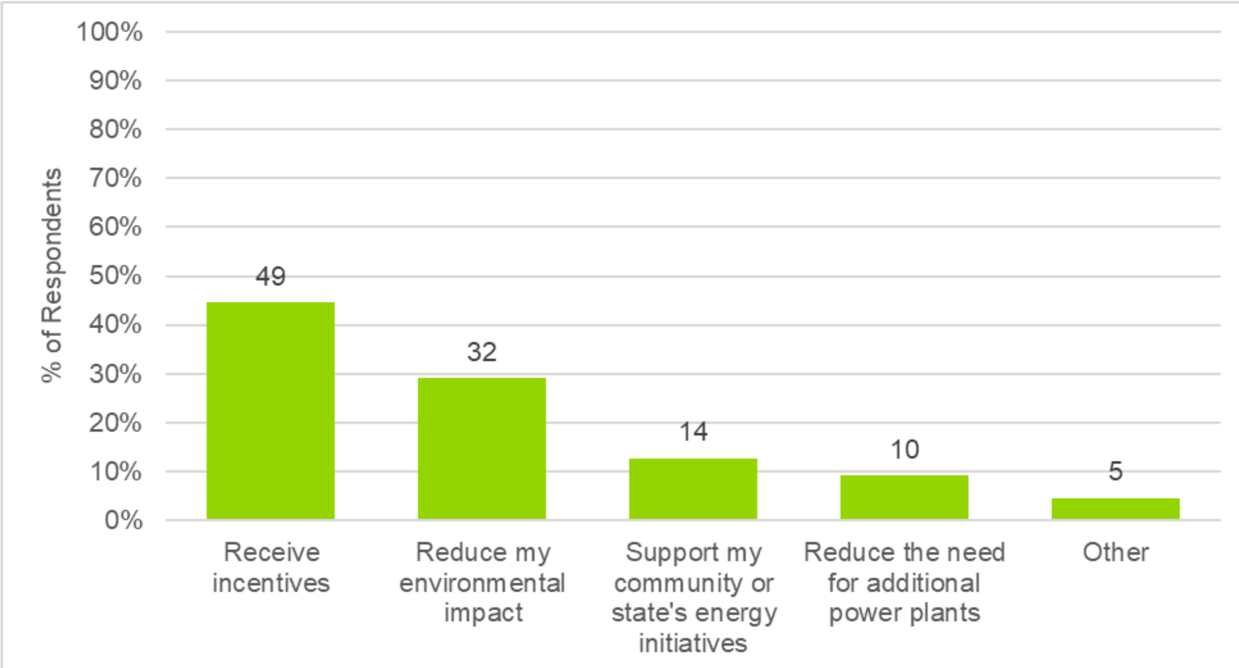
Source: Guidehouse

B.2 2020 Participant Survey Output

B.2.1 Enrollment

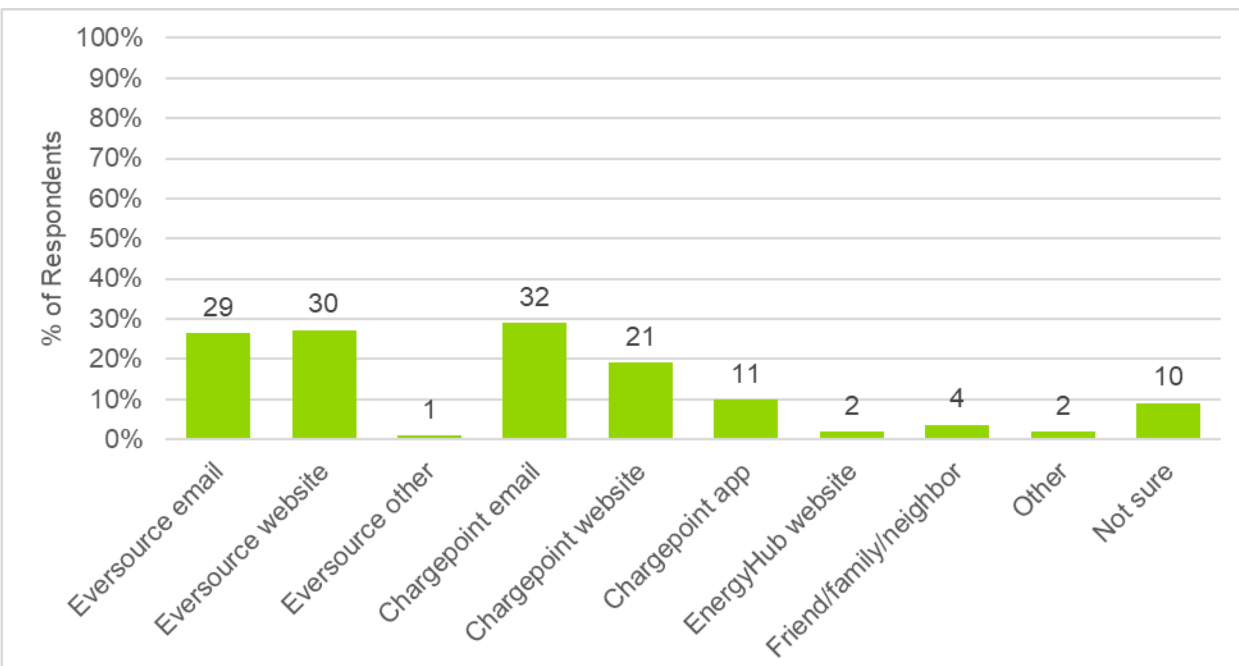
Note that 35 of the 110 survey respondents for the 2020 post-summer participant survey also took the 2019 participant survey. Their responses for the enrollment section are taken from the 2019 participant survey (i.e., they were not asked the enrollment questions again when taking the 2020 survey).

E1. What was your top motivation for enrolling in Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=110)



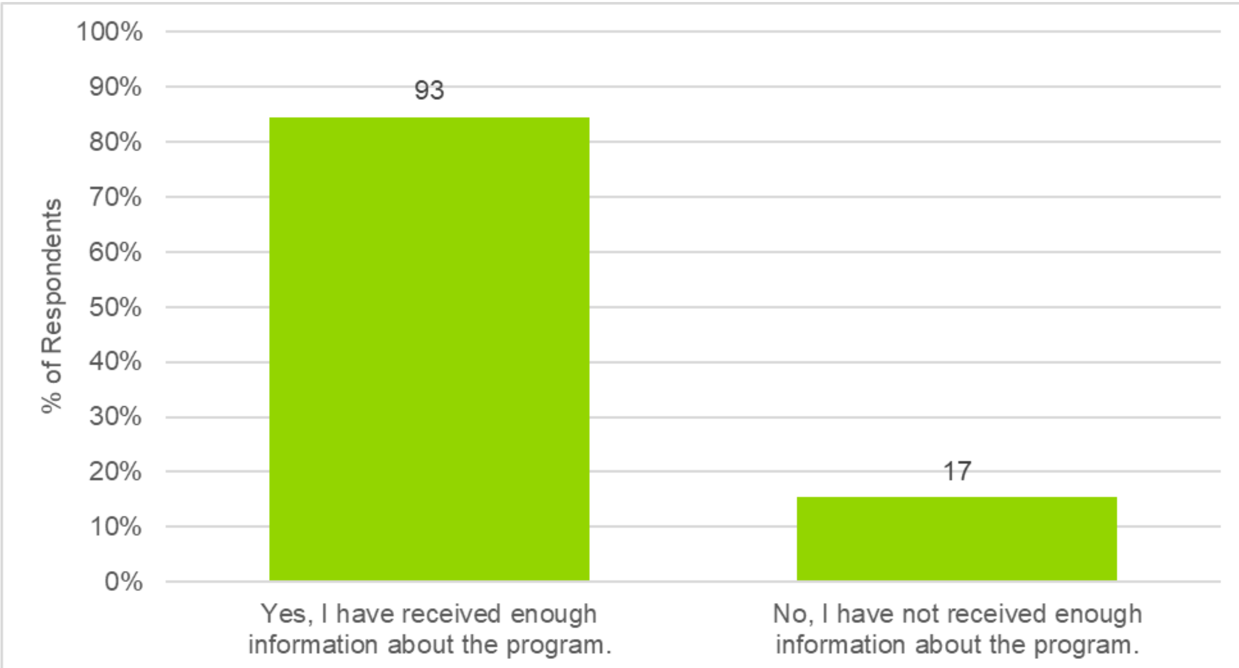
Source: Guidehouse

E2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? Select all that apply. (n=110)



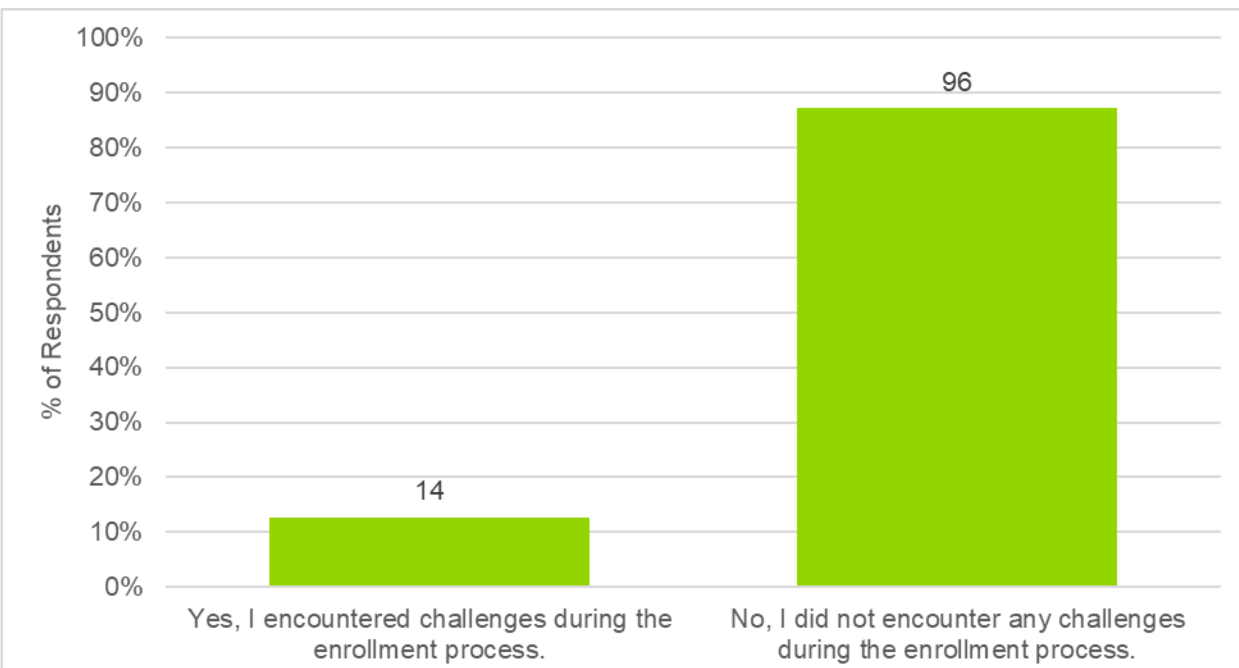
Source: Guidehouse

E3. Has enough information been provided to you about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=110)



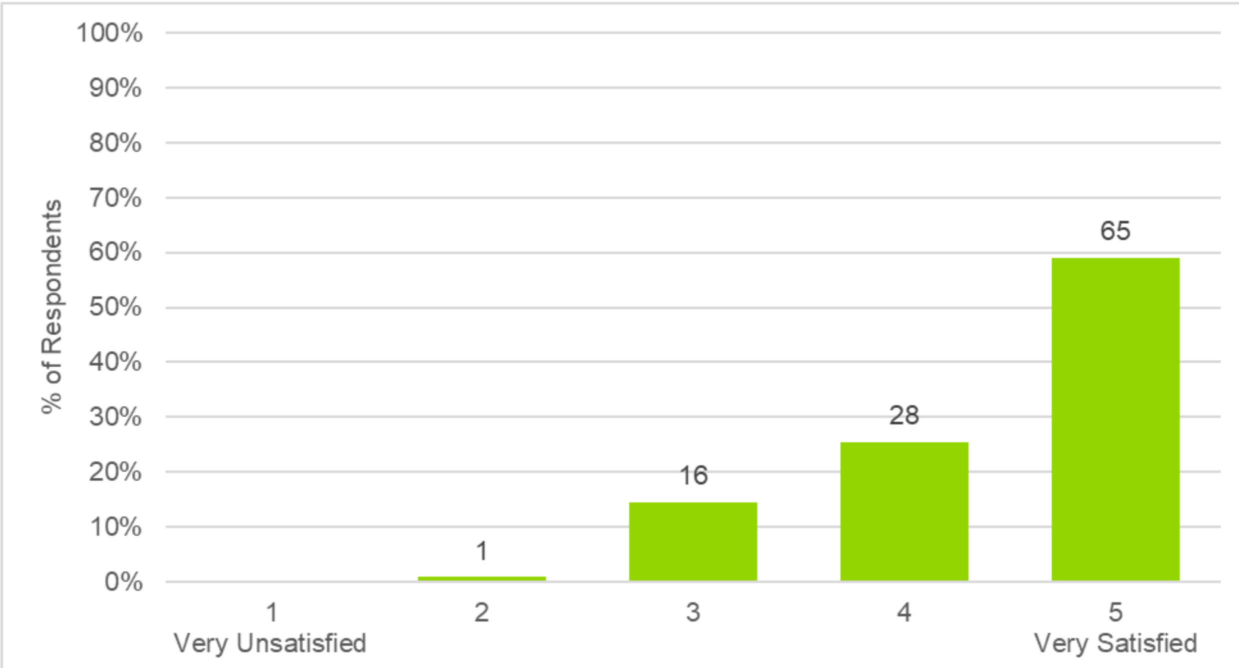
Source: Guidehouse

E5. Did you encounter any challenges or difficulties during the enrollment process? (n=110)



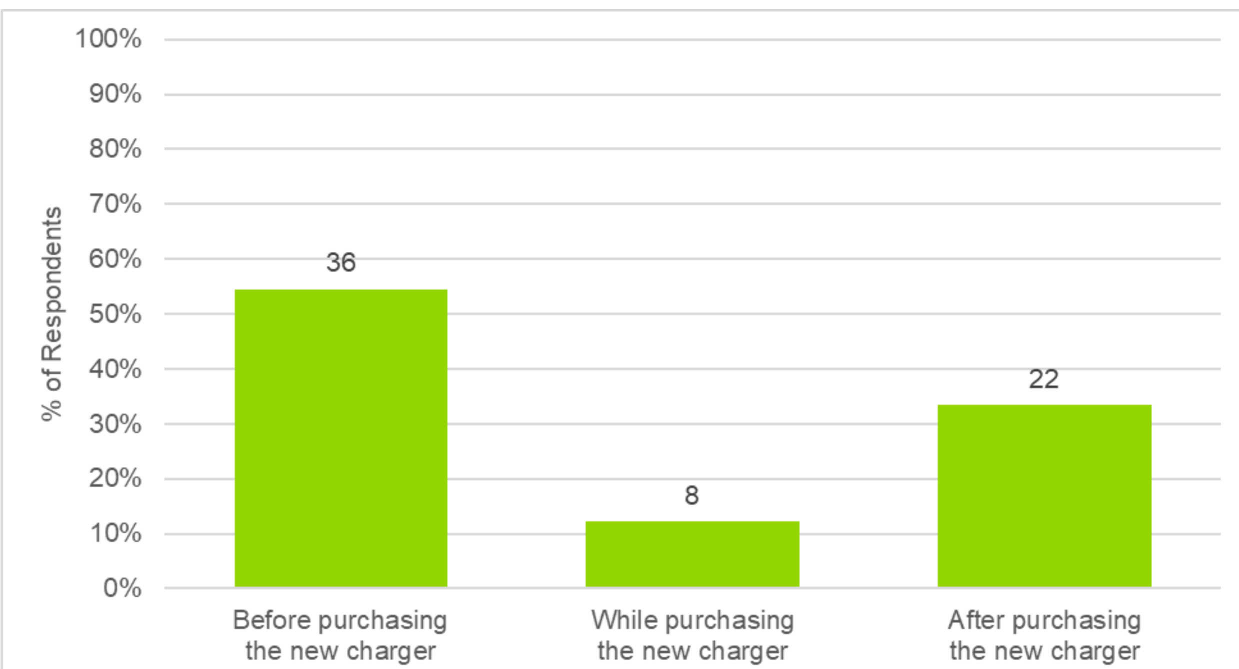
Source: Guidehouse

E7. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program? (n=110)



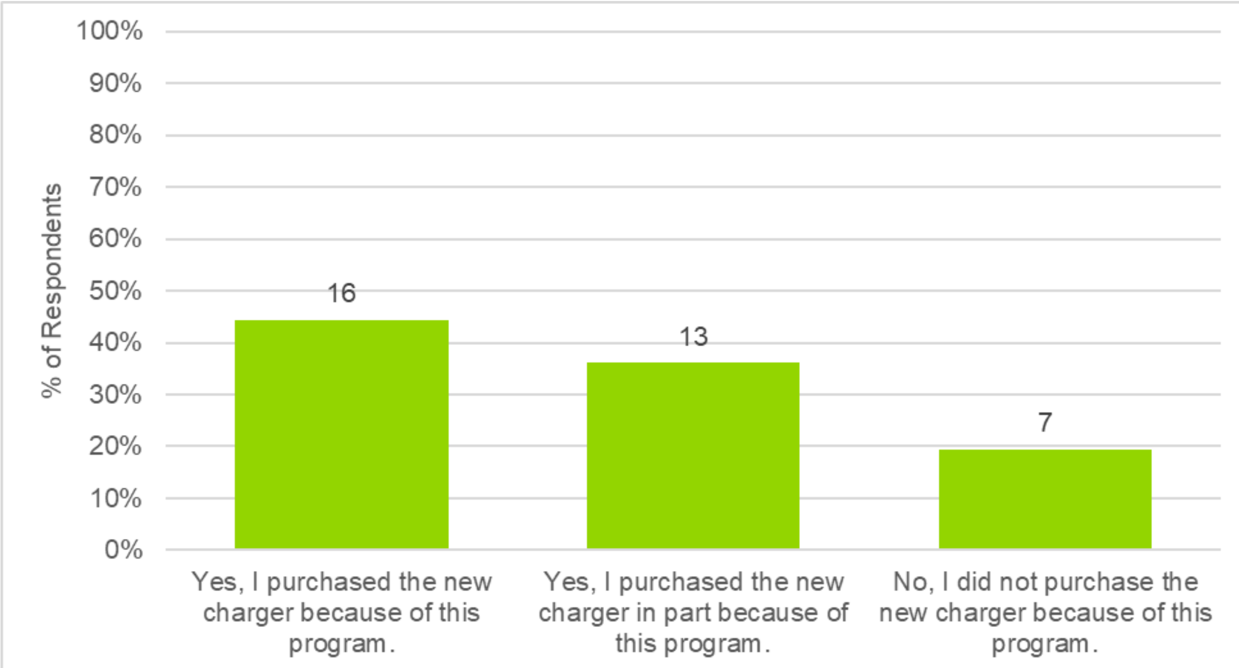
Source: Guidehouse

E10_1. At what point did you become aware of Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=66)



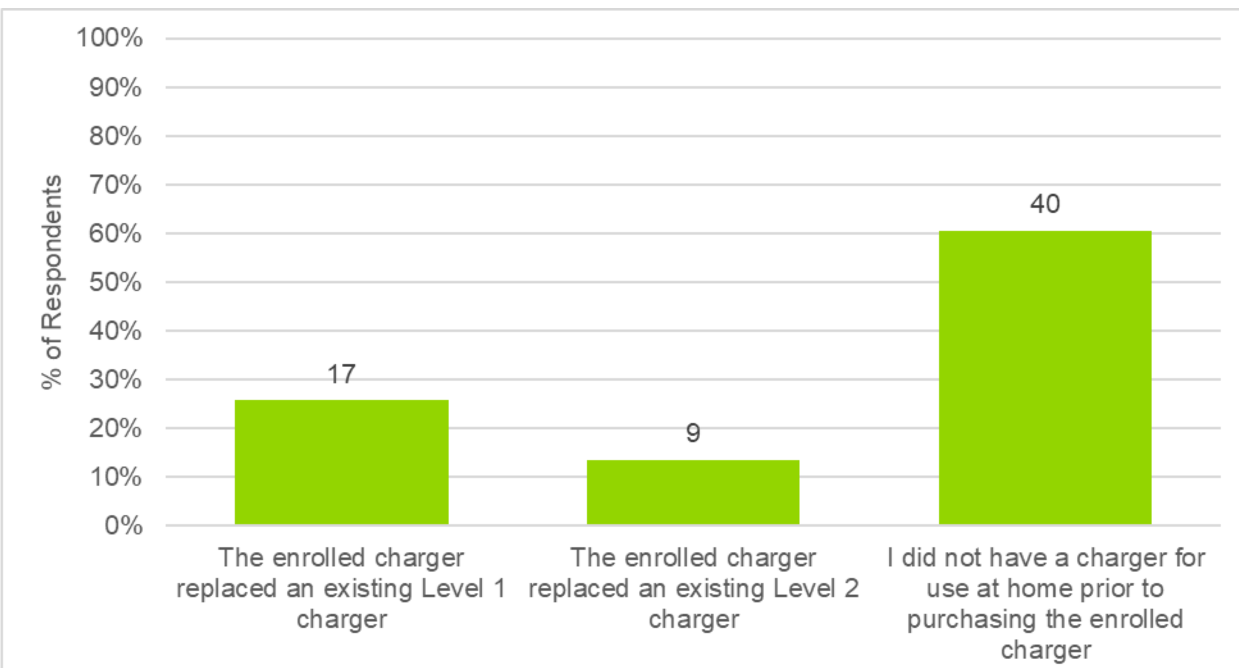
Source: Guidehouse

E10. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your decision to purchase the new charger? (n=36)



Source: Guidehouse

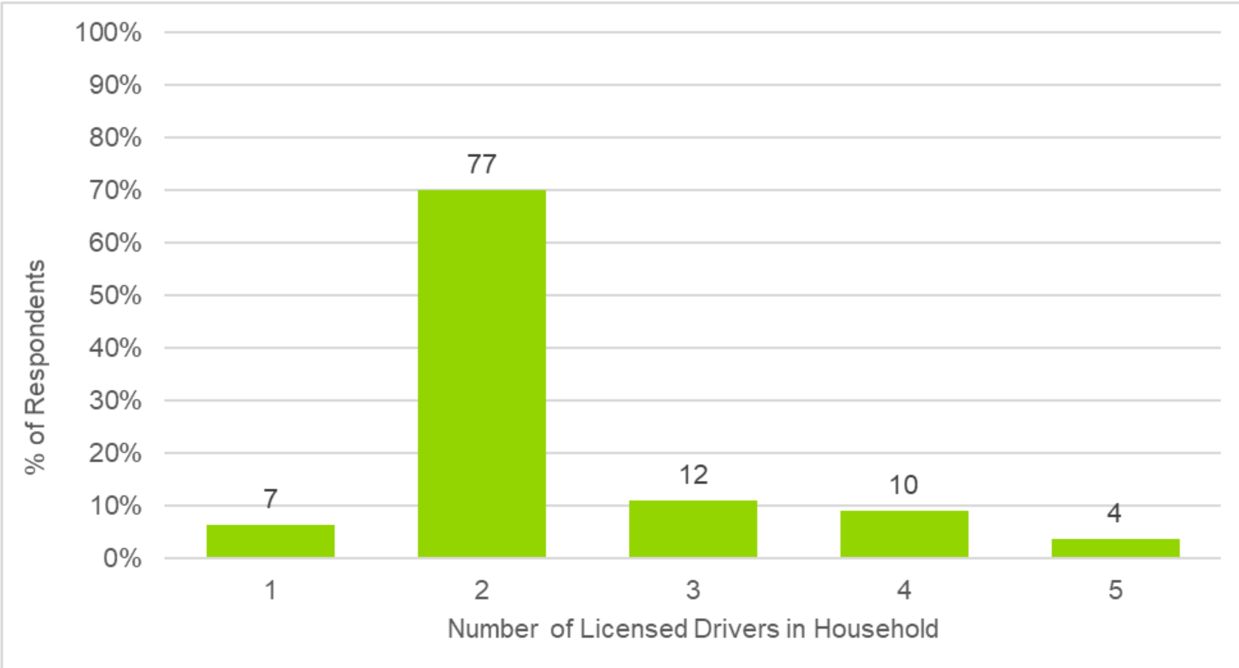
E11. Which of the following best describes the charger that you owned prior to purchasing the Level 2 charger that is currently enrolled in program? (n=66)



Source: Guidehouse

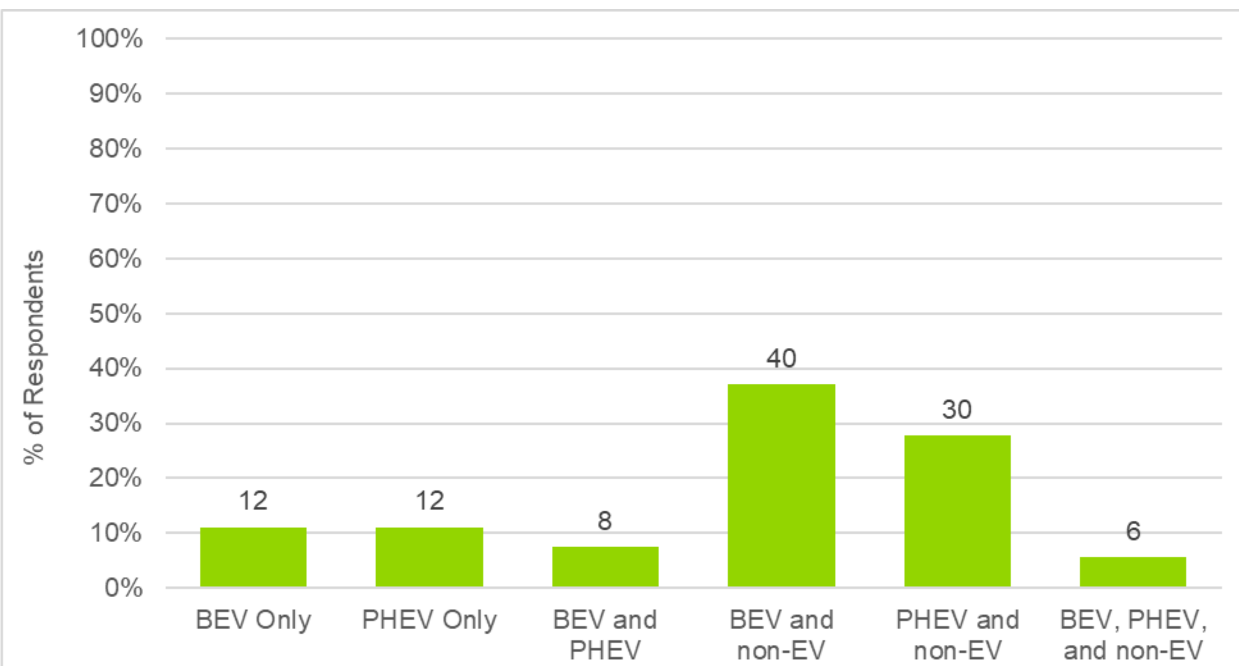
B.2.2 EV Charactersitcs and Driving Behavior

EV1. How many licensed drivers are there in your household? (n=110)



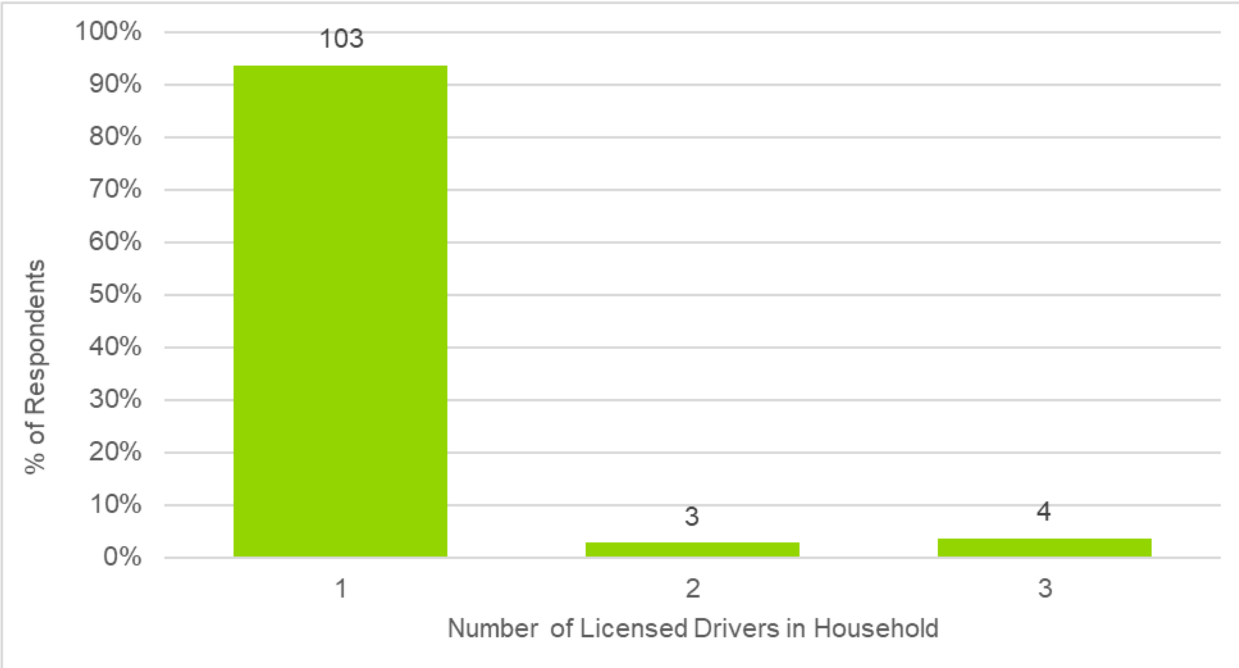
Source: Guidehouse

EV2. Please indicate the number of each type of vehicle your household owns. (n=108)



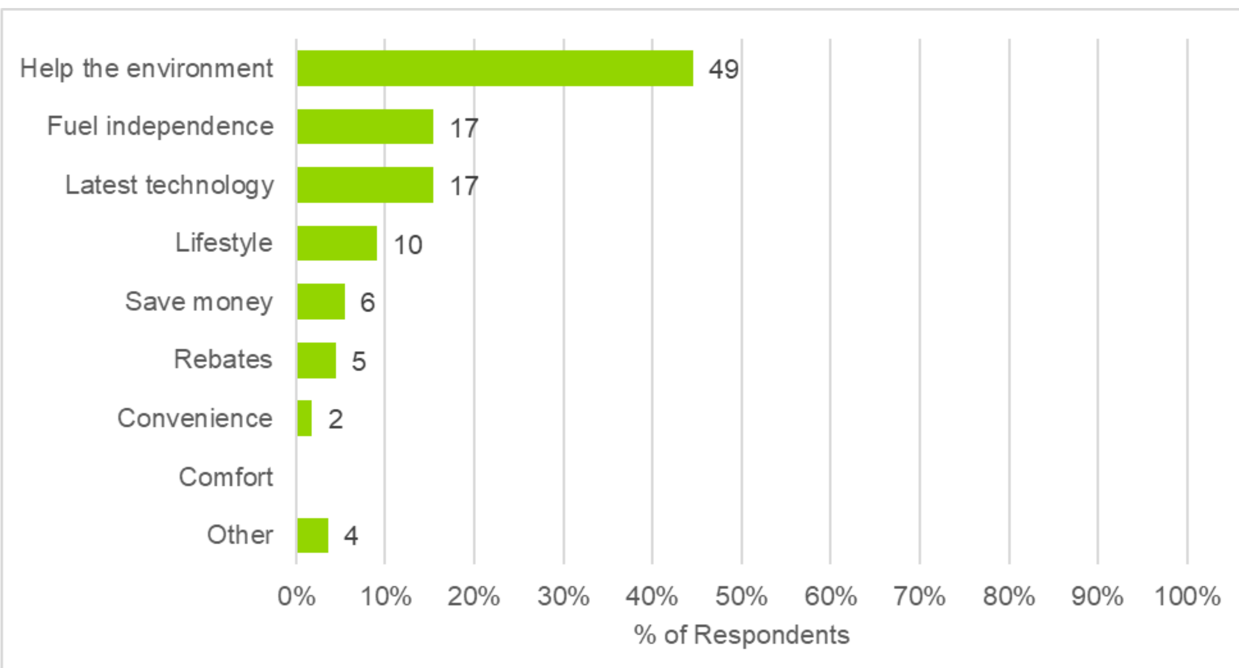
Source: Guidehouse

EV10. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the summer 2020 (June through August)? (n=110)



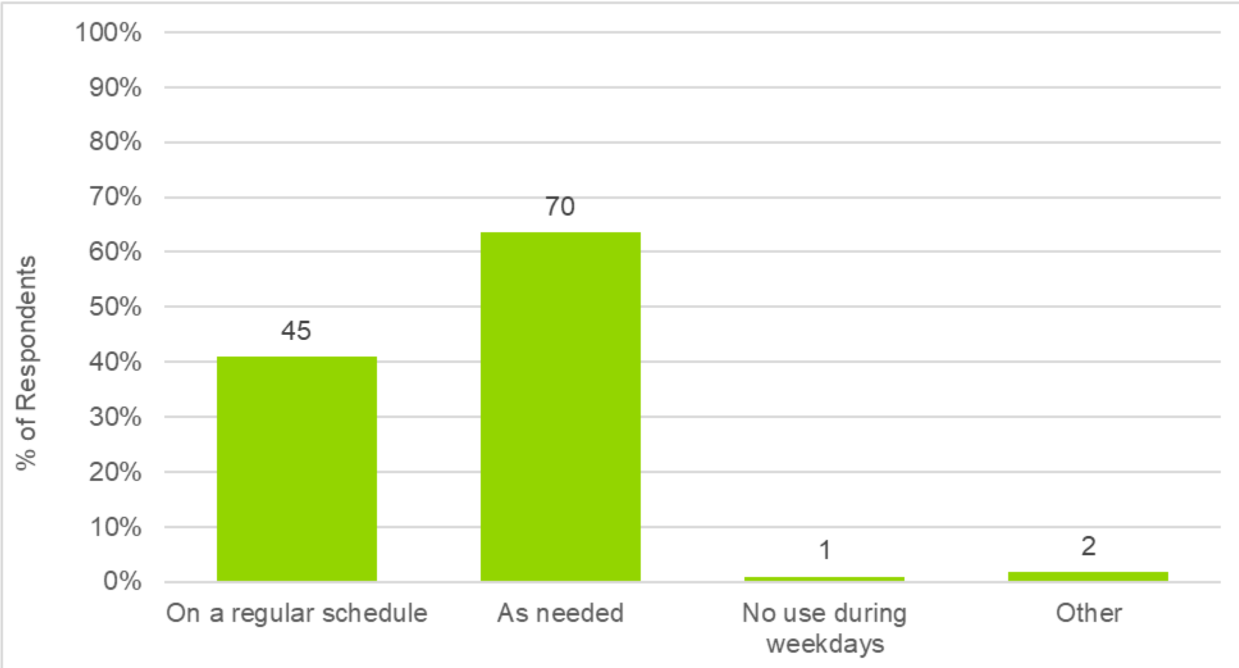
Source: Guidehouse

EV11. What was your household's top motivation for buying the electric vehicle? (n=110)



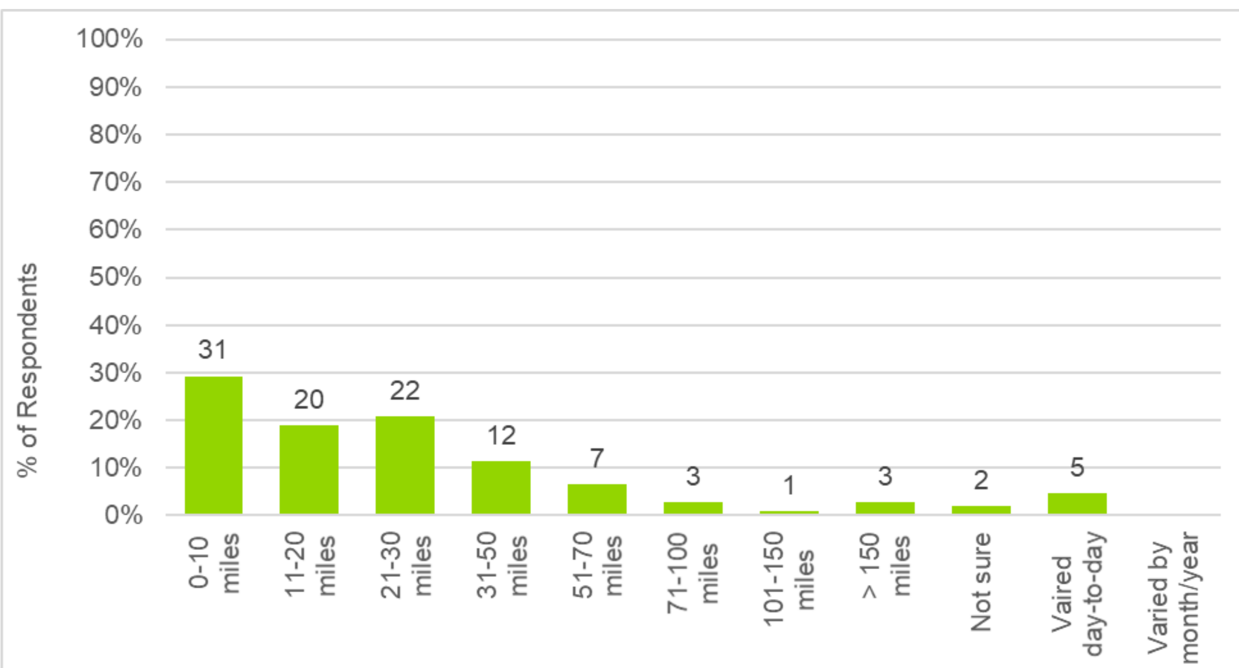
Source: Guidehouse

EV12. Which of the following best describes how your household typically used this electric vehicle on weekdays (Monday through Friday) during the summer 2020 (June through August)? Select all that apply. (n=110)



Source: Guidehouse

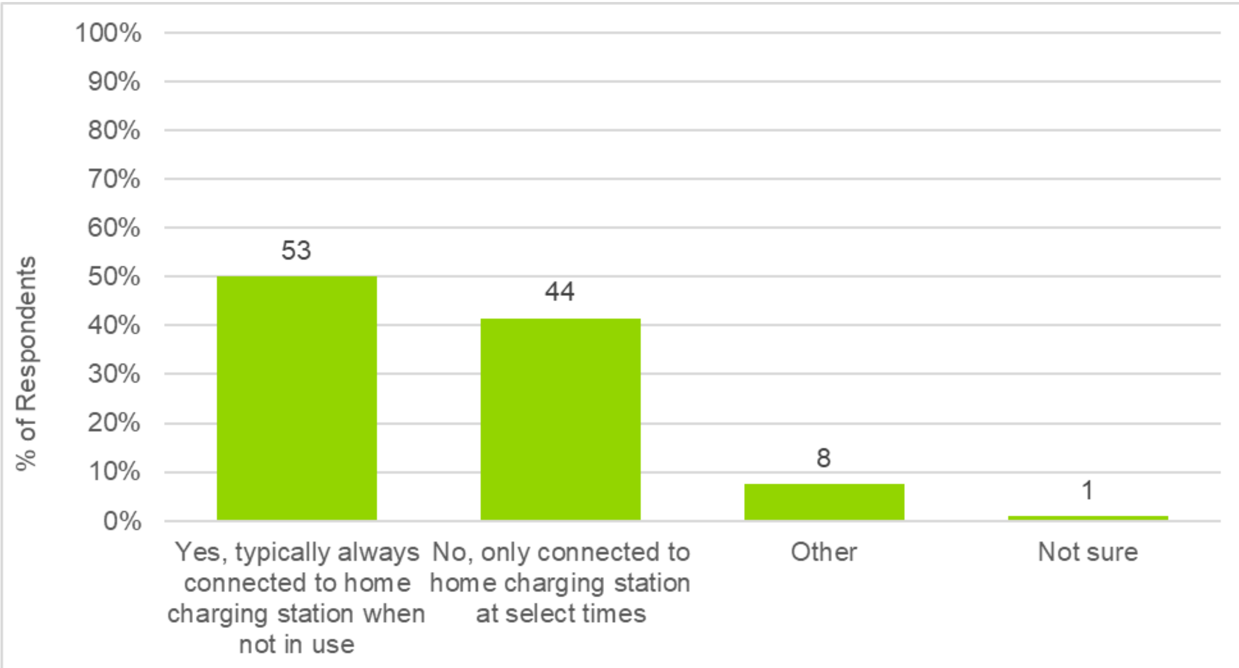
EV13. During a *typical* summer 2020 weekday (Monday through Friday), on average, how many miles was this electric vehicle driven by you and other members of your household? (n=106)



Source: Guidehouse

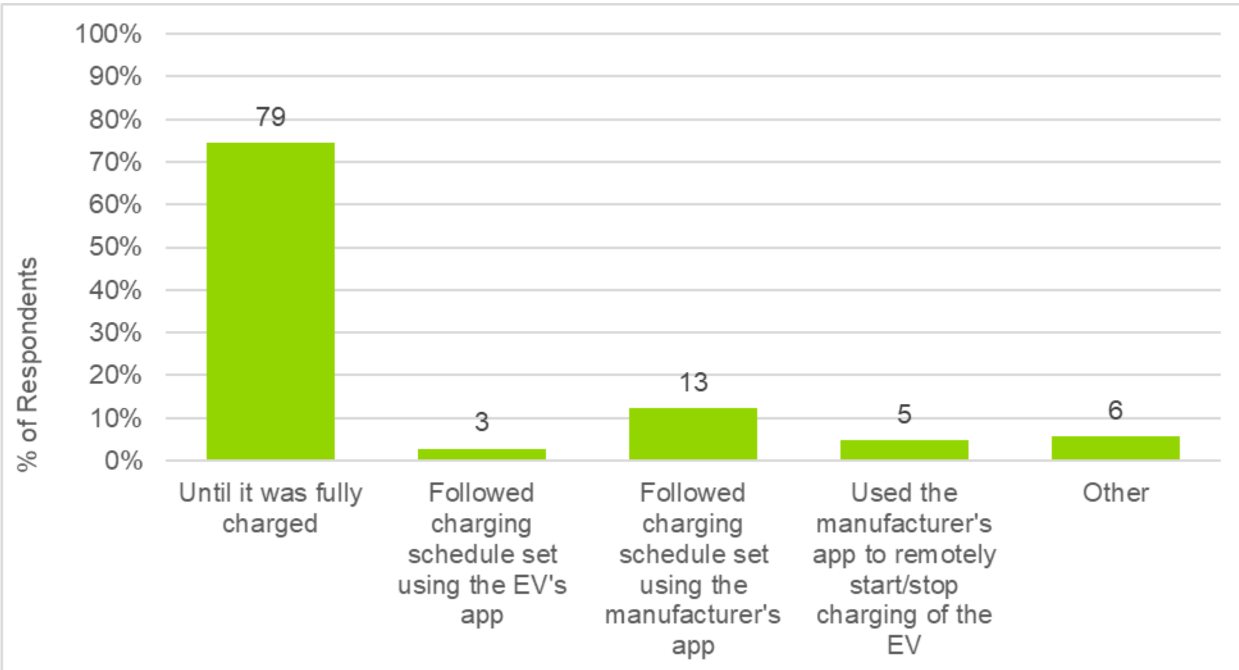
B.2.3 Charging Behavior

CB1. During summer 2020, when this electric vehicle was not being used and at home, was it typically connected to your home charging station?



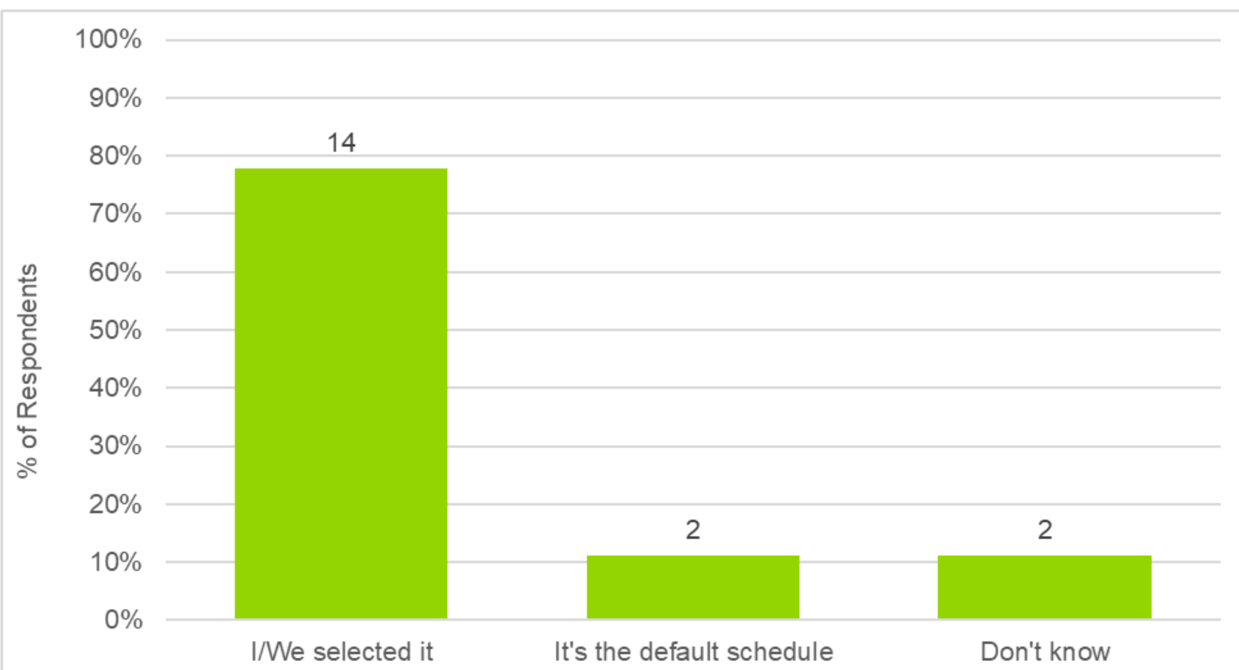
Source: Guidehouse

CB2. During summer 2020, which of the following best describes your household's use of your home charging station for this electric vehicle? (n=106)



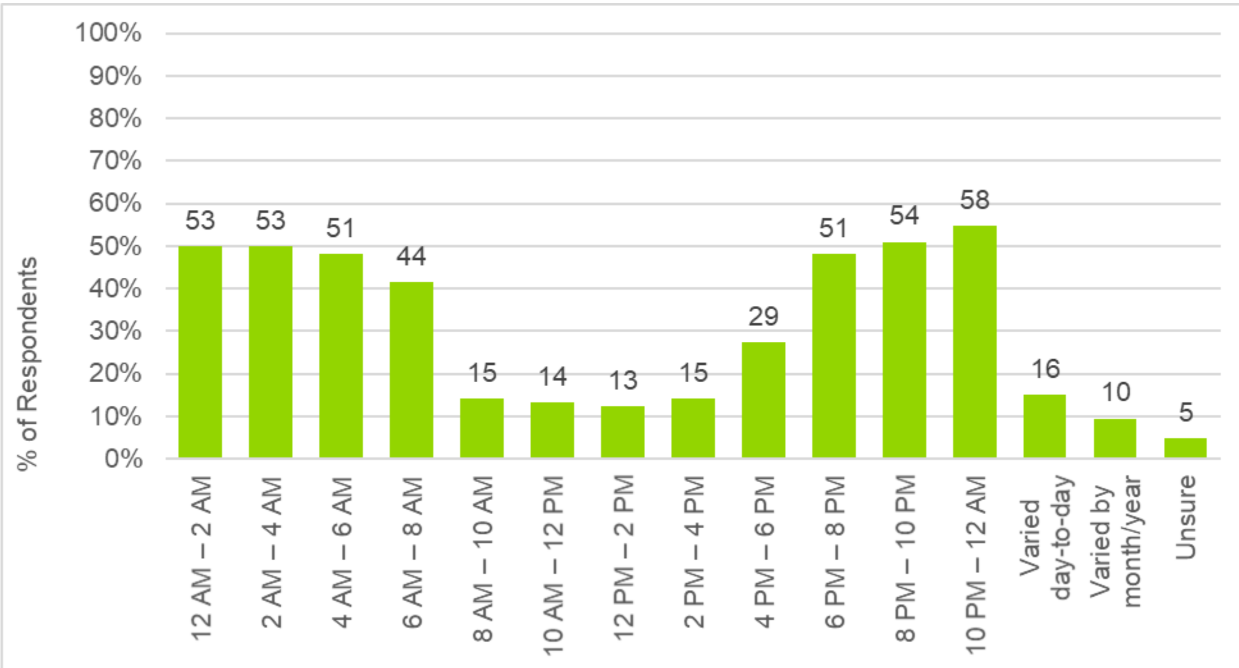
Source: Guidehouse

CB2_b. How was this electric vehicle's charging schedule determined? (n=18)



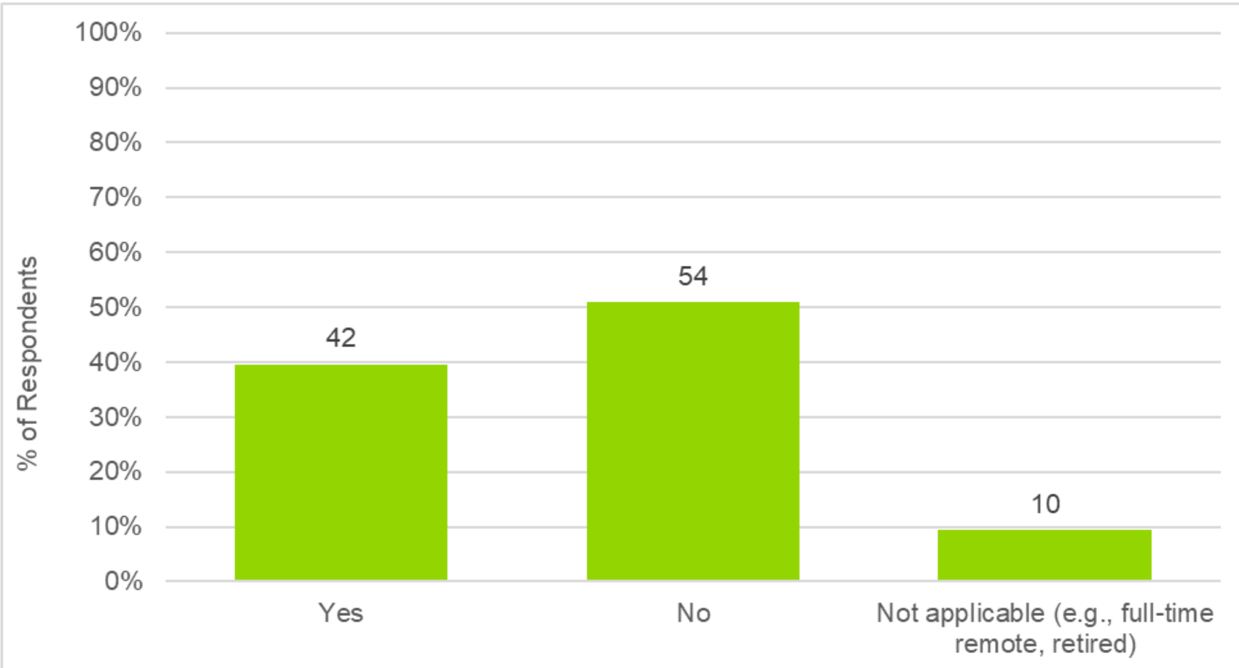
Source: Guidehouse

CB3. Below, please indicate the time ranges during which this electric vehicle was typically connected to your *home charging station* on weekdays (Monday through Friday) during summer 2020 (June through August). Select all the time ranges that apply. (n=106)



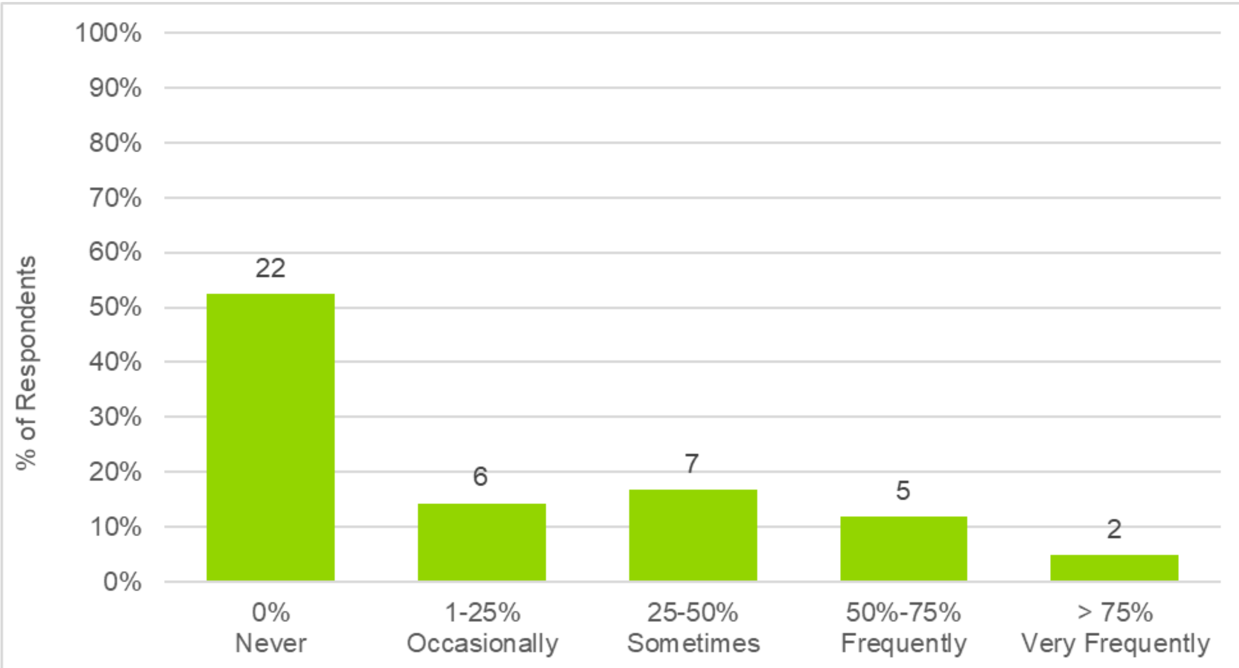
Source: Guidehouse

CB4. Do you or other members of your household have access to charging at a workplace? Please answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it. (n=106)



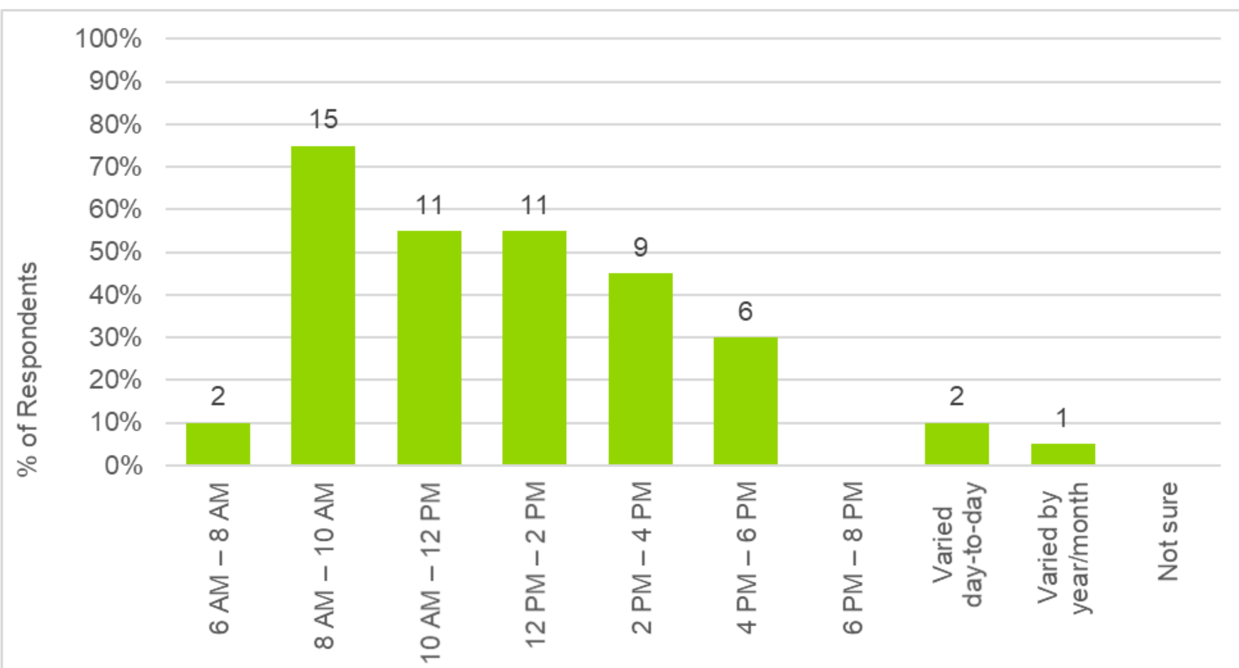
Source: Guidehouse

CB5. Approximately what percentage of this electric vehicle's charging during summer 2020 (June through August) occurred at a workplace? (n=42)



Source: Guidehouse

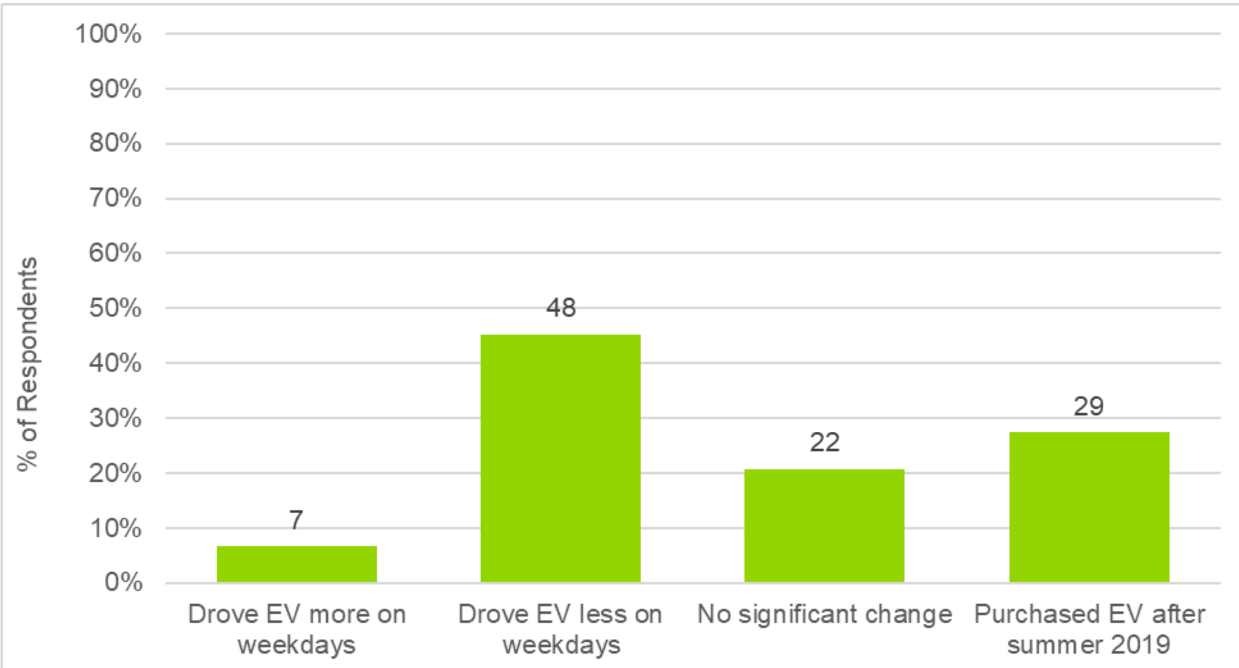
CB7. Below, please indicate when this electric vehicle was typically <u>connected</u> to a *workplace charging station* on weekdays (Monday through Friday) during the summer 2020 (June through August). (n=20)



Source: Guidehouse

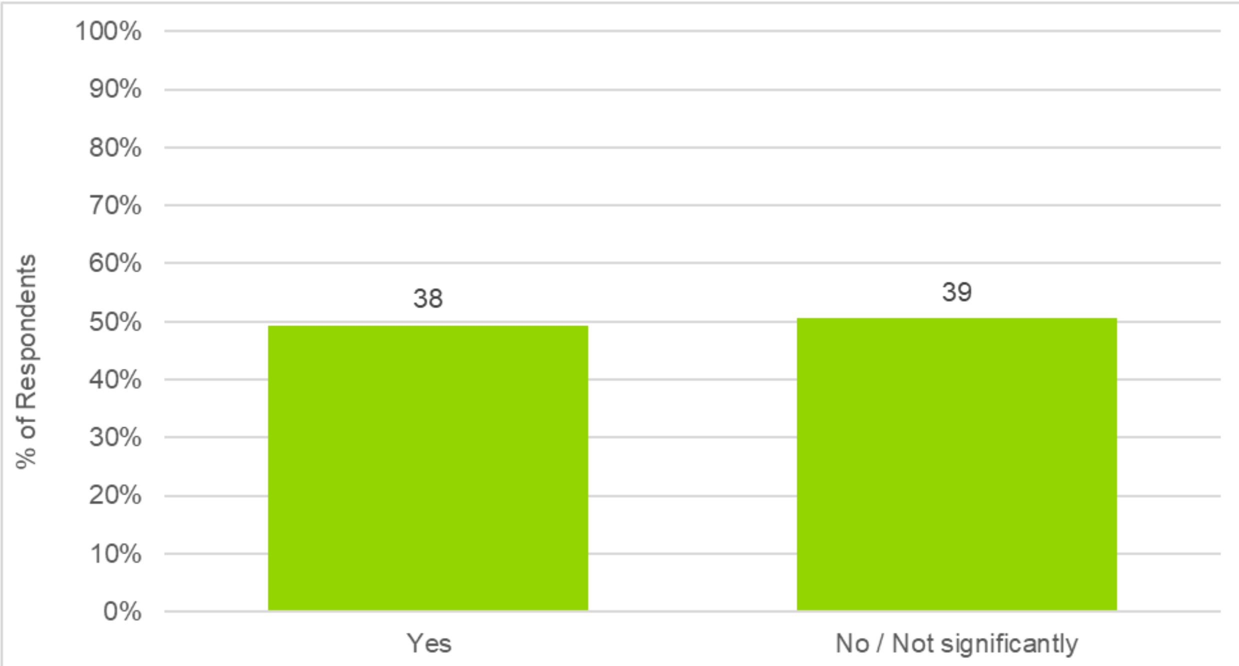
B.2.4 Changes Since Summer 2019

CS1. Compared to your household's use of this electric vehicle in the summer of 2019, did the typical miles per day that this electric vehicle was driven on weekdays change in summer 2020? (n=106)



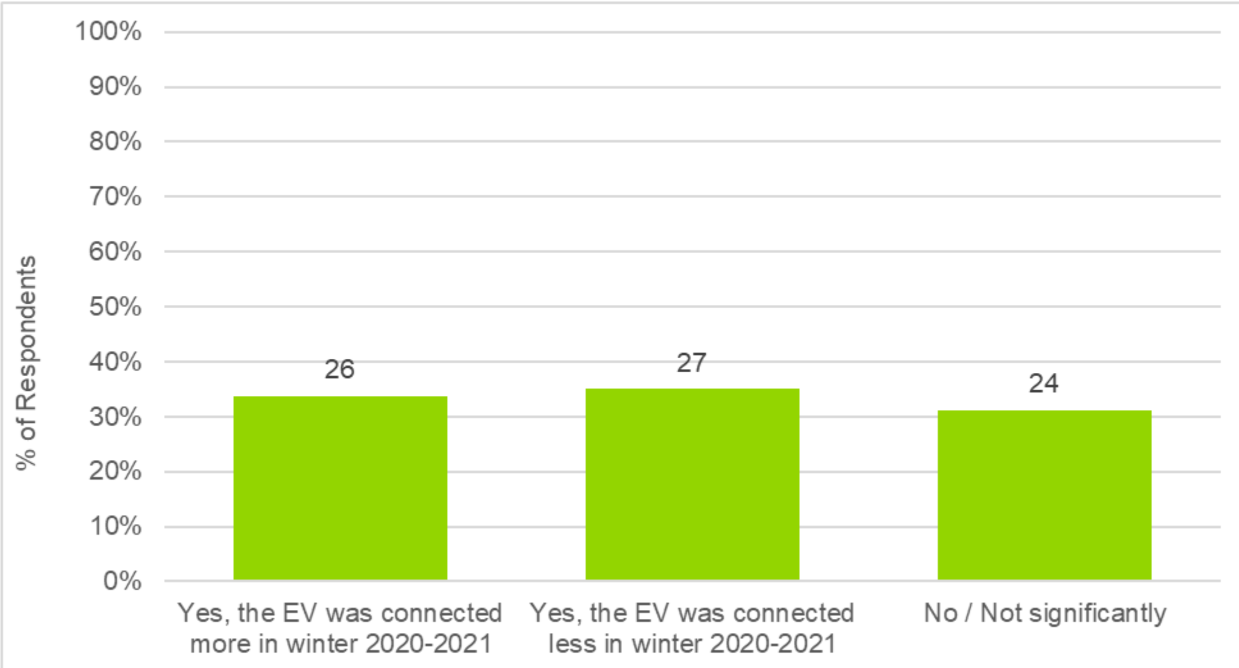
Source: Guidehouse

CS2. Compared to your household's use of your electric vehicle in the summer of 2019, did the timing of when your electric vehicle was typically driven on weekdays change in summer 2020? (n=77)



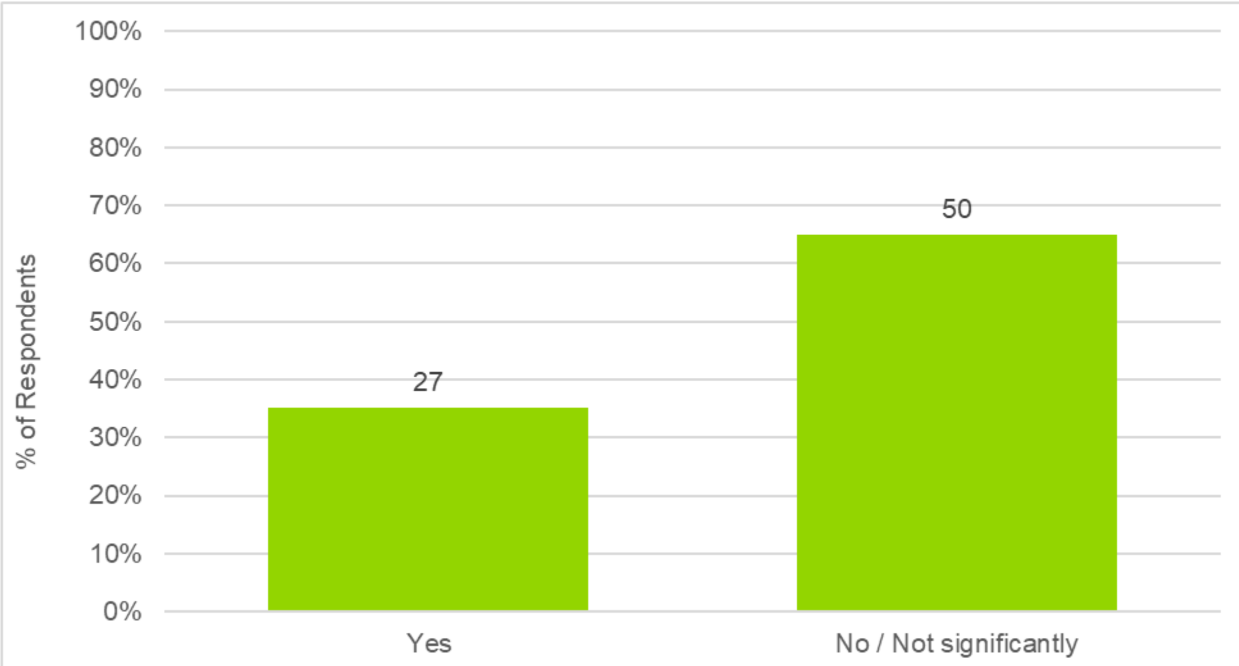
Source: Guidehouse

CS3. Compared to your household's use of your home charging station in the summer of 2019, did the amount of time your electric vehicle was typically connected to your home charging station on weekdays change in 2020? (n=77)



Source: Guidehouse

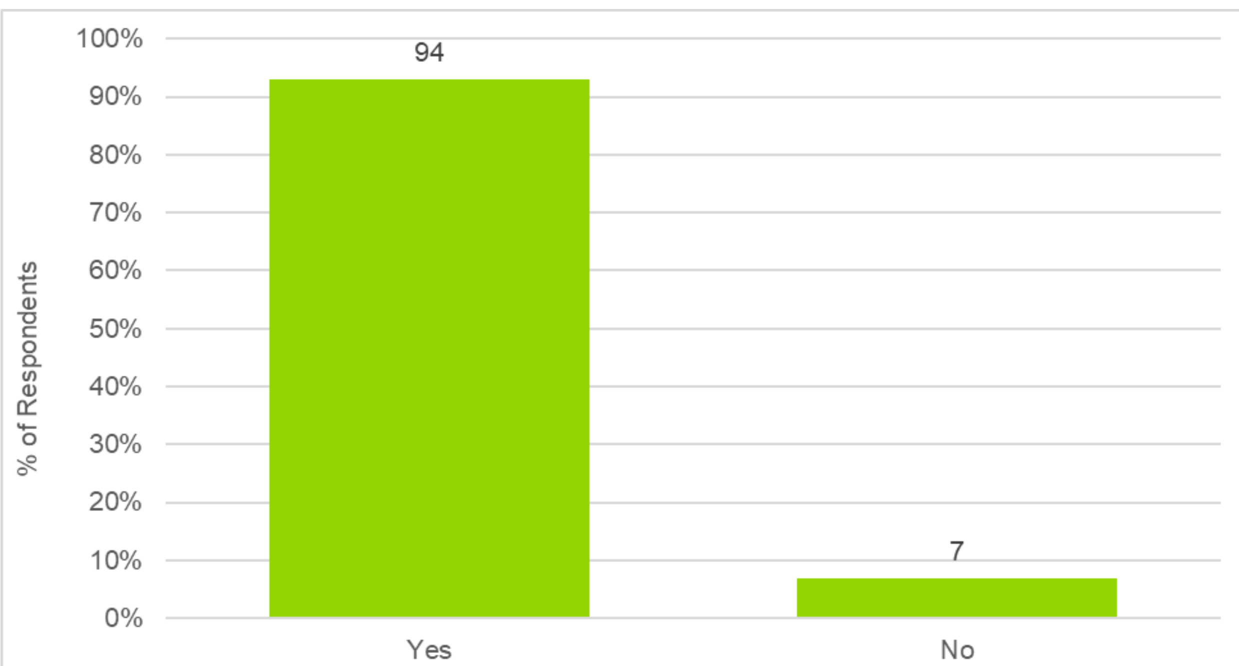
CS4. Compared to your household's use of your home charging station in the summer of 2019, did the timing of when your electric vehicle was typically connected to your home charging station on weekdays change in summer 2020? (n=77)



Source: Guidehouse

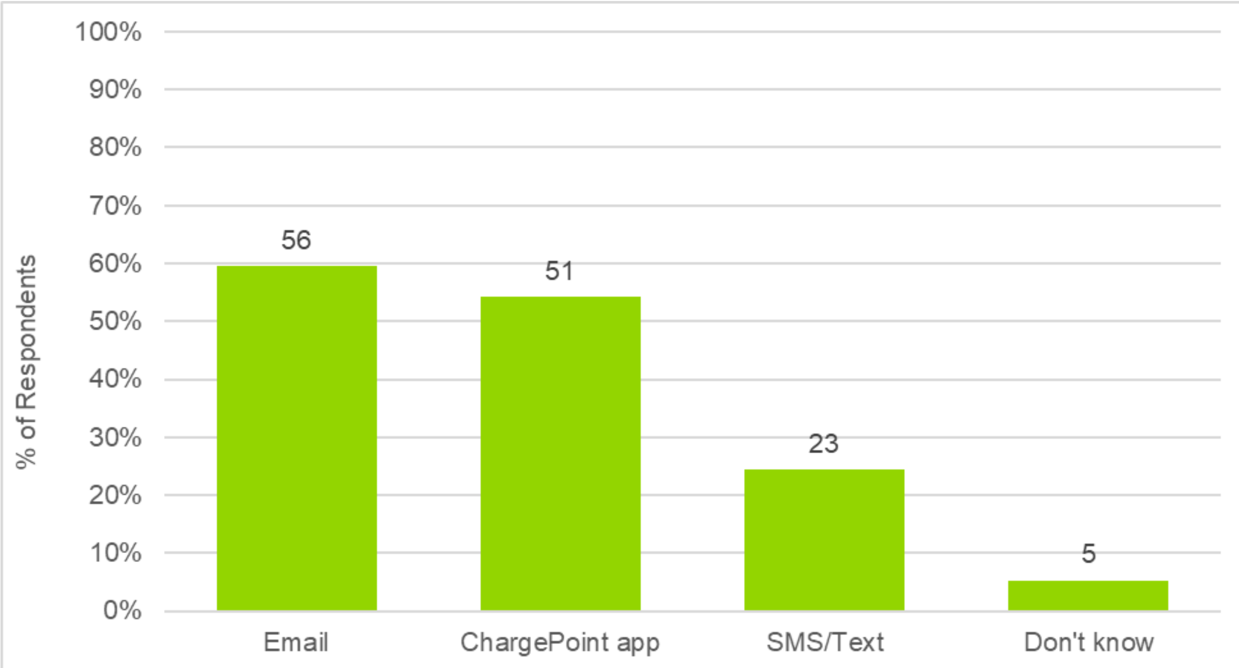
B.2.5 Behavior During Events

ET2. Do you recall ever receiving advance notifications about Events? (n=101)



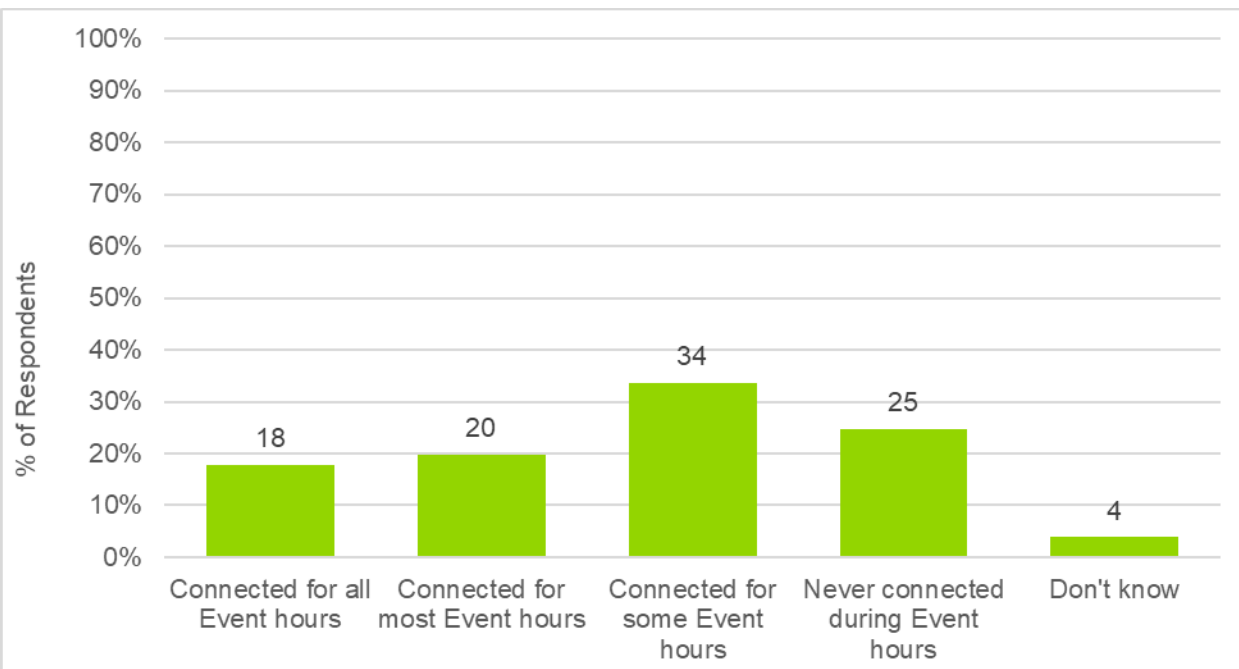
Source: Guidehouse

ET3. How were you notified in advance that an Event was going to occur? Select all that apply. (n=94)



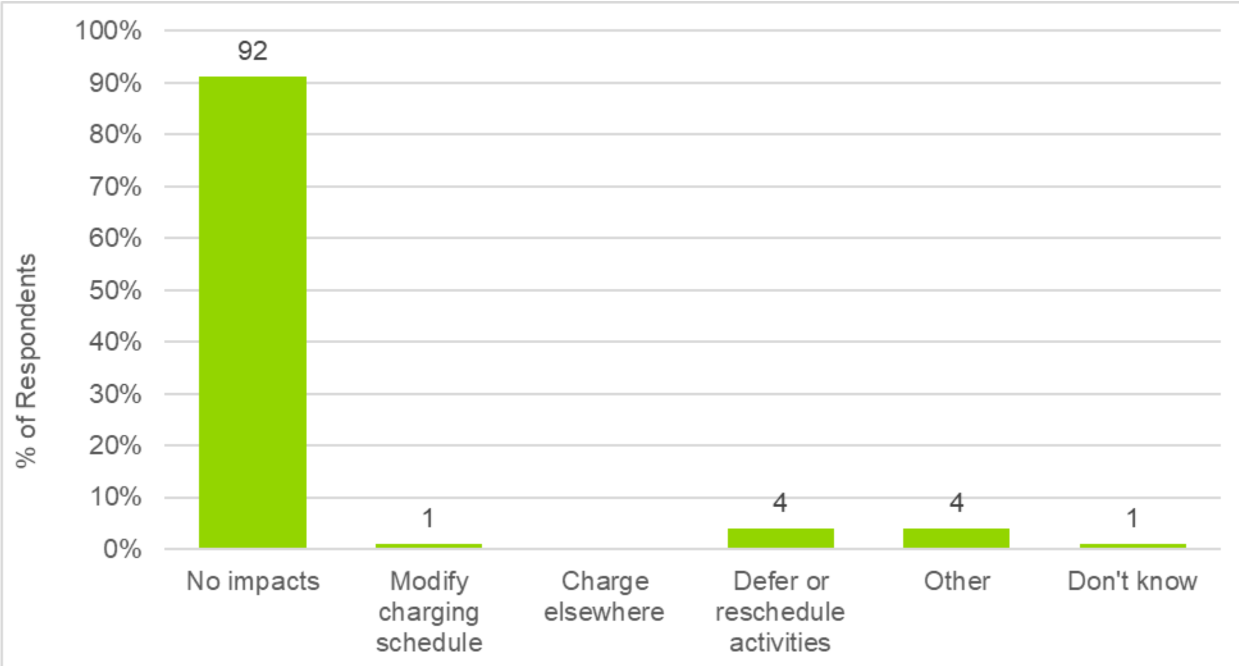
Source: Guidehouse

ET5. For the Events you can recall during summer 2020, how often was your electric vehicle connected to your home charging station during Event hours?



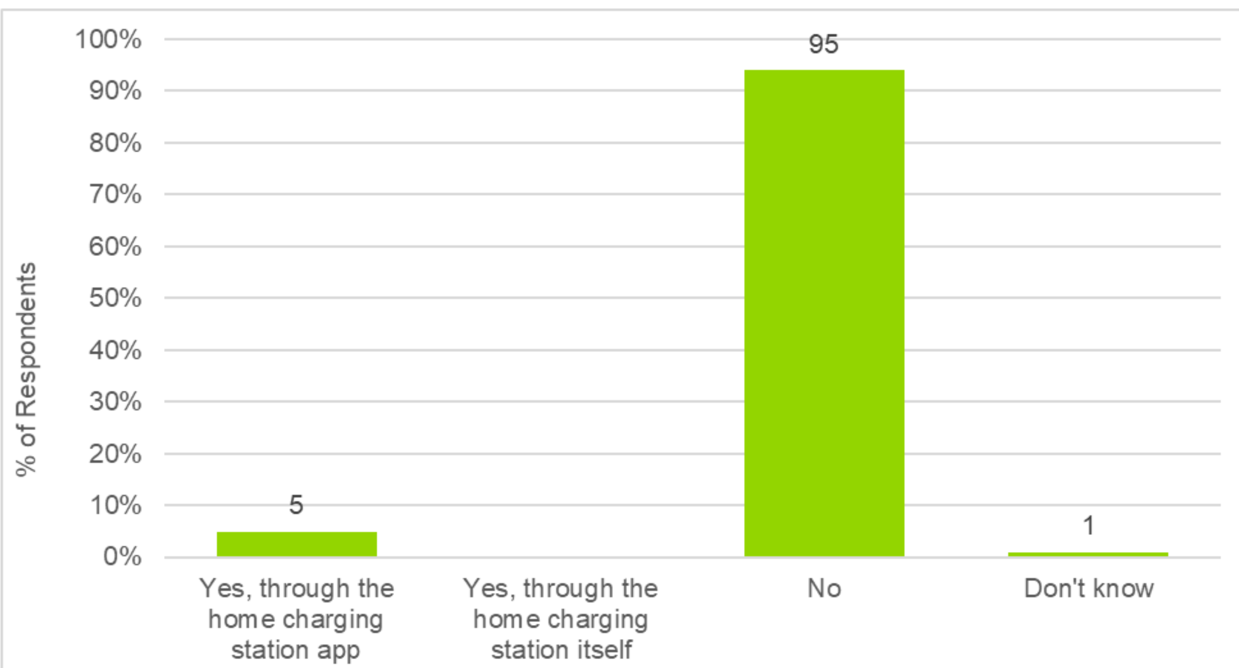
Source: Guidehouse

ET6. Please indicate how the Events affected your normal charging and/or driving behavior during summer 2020. Select all that apply. (n=101)



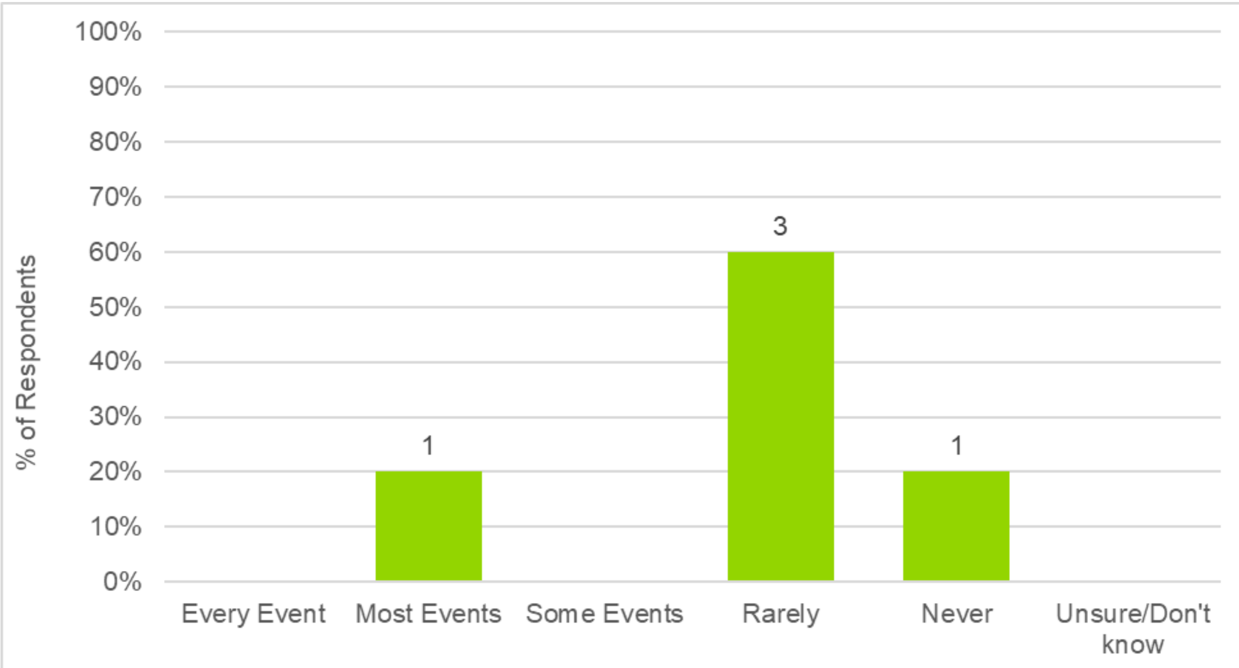
Source: Guidehouse

ET8. On Event days in summer 2020, did you ever “opt-out” or override your home charging station setting to stop the program from adjusting your charging during the Event (either through the app or on the device itself)? (n=101)



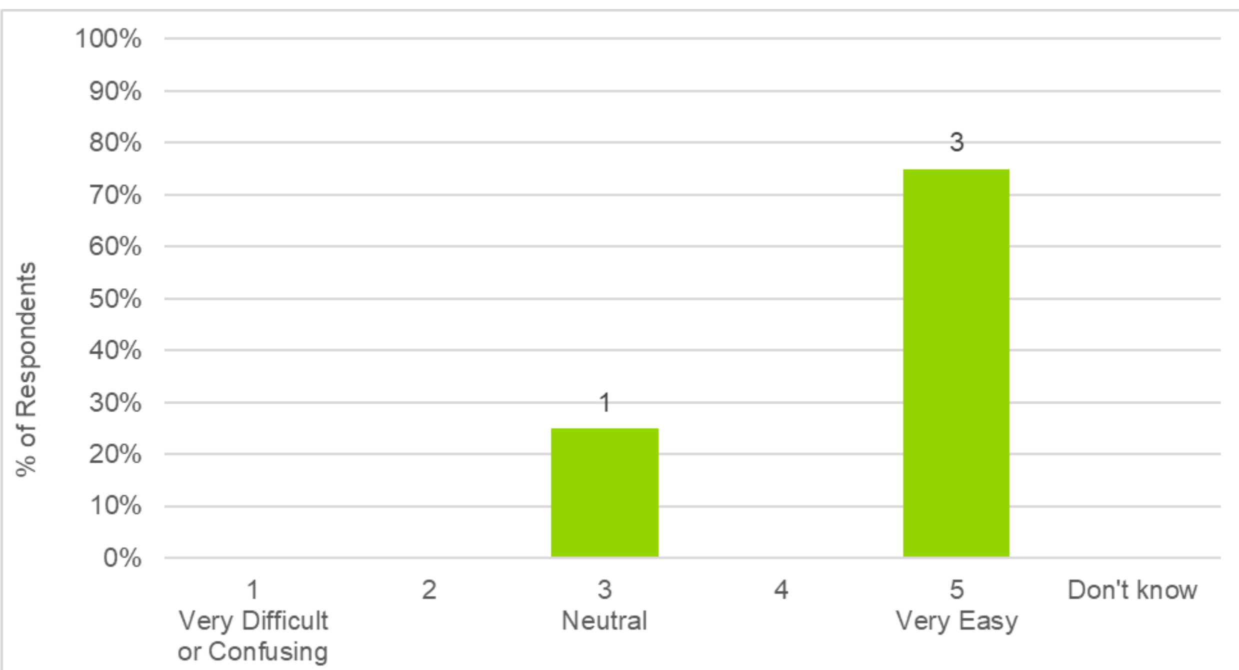
Source: Guidehouse

ET9. How often would you say you chose to override the scheduled Event charging setting once the Event was in-progress? (n=5)



Source: Guidehouse

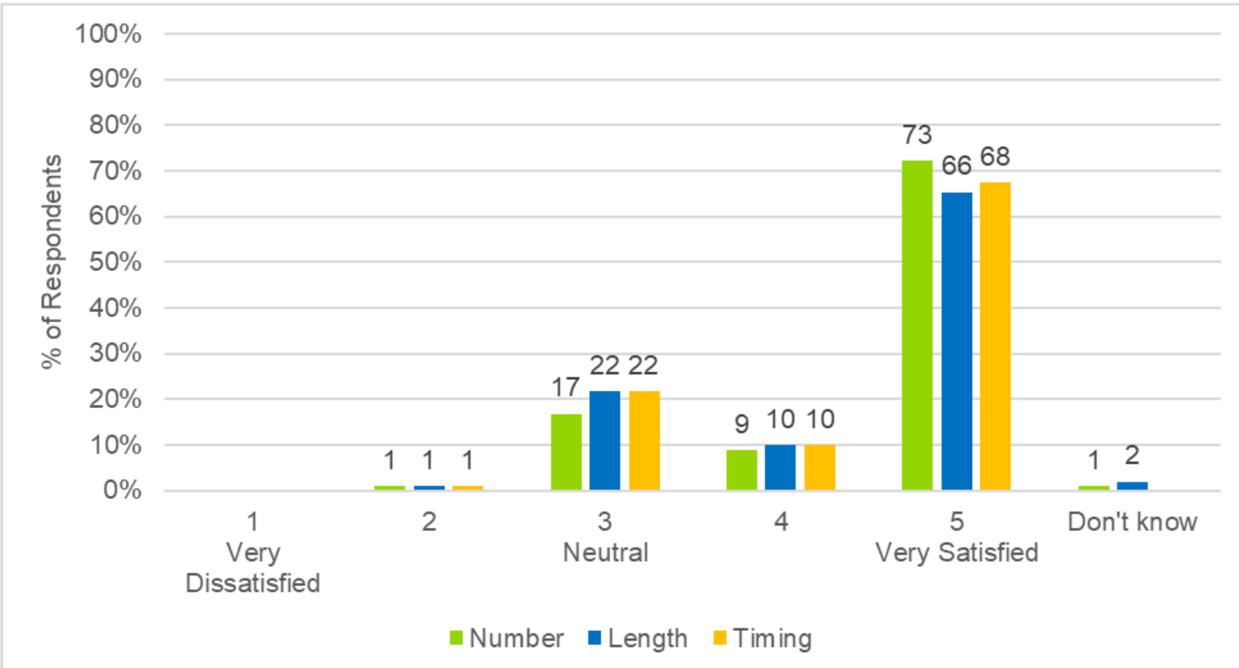
ET11. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override Events? (n=5)



Source: Guidehouse

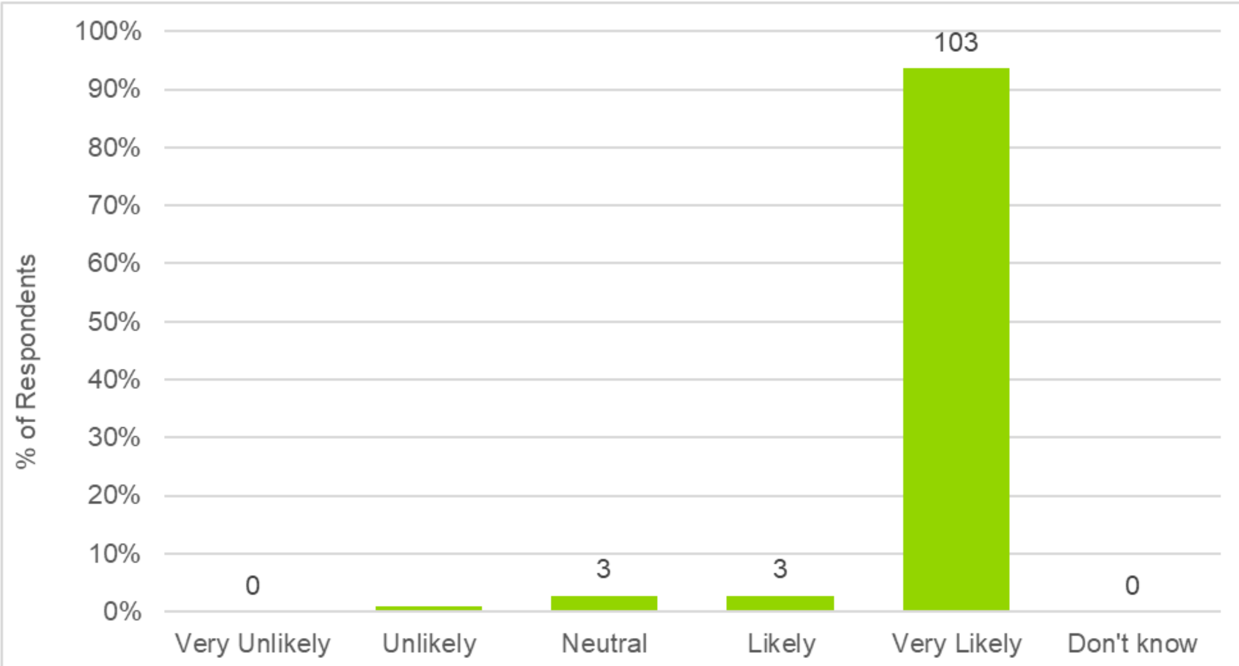
B.2.6 Program Satisfaction

S1. On a scale of 1 through 5, where 1 is “Very dissatisfied” and 5 is “Very satisfied”, how would you rate your satisfaction with the following aspects of Eversource’s ConnectedSolutions EV Home Charger Demand Response Program to-date? (n=101)



Source: Guidehouse

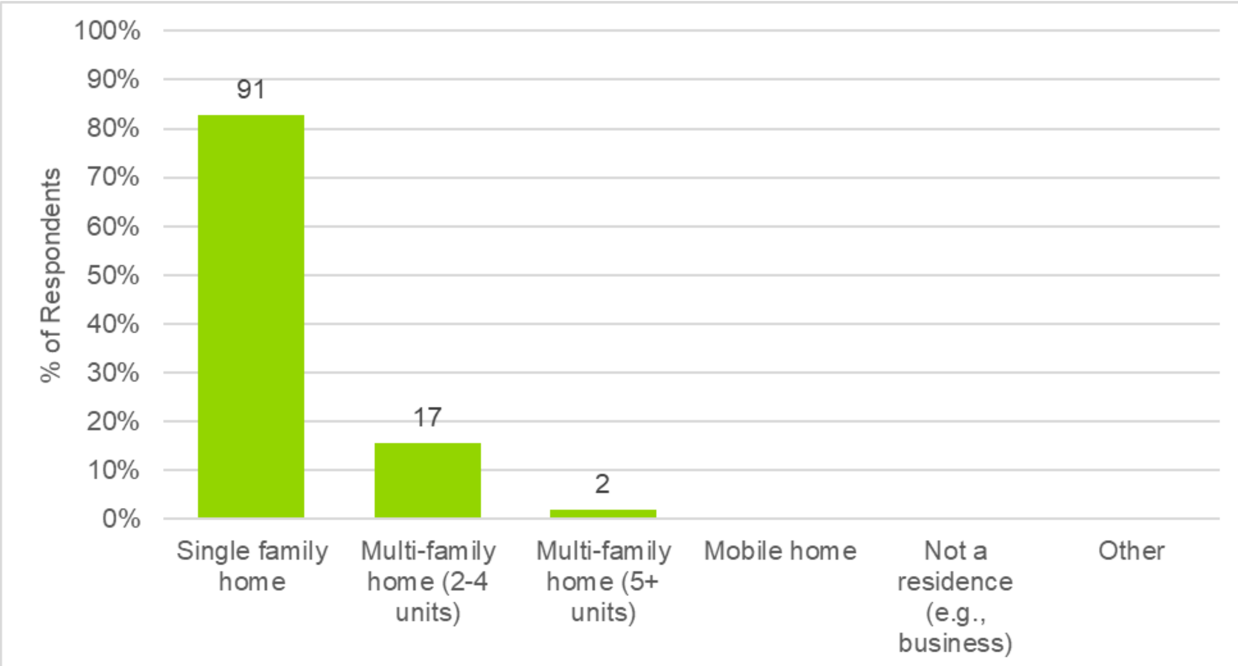
S5. How likely are you to continue to participate in Eversource's ConnectedSolutions EV Home Charger Demand Response Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? (n=110)



Source: Guidehouse

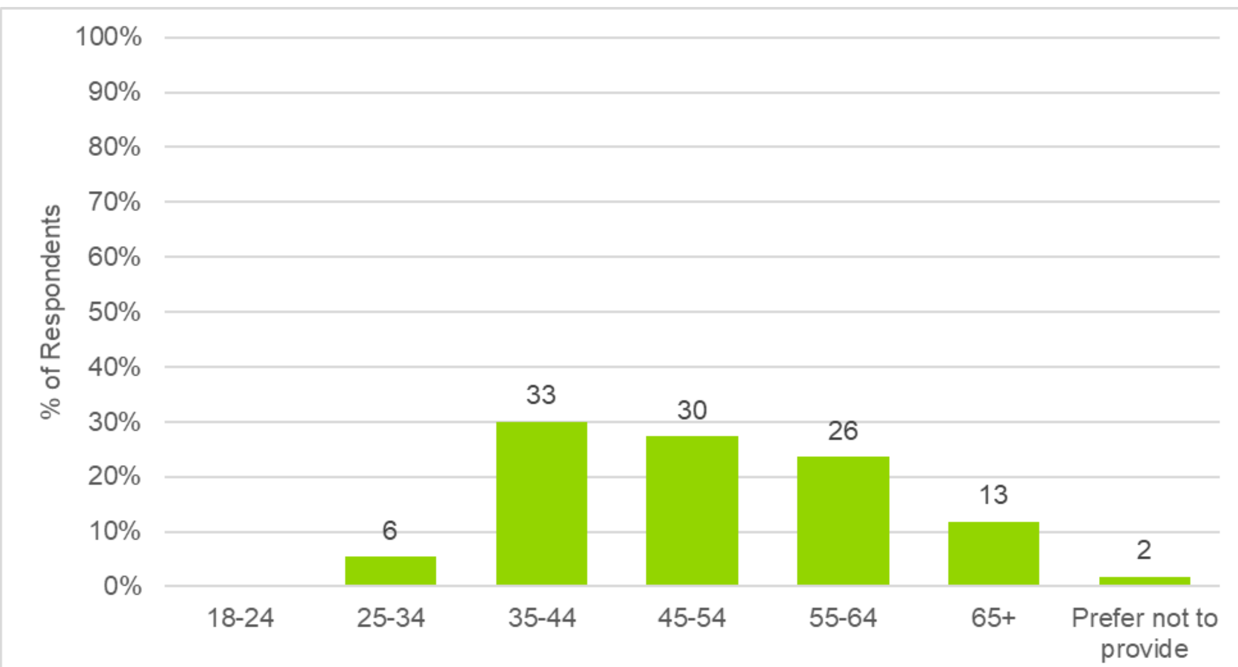
B.2.7 Demographics

D1. Which of the following best describes the property type where your home charging station is located? (n=110)



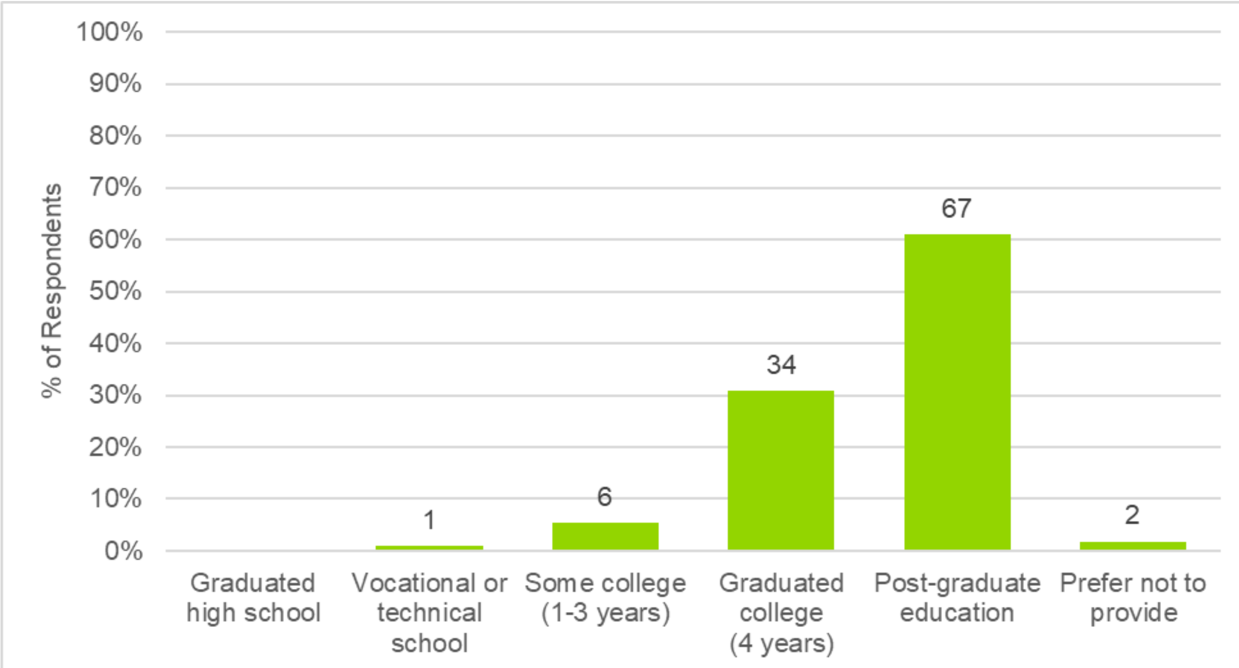
Source: Guidehouse

D2. Which of the following age categories do you fall into? (n=110)



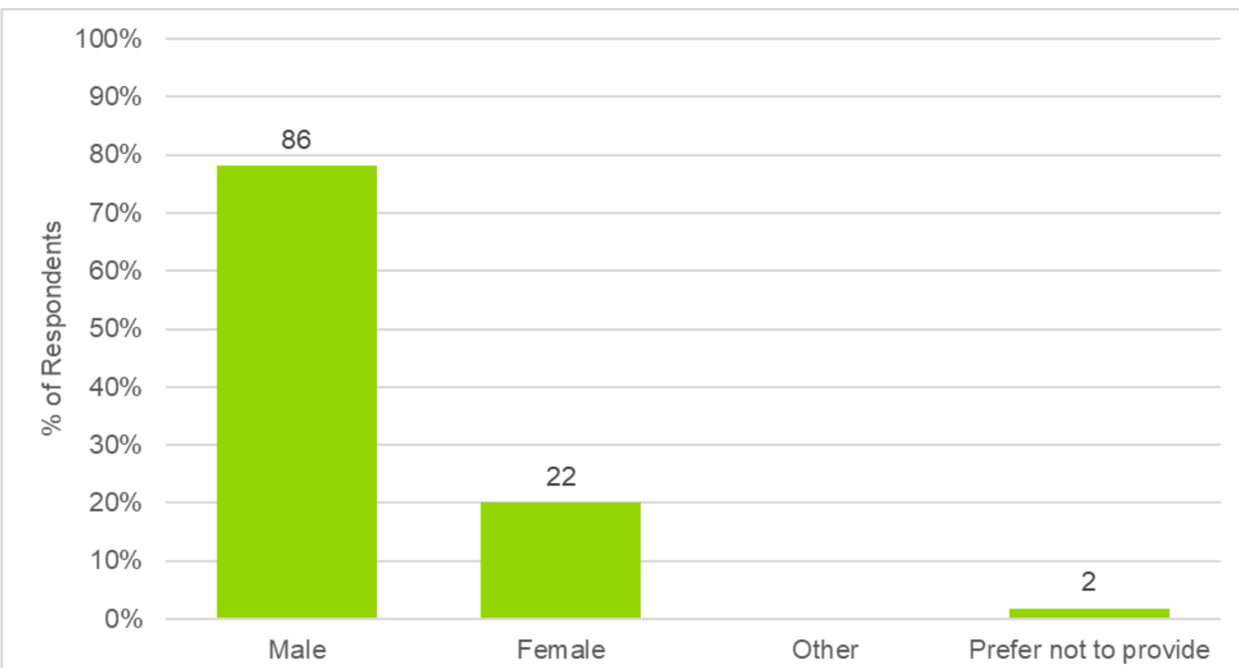
Source: Guidehouse

D3. What is the last grade of school you completed? (n=110)



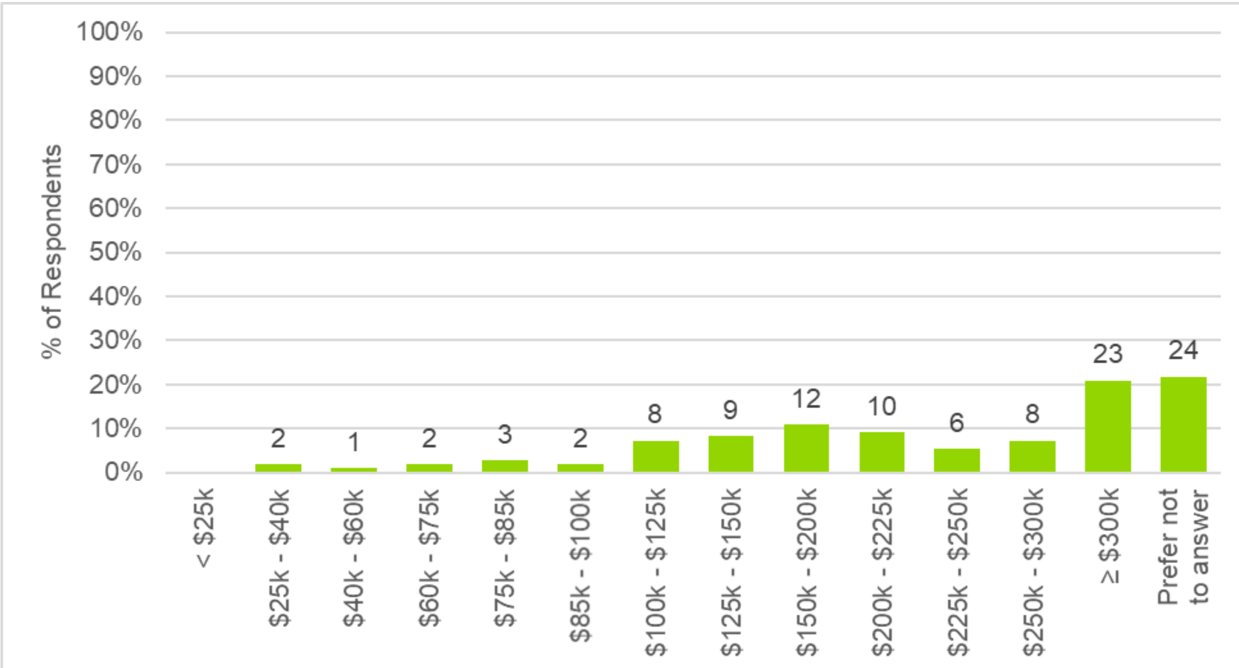
Source: Guidehouse

D4. Which category best describes your gender?



Source: Guidehouse

D5. Please indicate which range best describes the annual income of your entire household (everyone living in your home). (n=110)



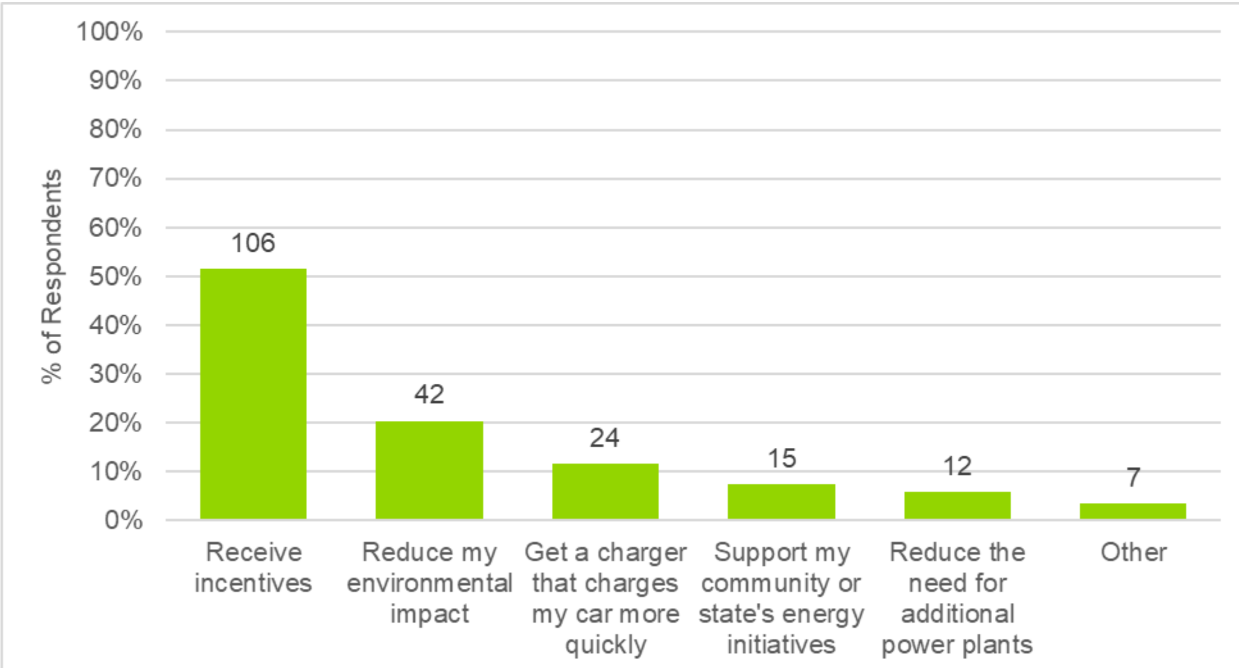
Source: Guidehouse

B.3 2021 Participant Survey Output

B.3.1 Enrollment

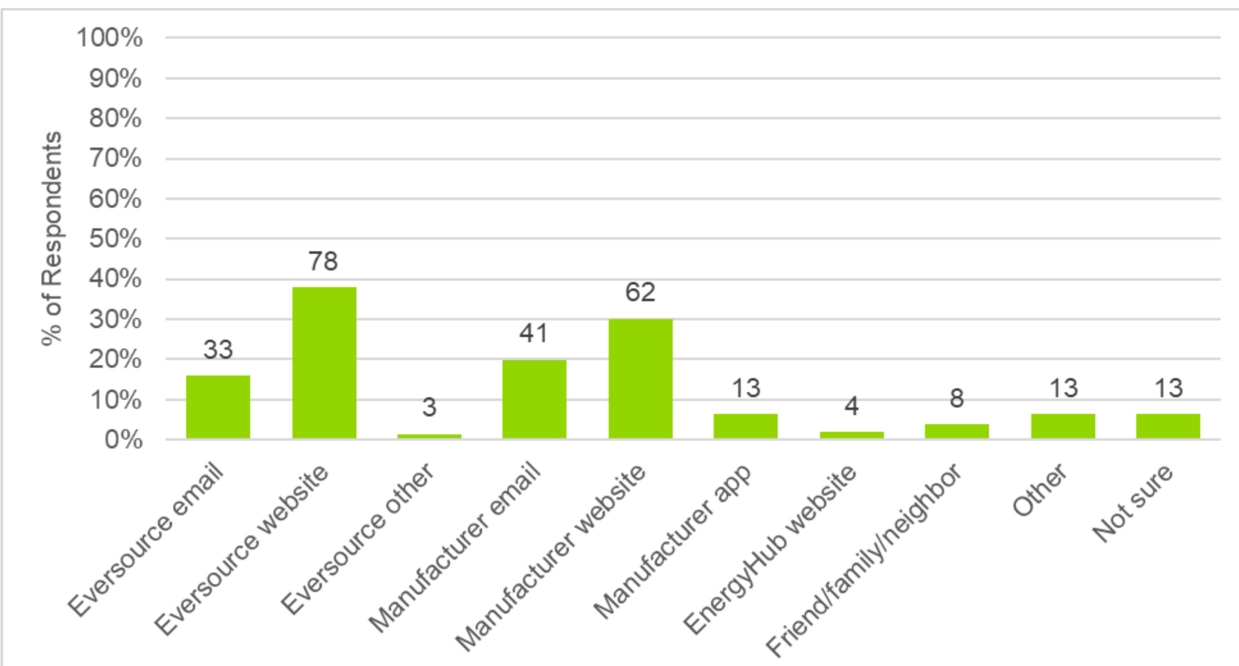
Note that 71 of the 206 survey respondents for the 2021 post-winter participant survey also took the 2020 post-summer participant survey and/or the 2019 participant survey. Their responses for the enrollment section are taken from the first survey that they completed (i.e., they were not asked these questions again).

E1. What was your top motivation for enrolling in Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=206)



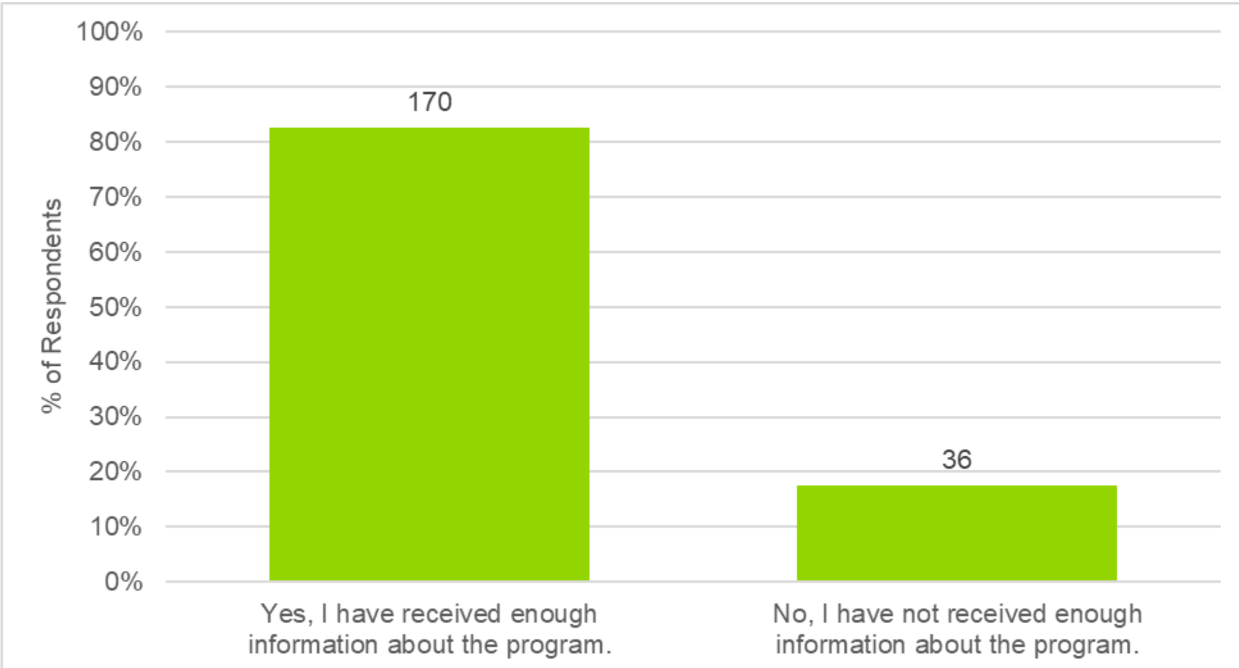
Source: Guidehouse

E2. How did you learn about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? Select all that apply. (n=206)



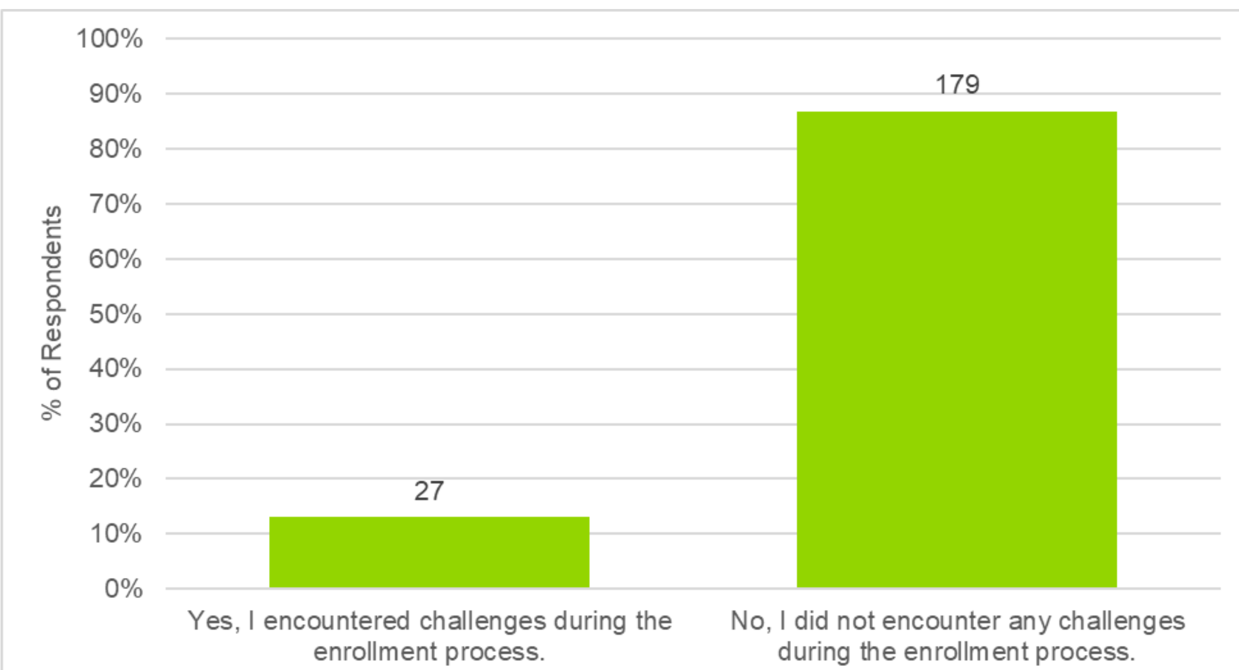
Source: Guidehouse

E3. Has enough information been provided to you about Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=206)



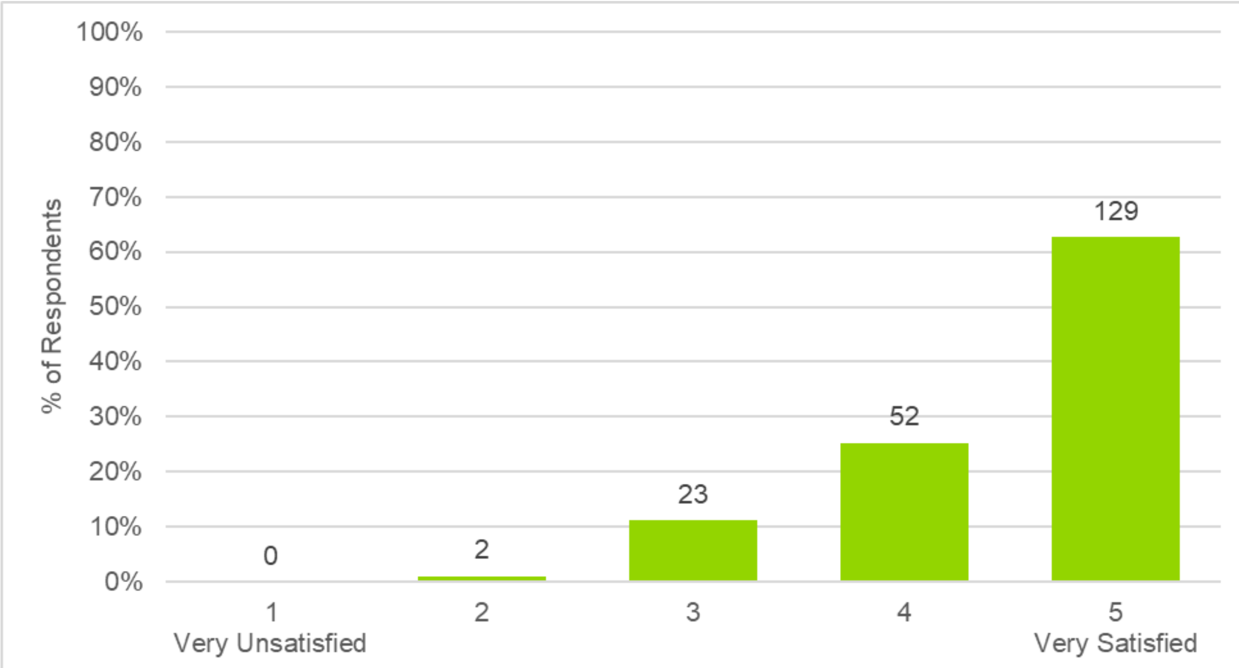
Source: Guidehouse

E5. Did you encounter any challenges or difficulties during the enrollment process? (n=206)



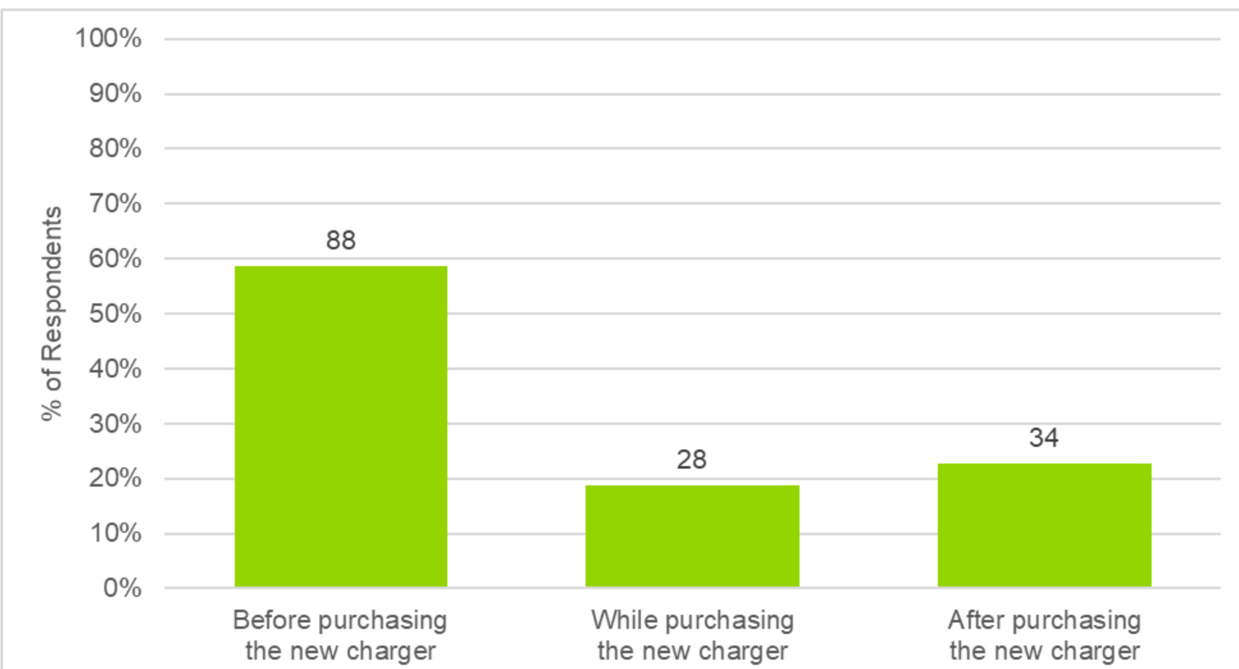
Source: Guidehouse

E7. How satisfied were you with the process of enrolling in the program? (n=206)



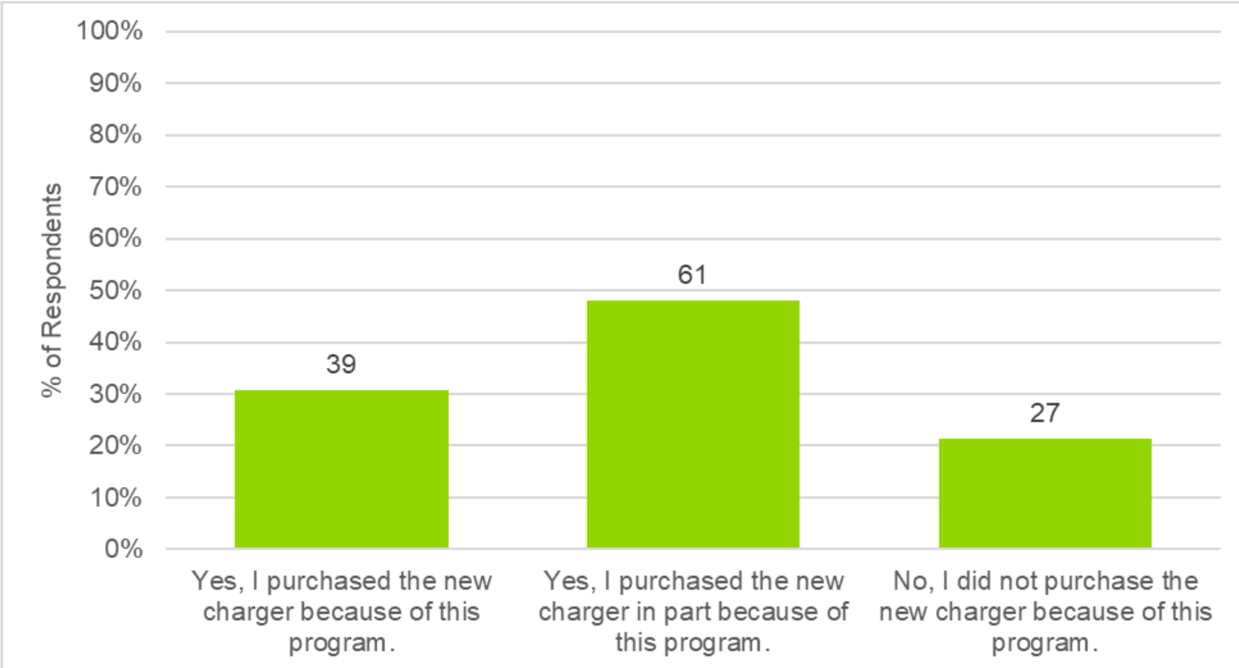
Source: Guidehouse

E10_1. At what point did you become aware of Eversource's ConnectedSolutions EV Home Charger Demand Response Program? (n=150)



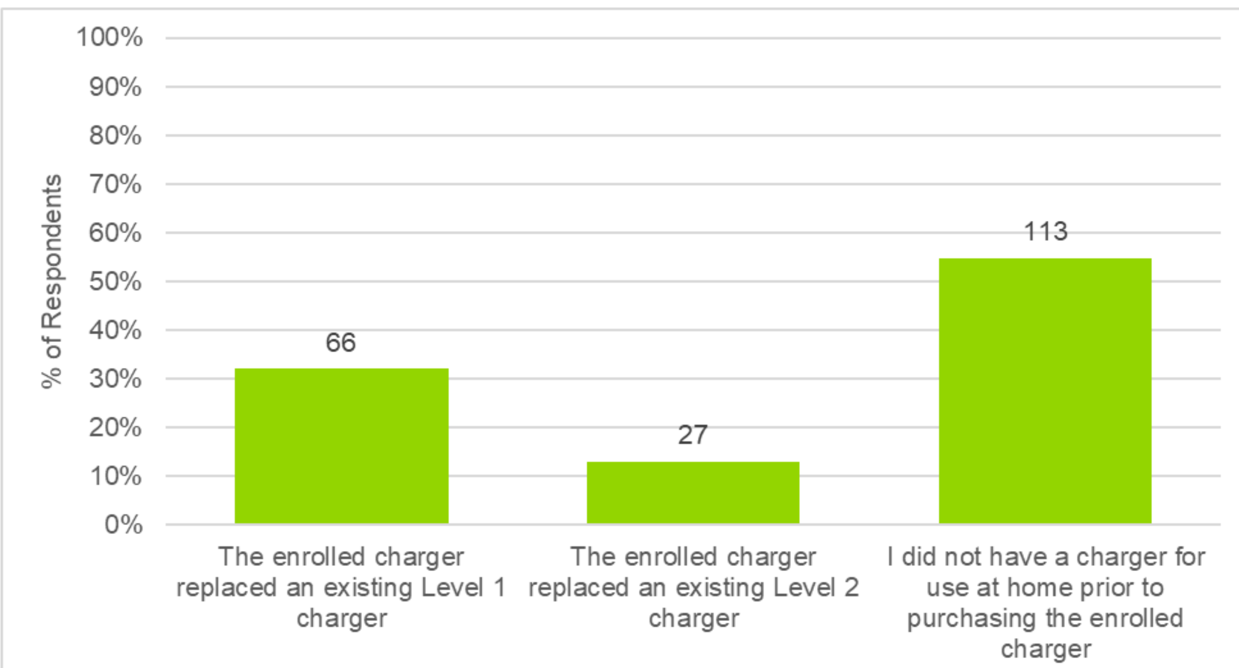
Source: Guidehouse

E10. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your decision to purchase the new charger? (n=127)



Source: Guidehouse

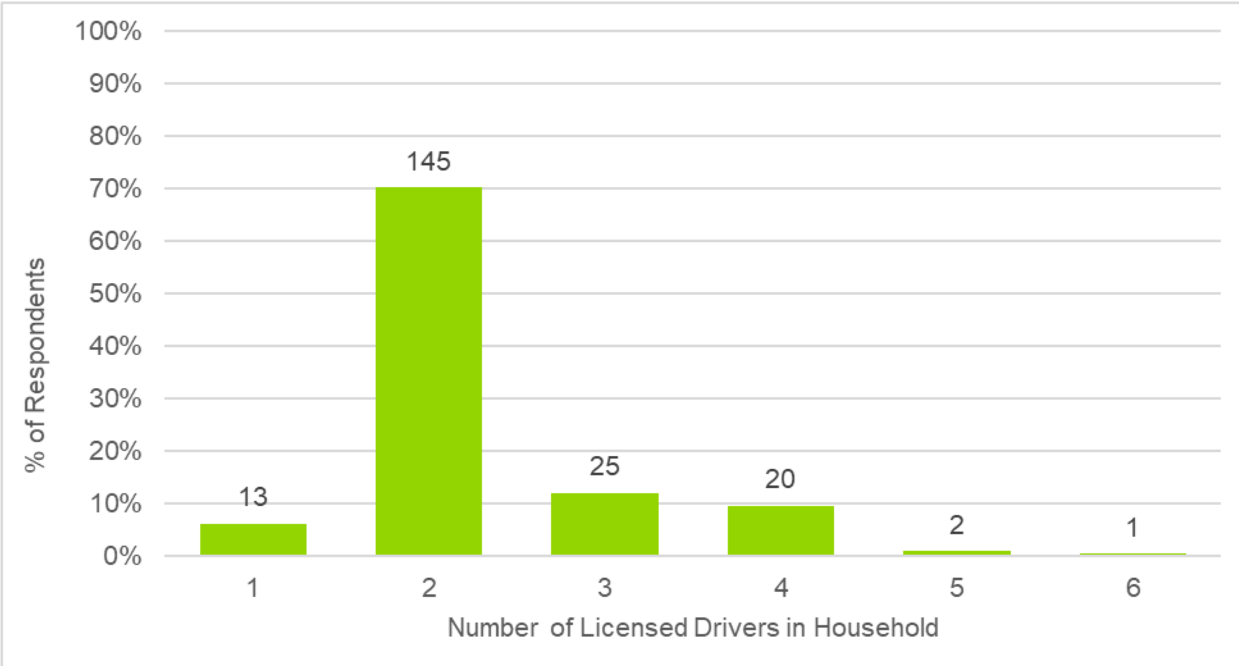
E11. Which of the following best describes the charger that you owned prior to purchasing the Level 2 charger that is currently enrolled in program? (n=206)



Source: Guidehouse

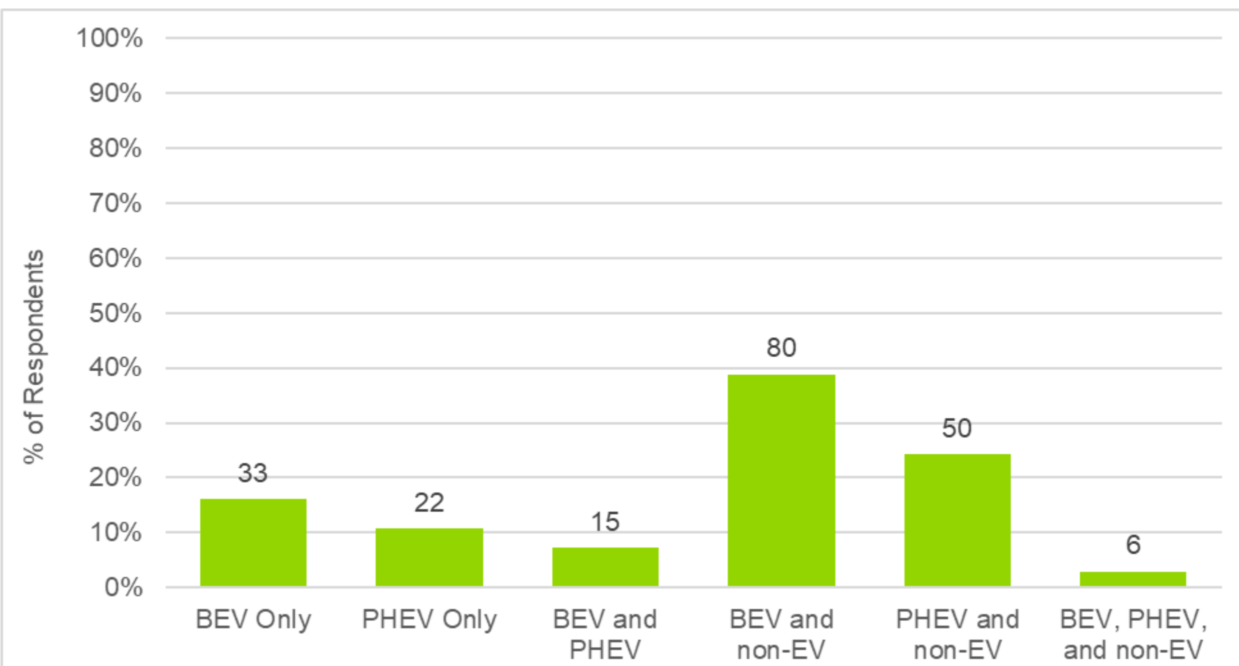
B.3.2 EV Charactersitcs and Driving Behavior

EV1. How many licensed drivers are there in your household? (n=206)



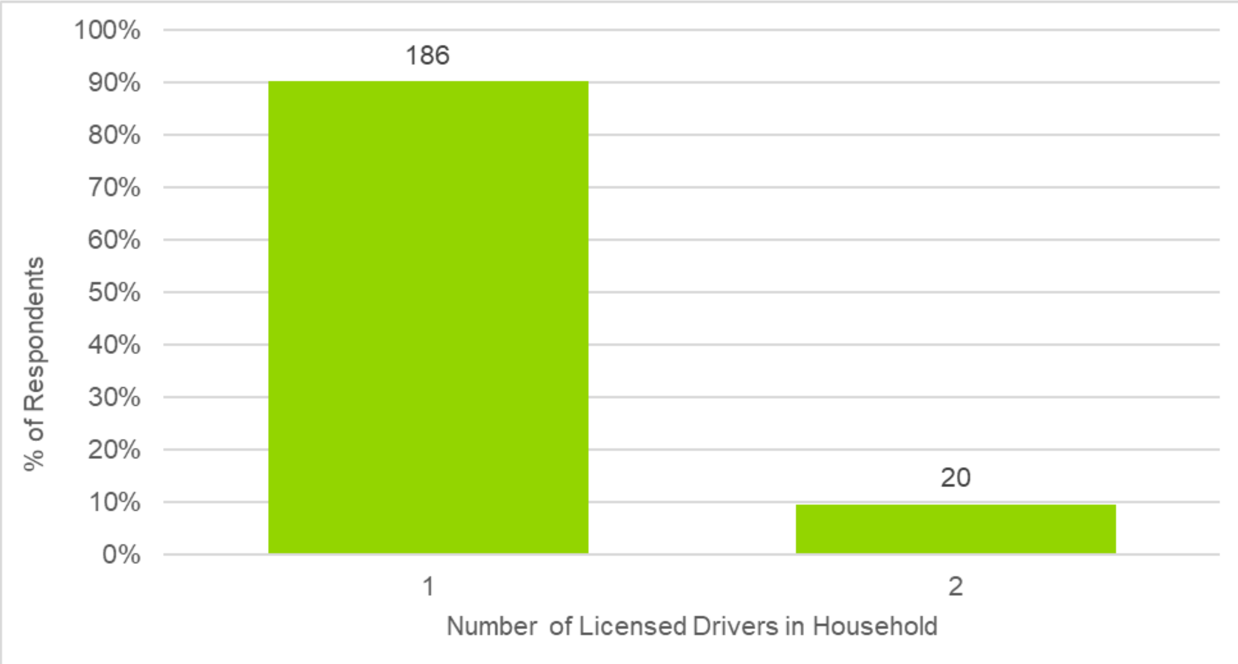
Source: Guidehouse

EV2. Please indicate the types of vehicle your household owns. (n=206)



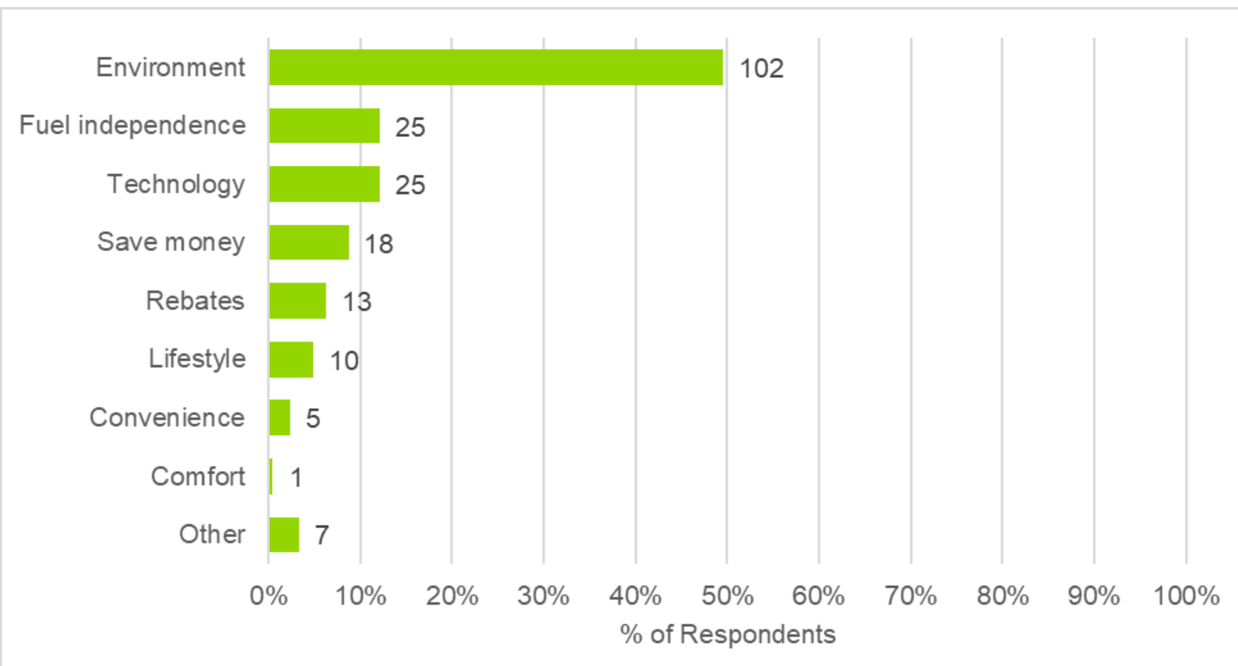
Source: Guidehouse

EV10. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during the winter 2020-2021 (November 2020 through March 2021)? (n=206)



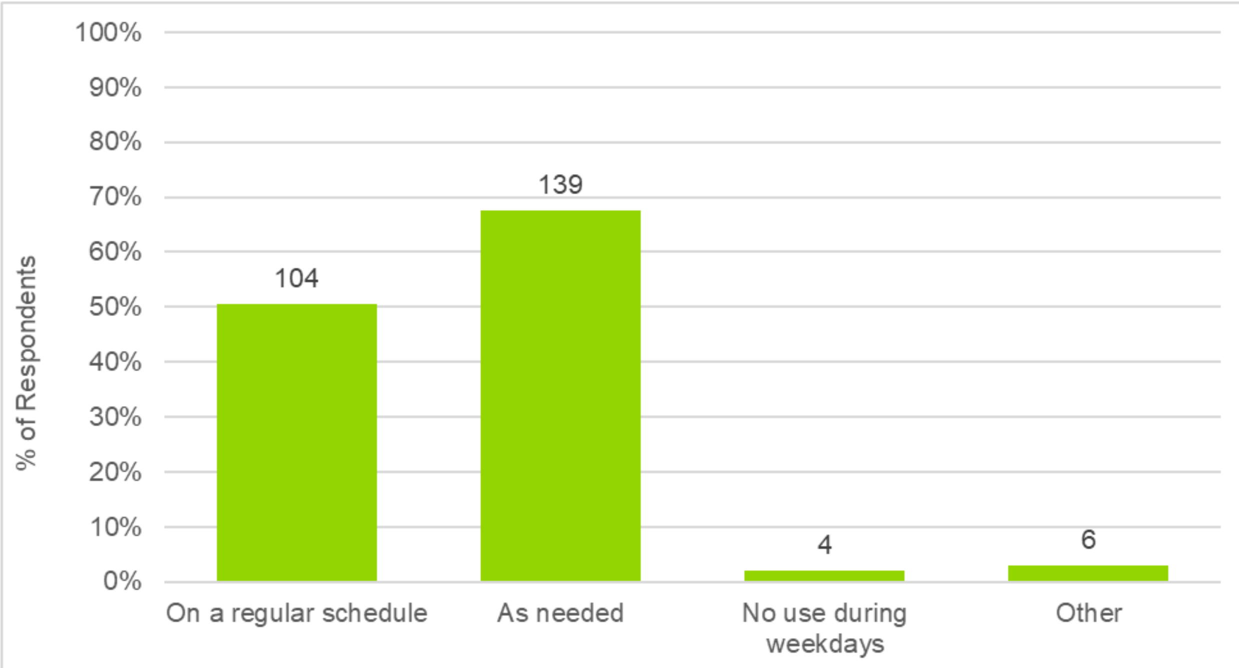
Source: Guidehouse

EV11. What was your household's top motivation for buying the electric vehicle? (n=209)



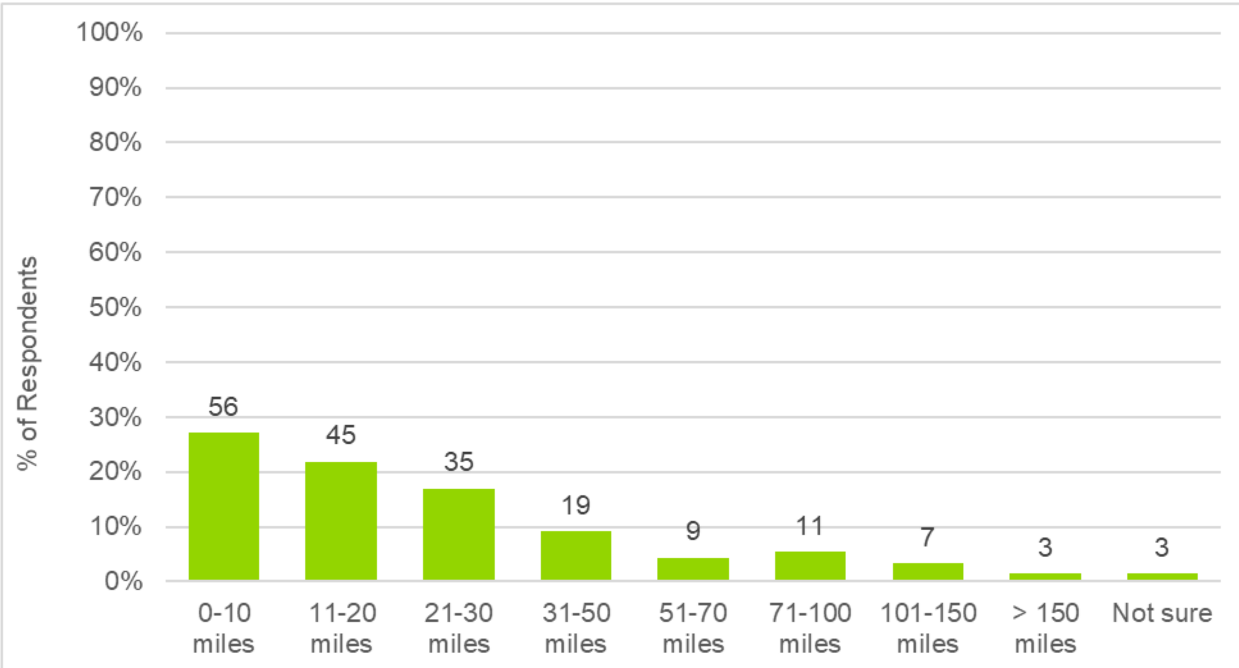
Source: Guidehouse

EV12. Which of the following best describes how your household typically used this electric vehicle on weekdays (Monday through Friday) during the winter 2020-2021 (November through March)? Select all that apply. (n=206)



Source: Guidehouse

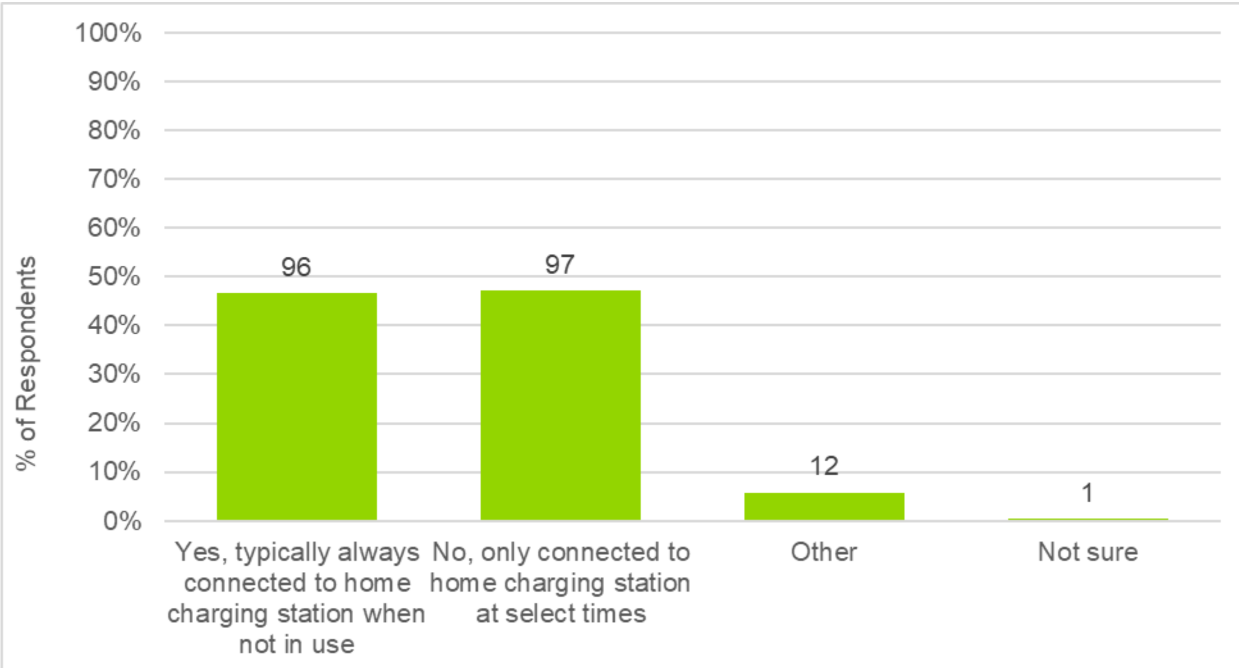
EV13. During a typical winter 2020-2021 weekday (Monday through Friday), on average, how many miles was this electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for the total miles driven on a typical winter weekday for 2020-2021. (n=206)



Source: Guidehouse

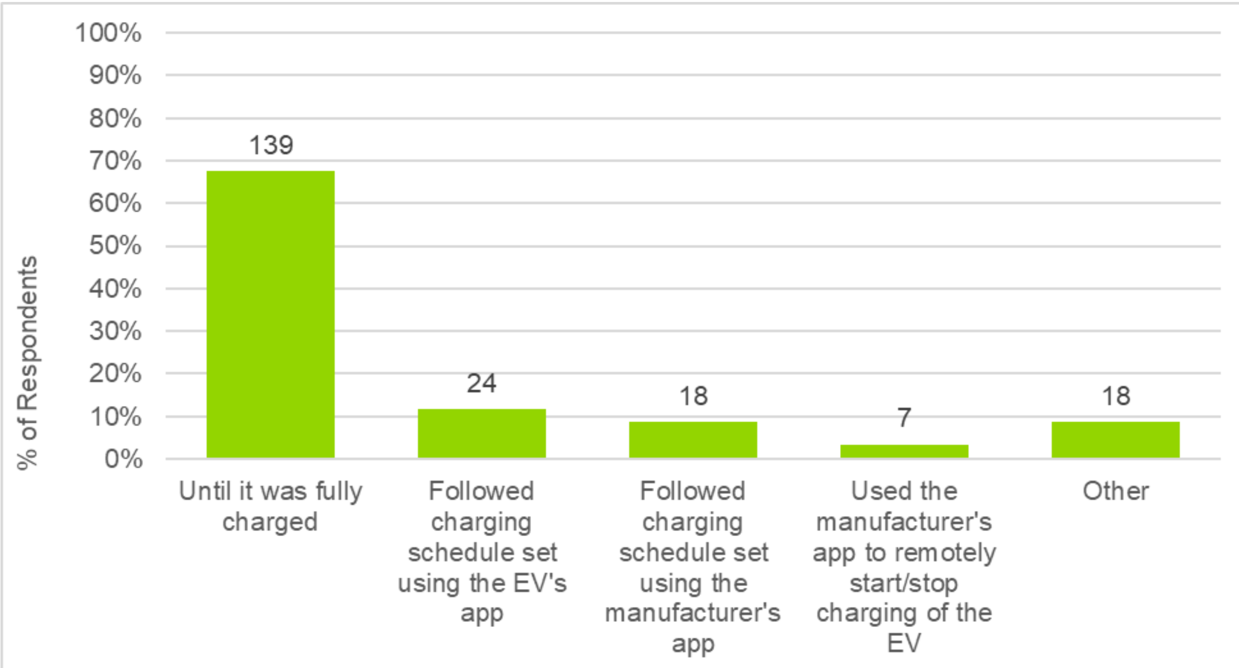
B.3.3 Charging Behavior

CB1. During winter 2020-2021, when this electric vehicle was not being used and at home, was it typically connected to your home charging station? (n=206)



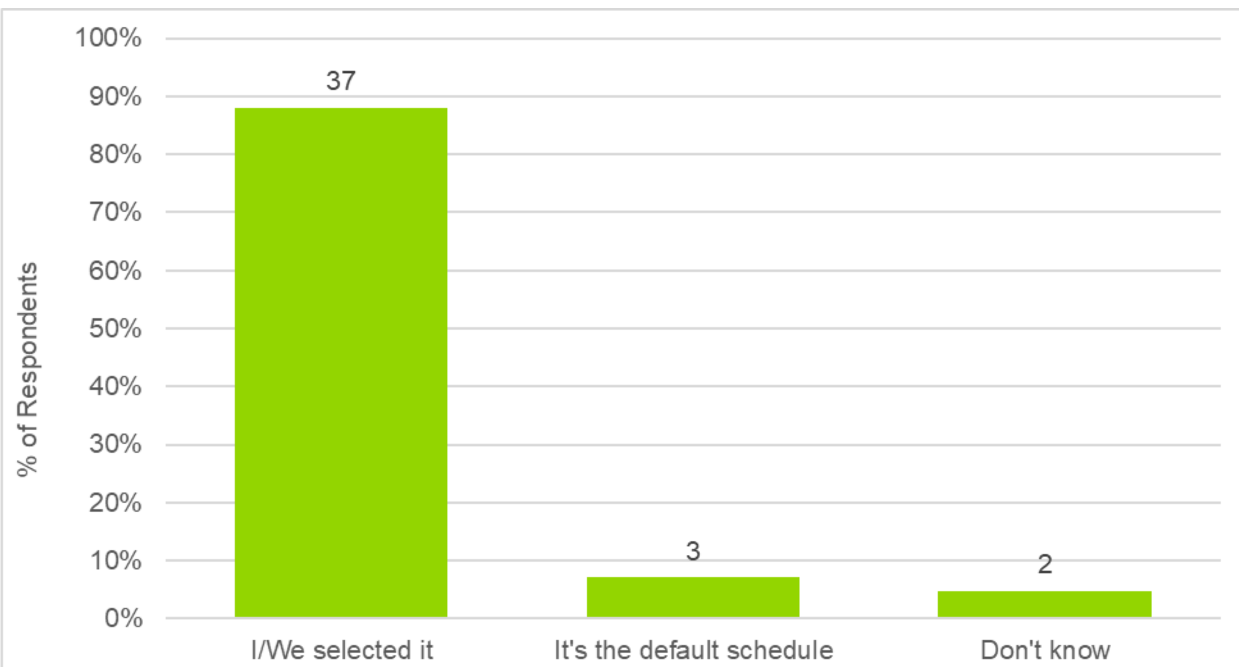
Source: Guidehouse

CB2. During winter 2020-2021, which of the following best describes your household's use of your home charging station for this electric vehicle? (n=206)



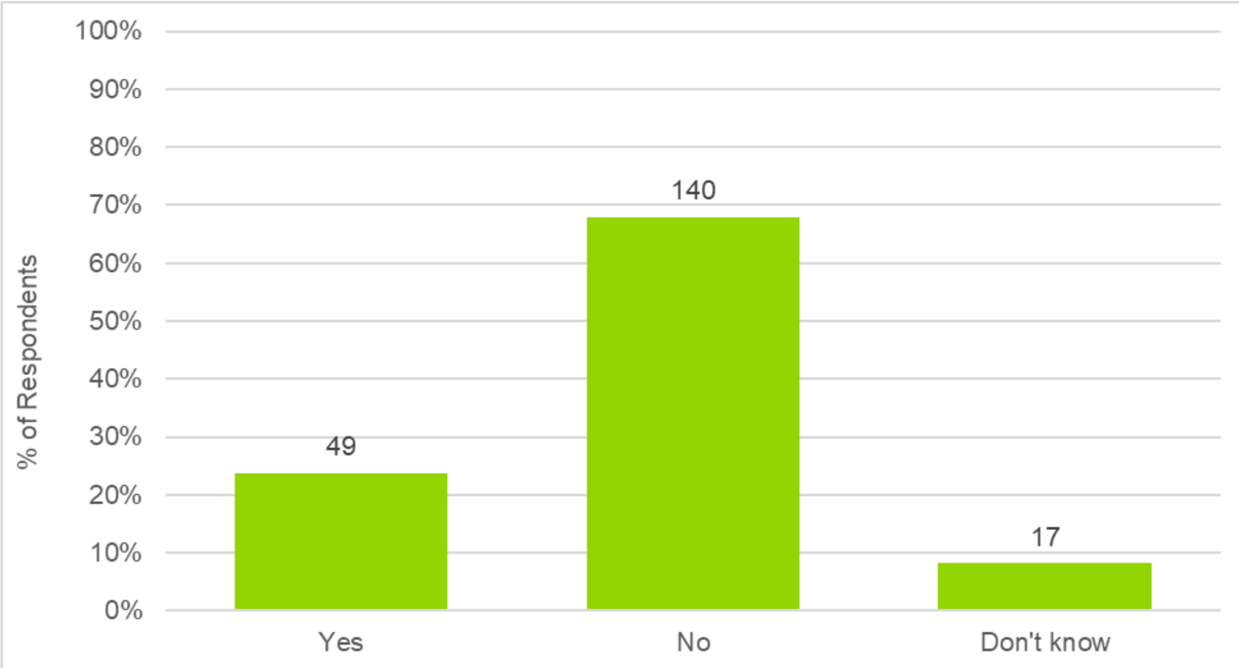
Source: Guidehouse

CB2_b. How was this electric vehicle's charging schedule determined? (n=42)



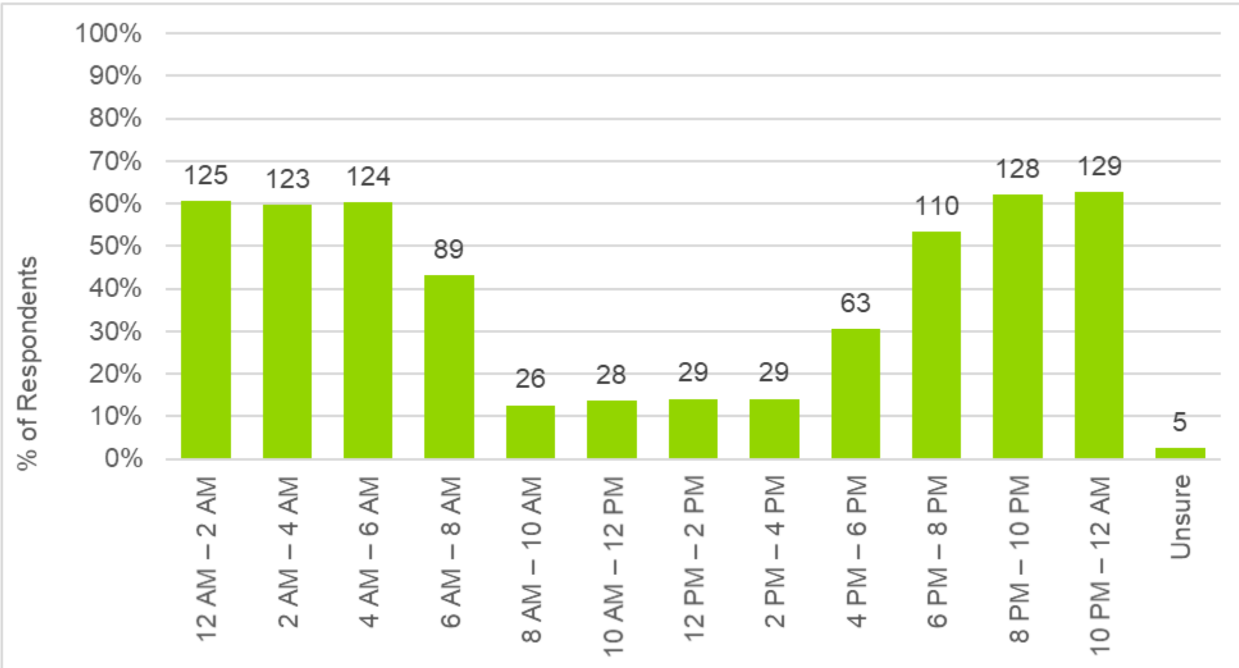
Source: Guidehouse

CB2_c. Did Eversource's ConnectedSolutions EV Home Charger Demand Response Program influence your choice of charging schedule at all? (n=206)



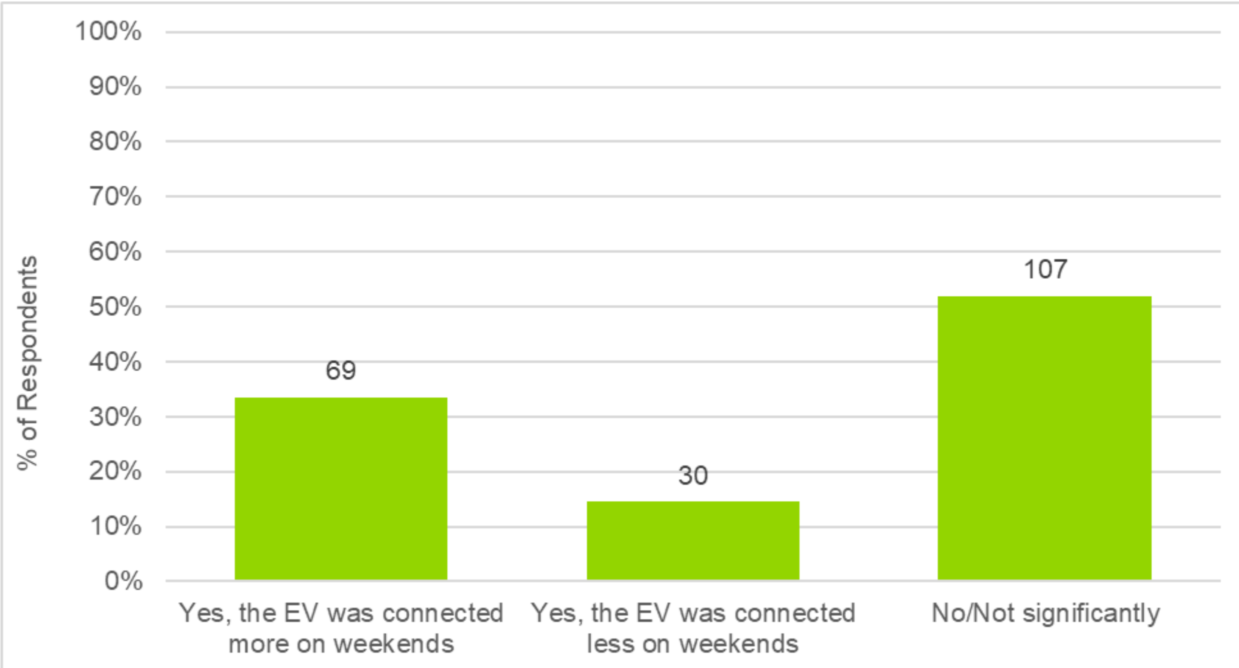
Source: Guidehouse

CB3. Below, please indicate the time ranges during which this electric vehicle was typically <u>connected</u> (regardless of charging or not) to your *home charging station* on weekdays (Monday through Friday) during winter 2020-2021 (November through March). Select all the time ranges that apply. (n=206)



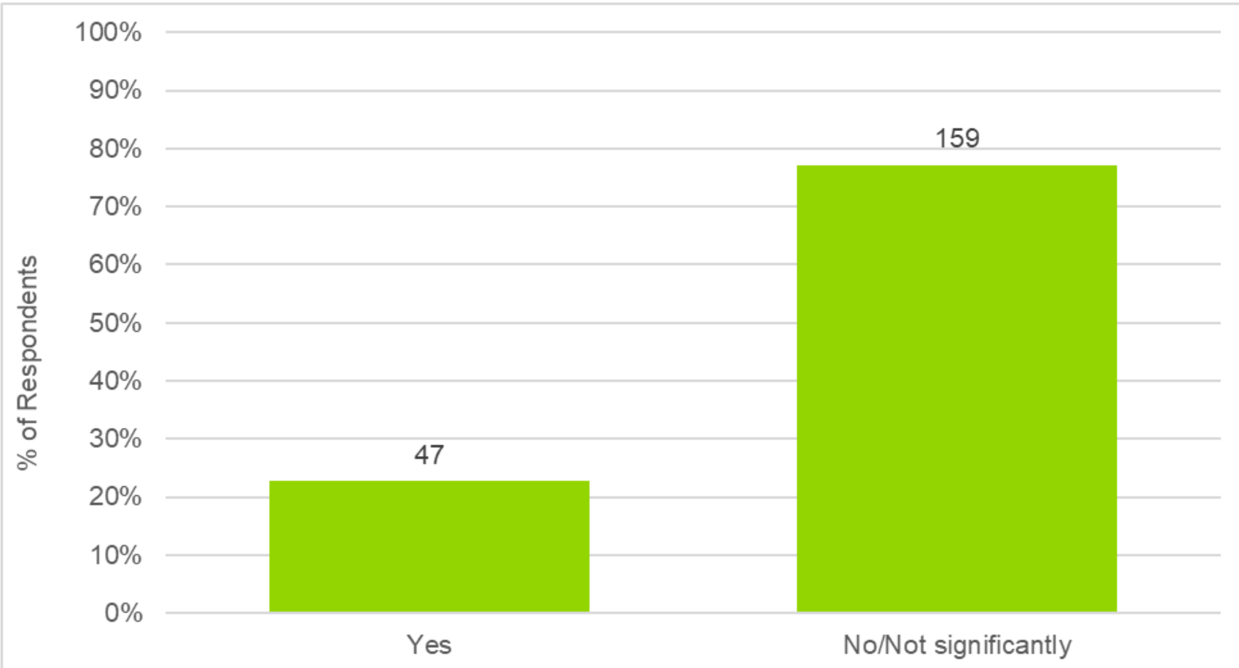
Source: Guidehouse

CB4_a. Compared to your household's use of your home charging station on weekdays, was the amount of time this electric vehicle was typically connected to your home charging station in winter 2020-2021 different on weekends? (n=206)



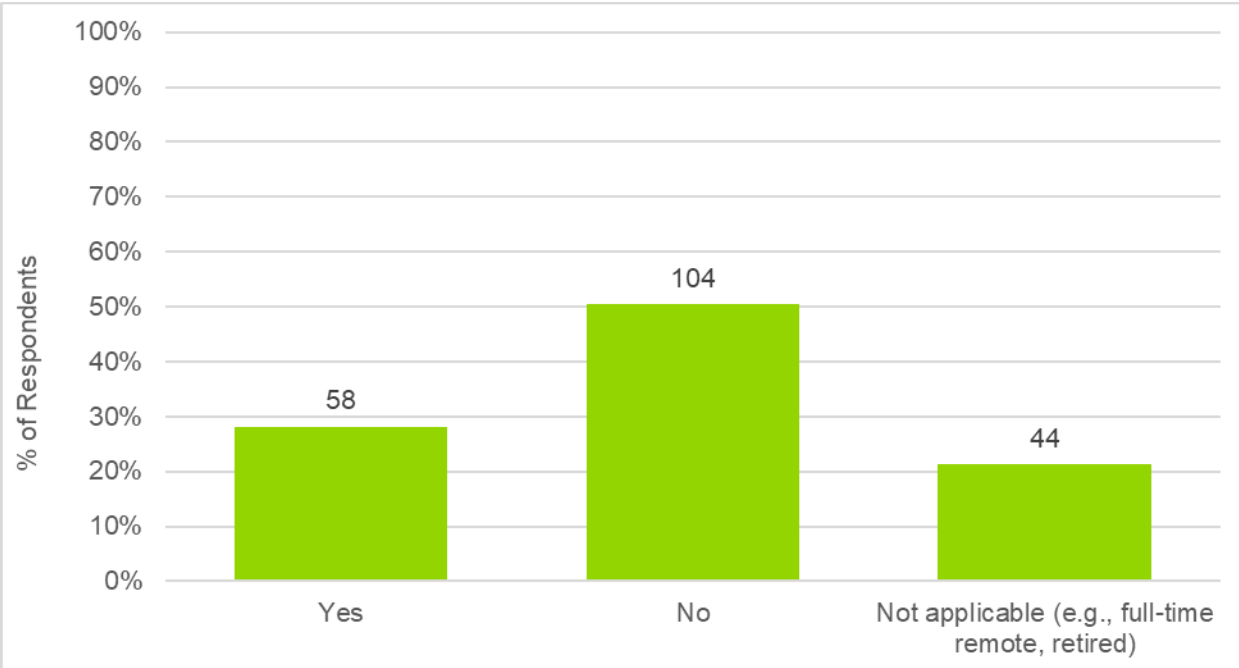
Source: Guidehouse

CB4_b. Compared to your household's use of your home charging station on weekdays, was the timing of when this electric vehicle was typically connected to your home charging station in winter 2020-2021 different on weekends (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)? (n=206)



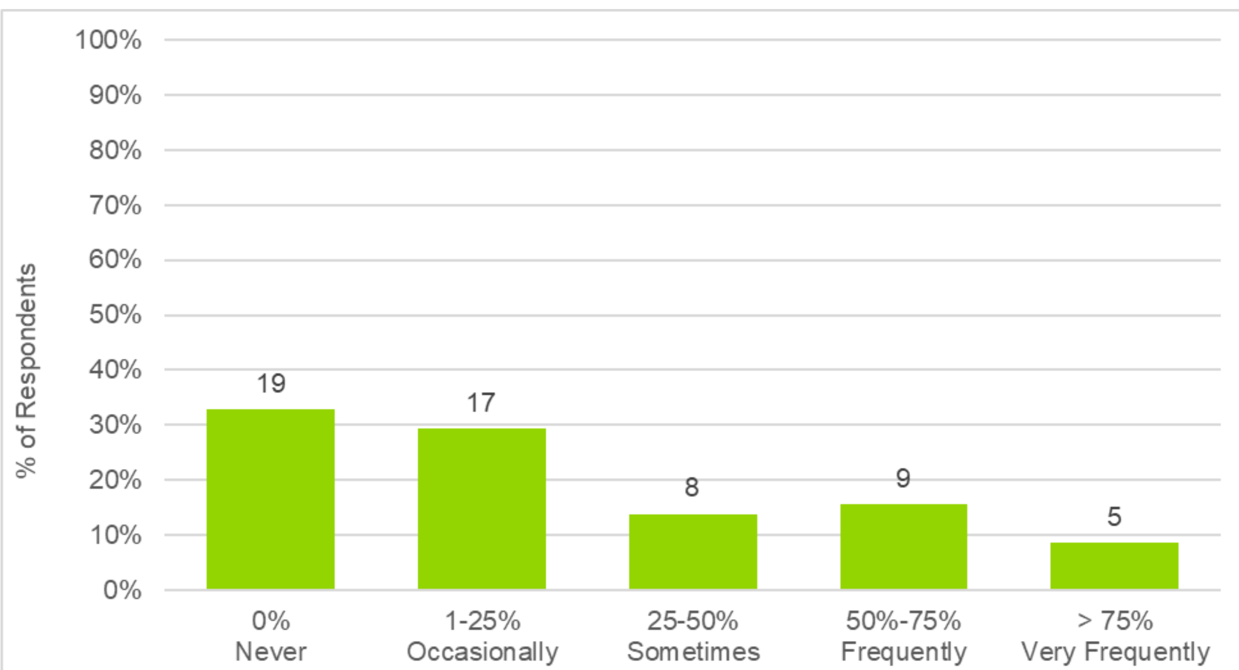
Source: Guidehouse

CB4. Is this electric vehicle driven to a workplace that has workplace charging available? Please answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it. (n=206)



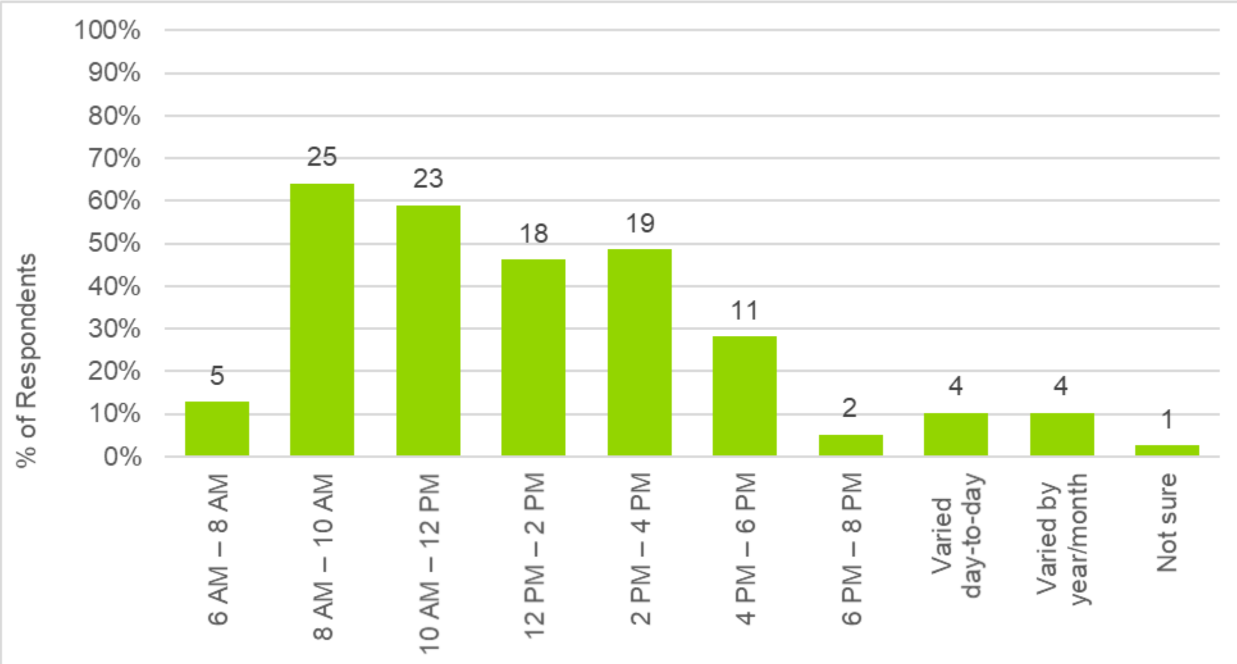
Source: Guidehouse

CB5. Approximately what percentage of this electric vehicle's charging during winter 2020-2021 (November through March) occurred at a workplace? (n=58)



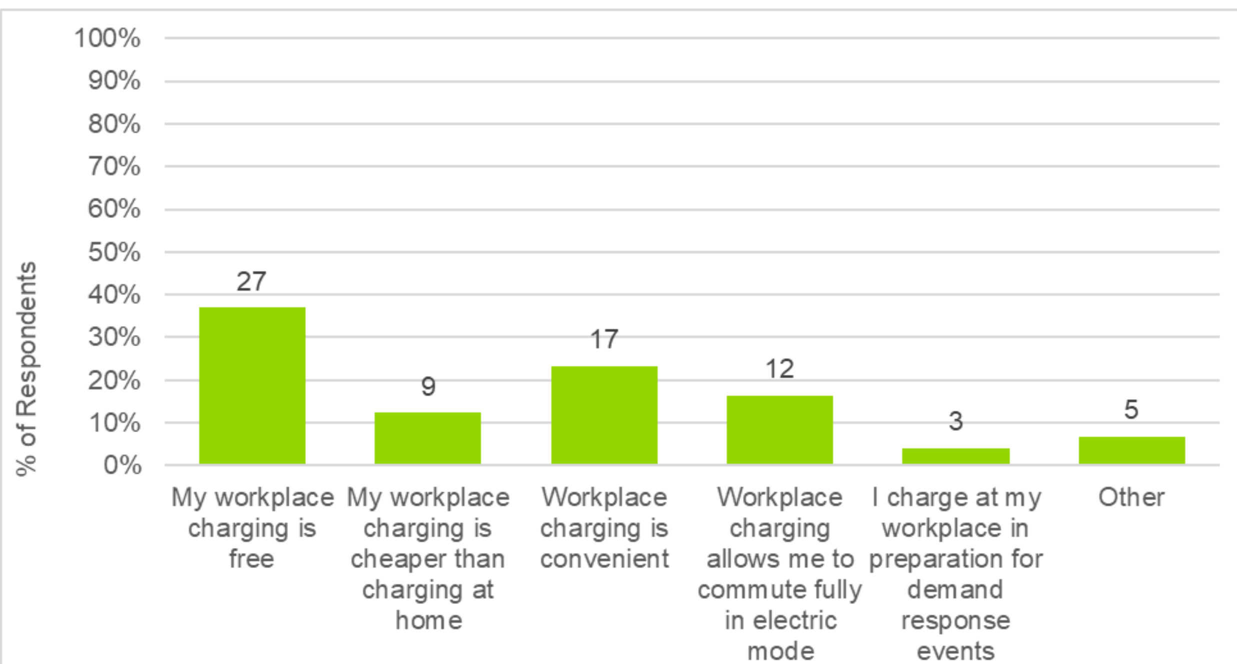
Source: Guidehouse

CB7. Below, please indicate when this electric vehicle was typically connected to a *workplace charging station* on weekdays (Monday through Friday) during the winter 2020-2021 (November through March). Select all the time ranges that apply. (n=39)



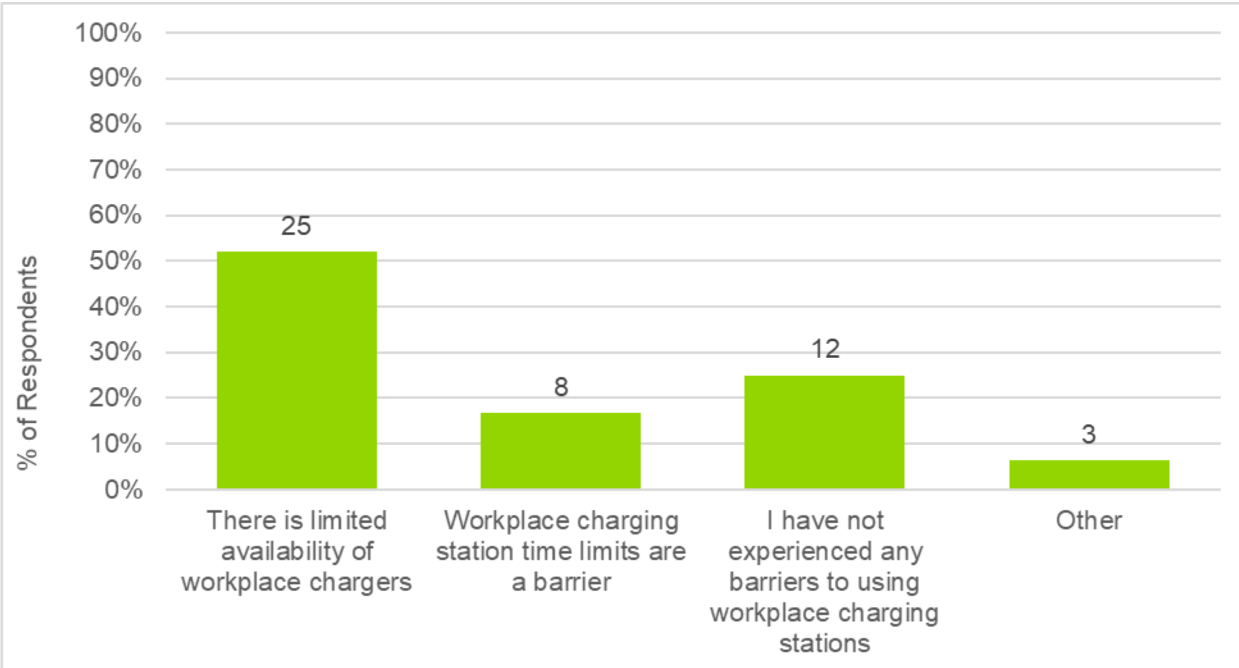
Source: Guidehouse

CB8. What are your main motivations for using *workplace charging stations*? Select all that apply. (n=39)



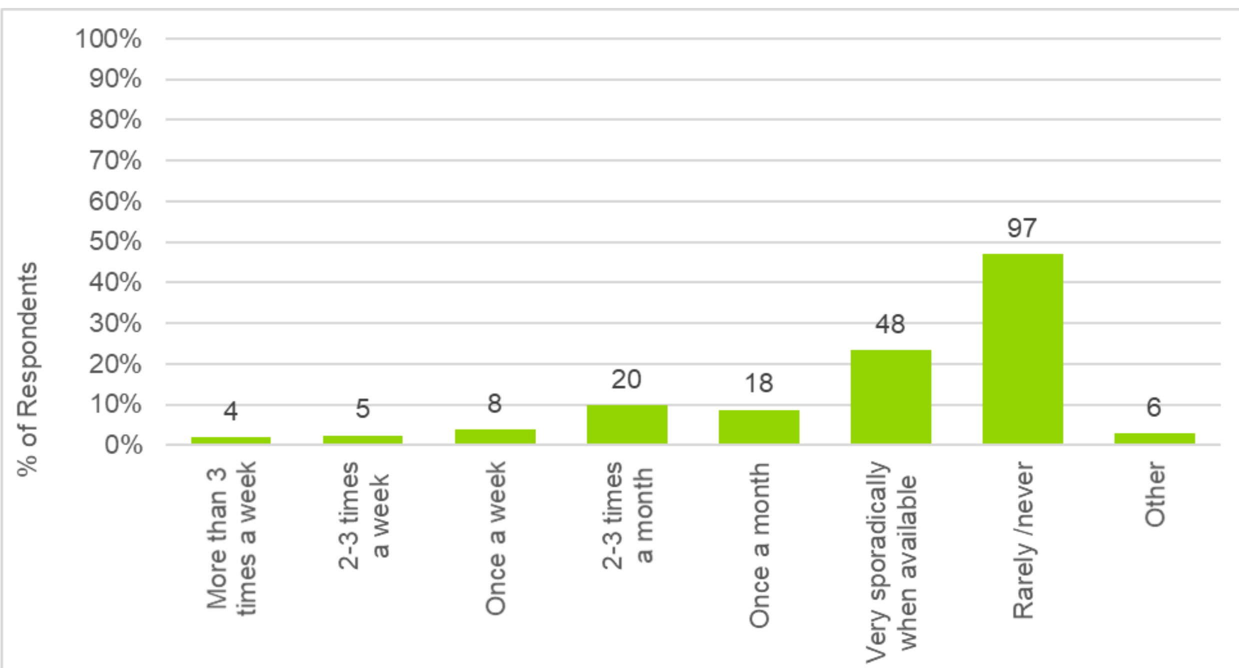
Source: Guidehouse

CB9. Are there are any barriers for you or your household members to use *workplace charging stations* to charge this electric vehicle? Select all that apply. (n=39)



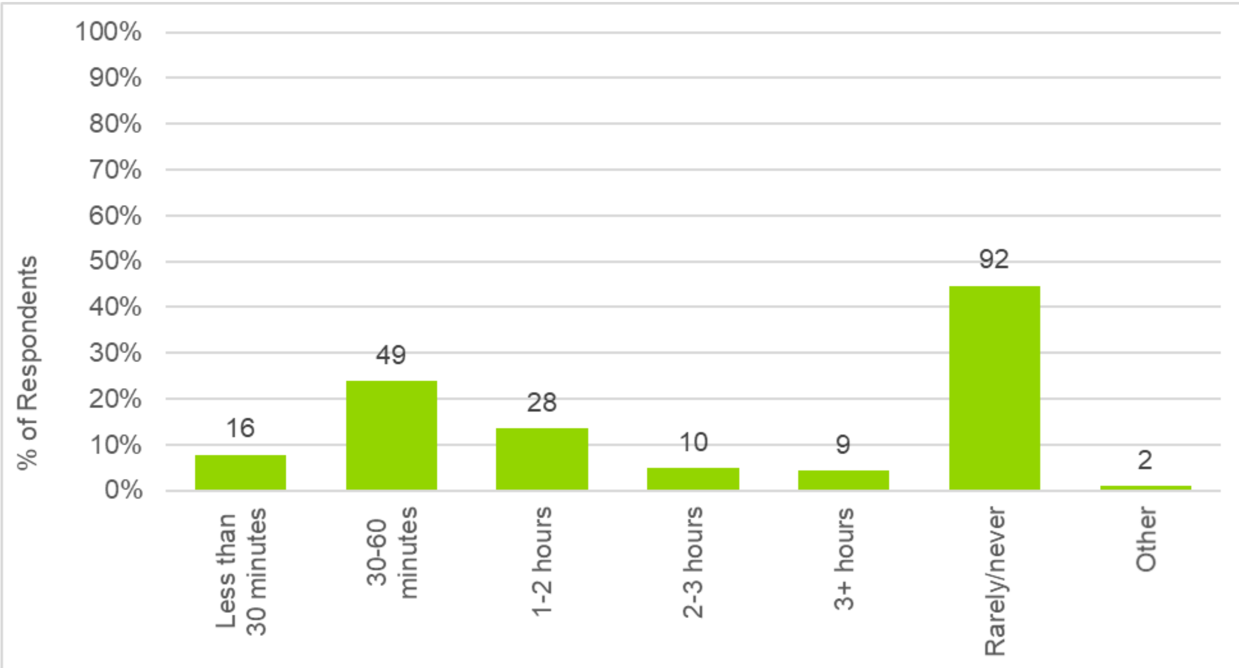
Source: Guidehouse

CB10. How frequently did you typically use *public charging stations* for this vehicle during the typical weekday (Monday through Friday) in winter 2020-2021 (November through March)? (n=206)



Source: Guidehouse

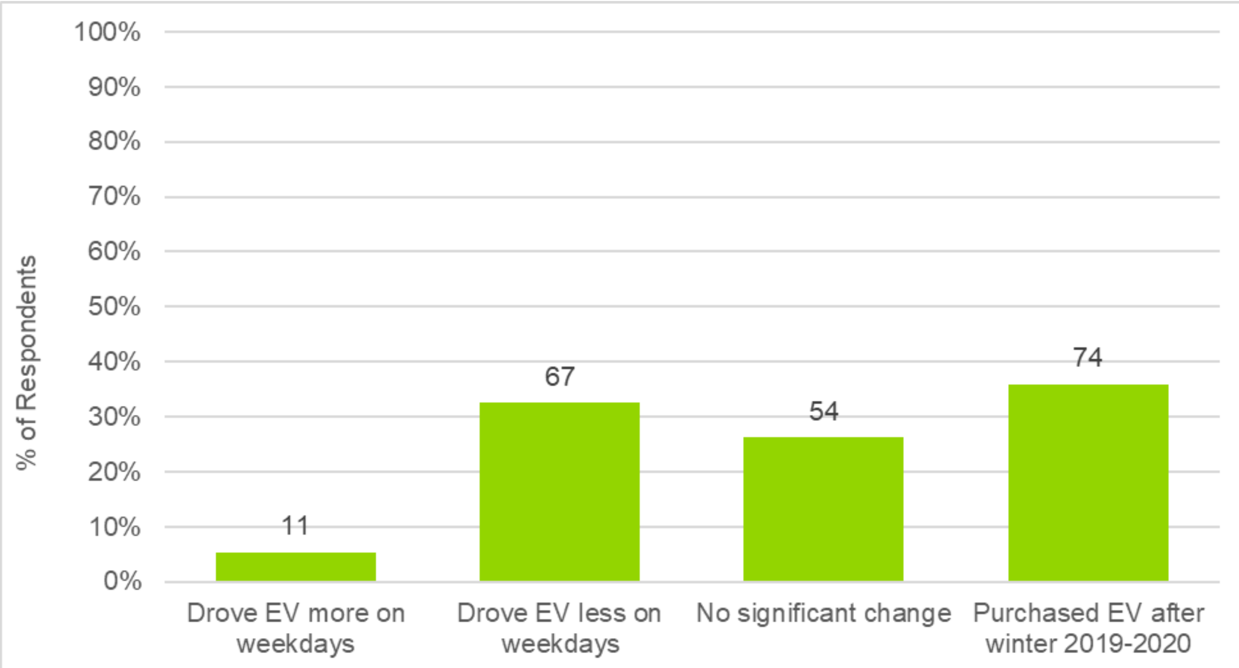
CB11. How long was your typical charging session at public charging stations during the typical weekday (Monday through Friday) in winter 2020-2021 (November through March)? (n=206)



Source: Guidehouse

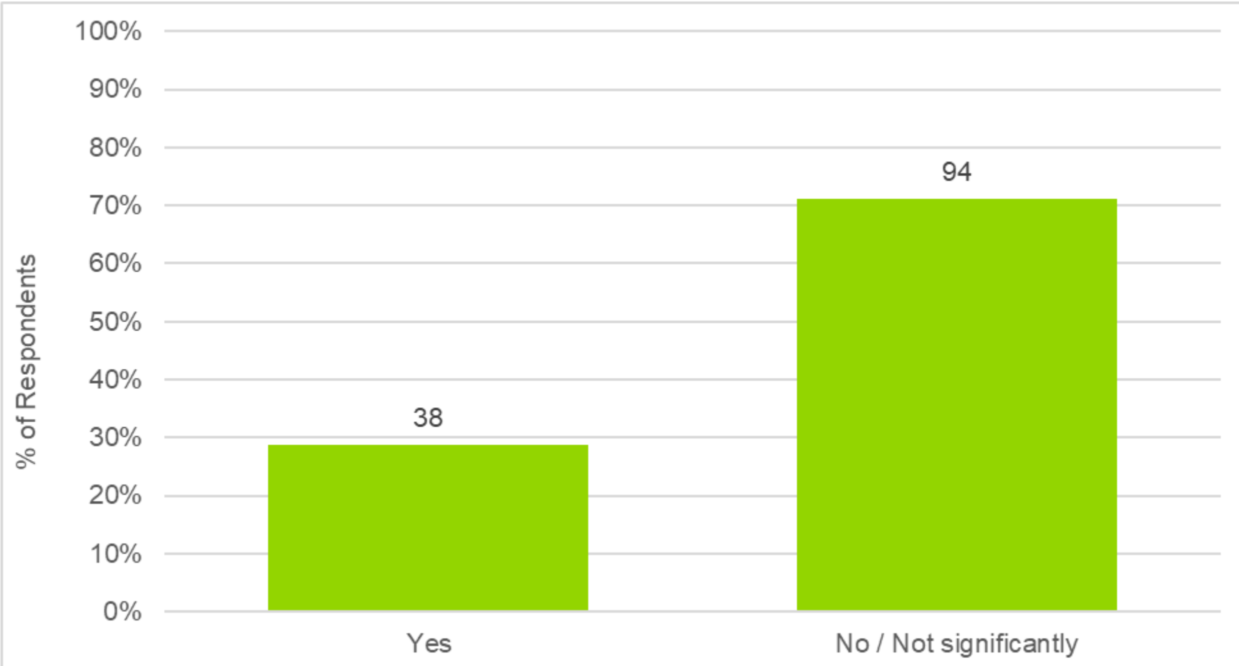
B.3.4 Changes Since Winter 2019-2020

CS1. Compared to your household's use of this electric vehicle in the winter of 2019-2020, did the typical miles per day that this electric vehicle was driven on weekdays change in winter 2020-2021? (n=206)



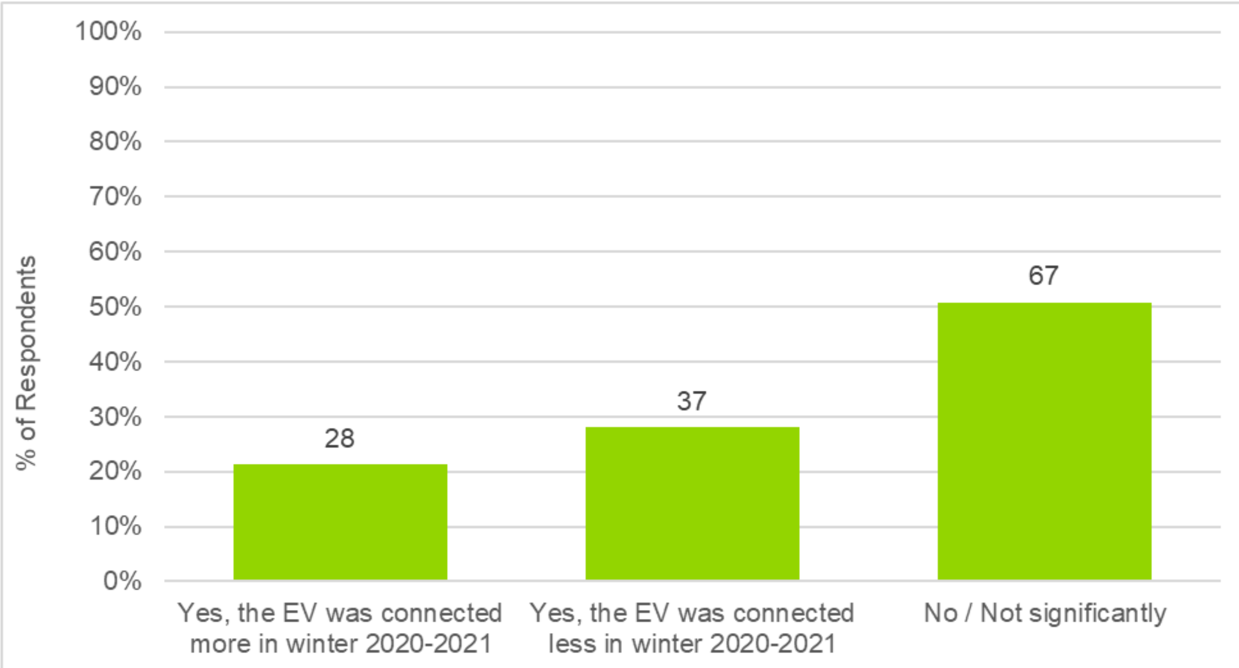
Source: Guidehouse

CS2. Compared to your household's use of this electric vehicle in the winter of 2019-2020, did the timing of when this electric vehicle was typically driven on weekdays change in winter 2020-2021 (e.g., shifted from morning and early evening to scattered throughout the day)? (n=132)



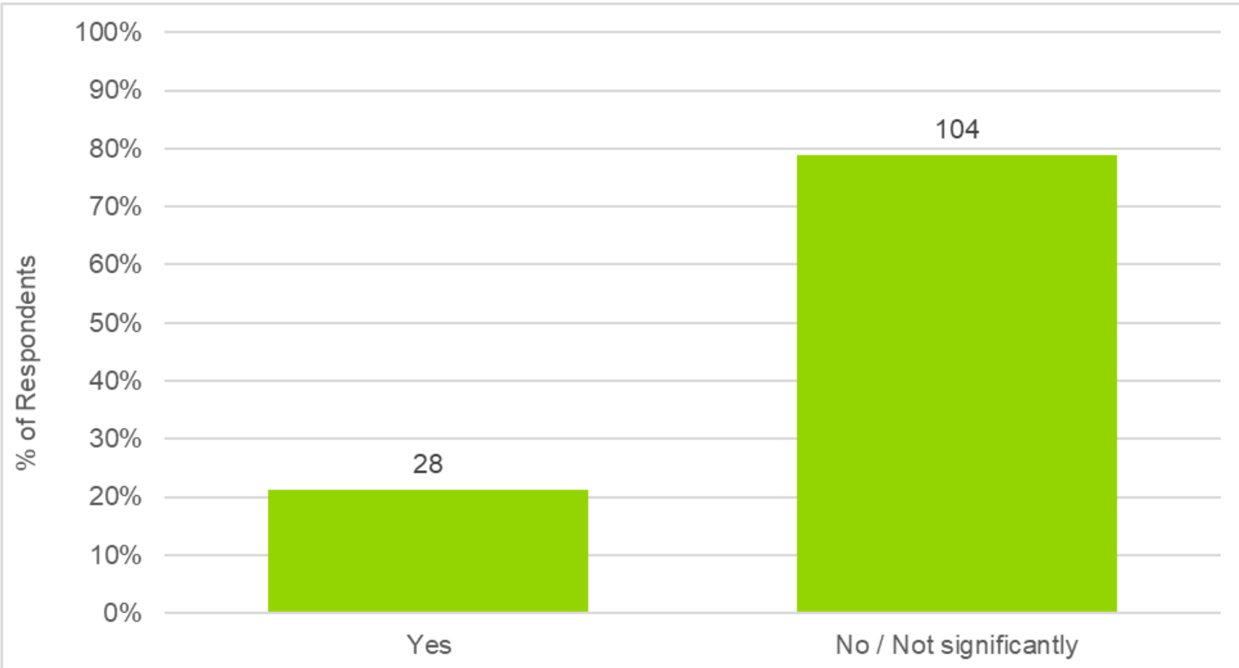
Source: Guidehouse

CS3. Compared to your household's use of your home charging station in the winter of 2019-2020, did the amount of time this electric vehicle was typically connected to your home charging station on weekdays change in winter 2020-2021? (n=132)



Source: Guidehouse

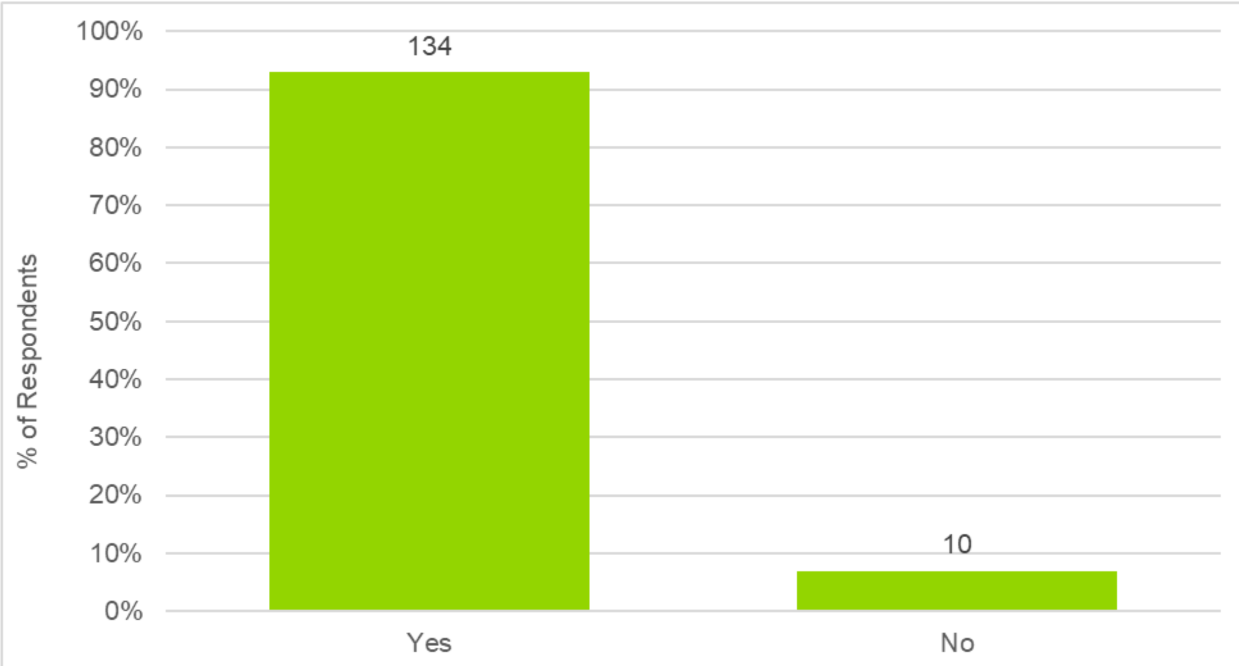
CS4. Compared to your household's use of your home charging station in the winter of 2019-2020, did the timing of when this electric vehicle was typically connected to your home charging station on weekdays change in winter 2020-2021 (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)? (n=132)



Source: Guidehouse

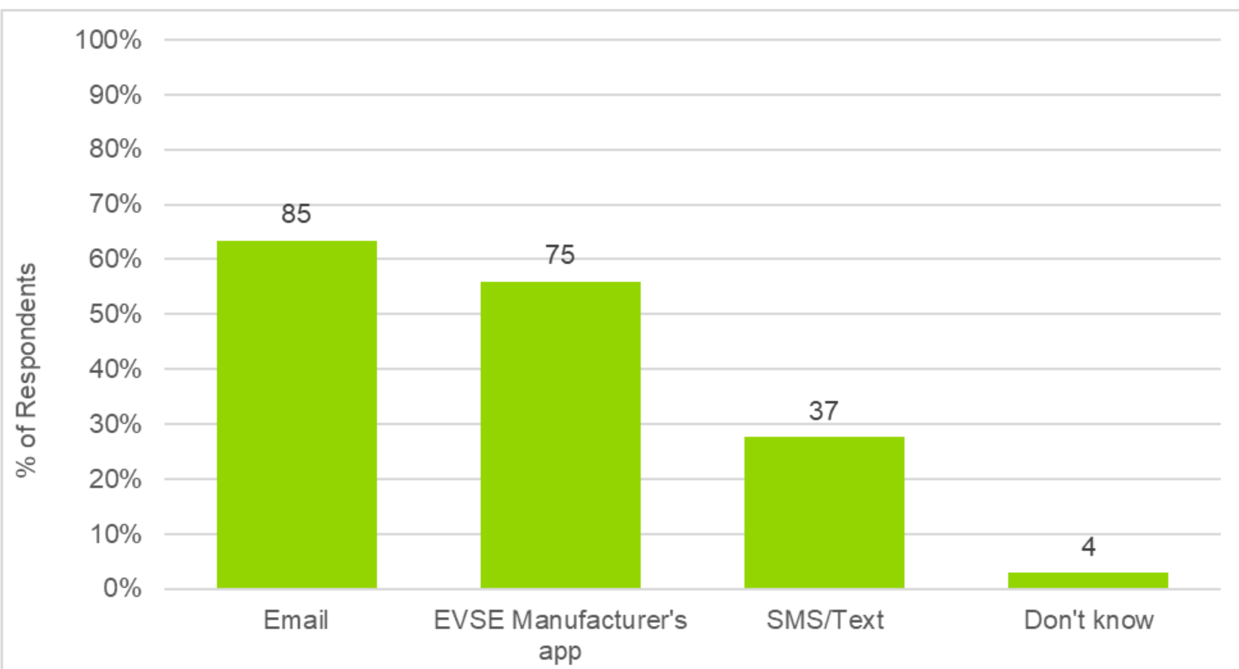
B.3.5 Behavior During Events

ET2. Do you recall ever receiving advance notifications about Events? (n=144)



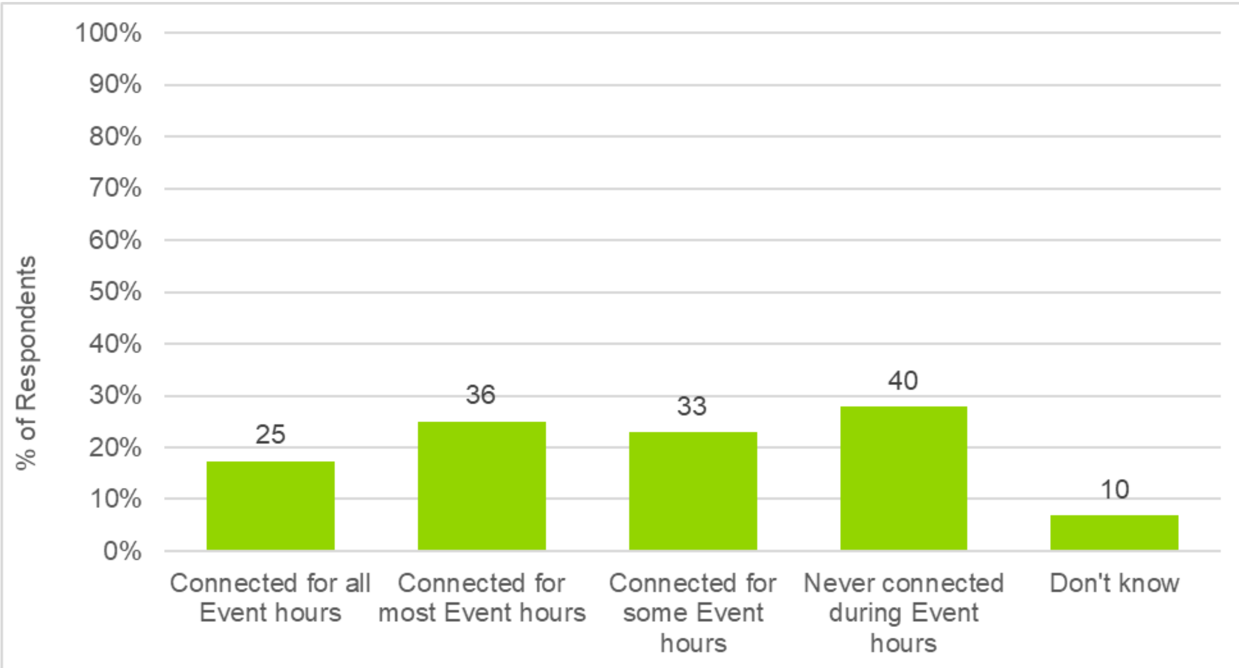
Source: Guidehouse

ET3. How were you notified in advance that an Event was going to occur? (select all that apply) (n=134)



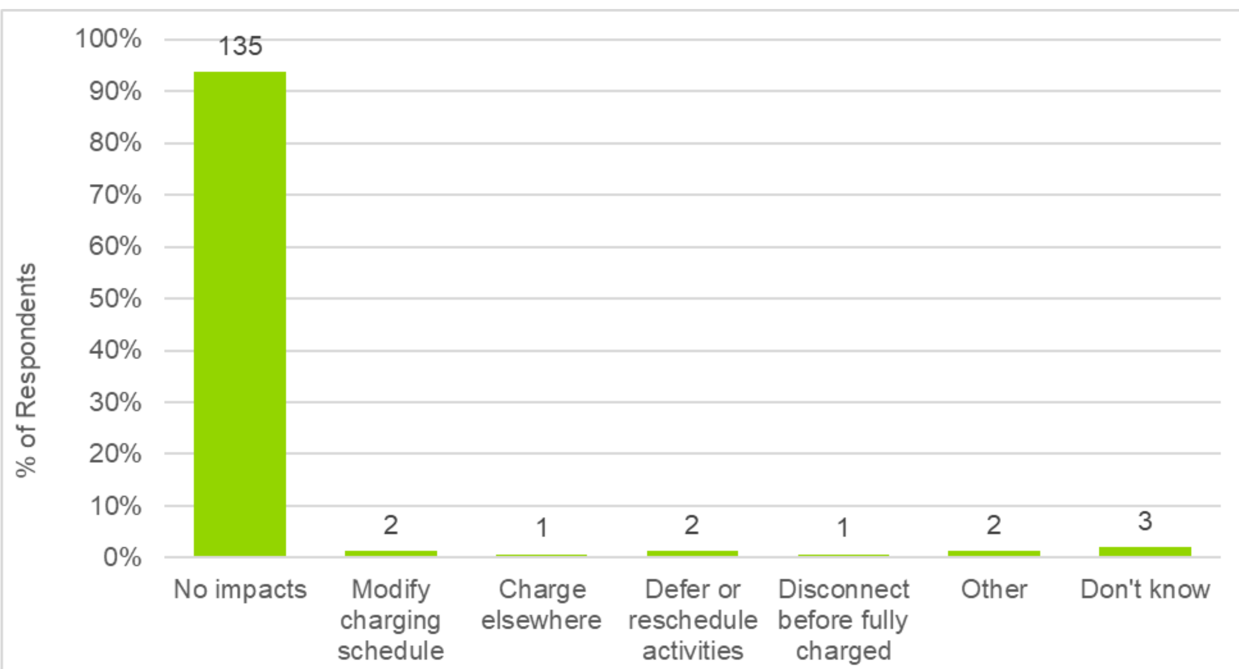
Source: Guidehouse

ET5. For the Events you can recall during winter 2020-2021, how often was your electric vehicle connected to your home charging station during Event hours?



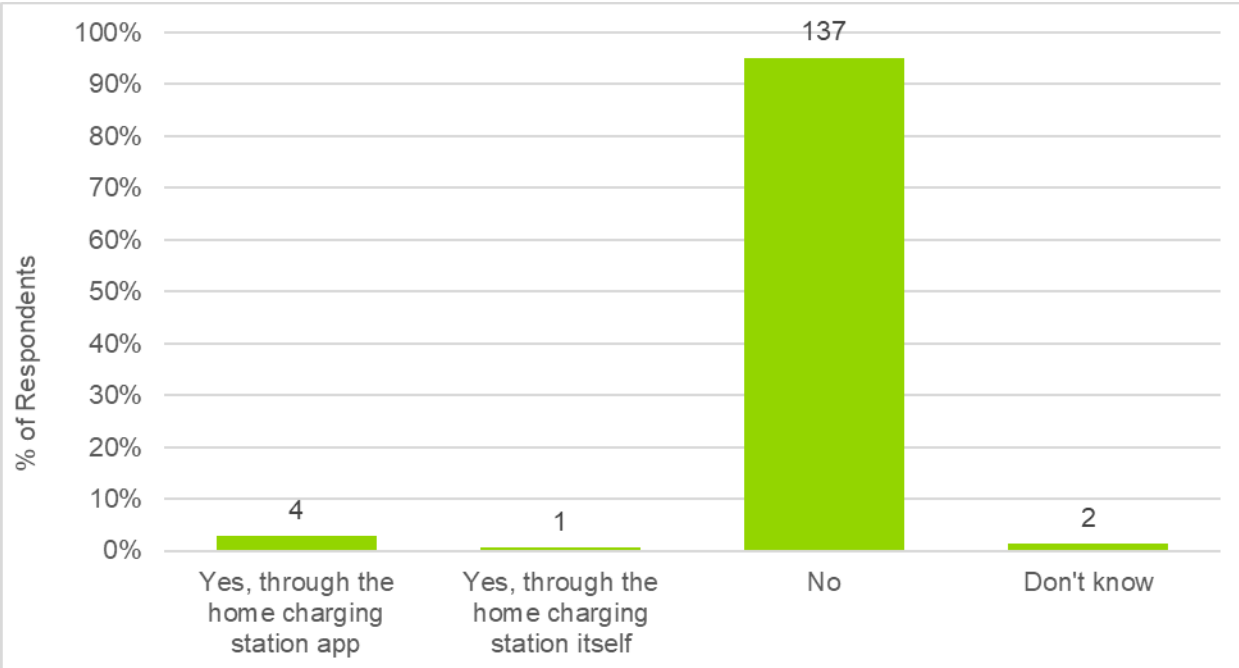
Source: Guidehouse

ET6. Please indicate how the Events affected your normal charging and/or driving behavior during winter 2020-2021. Select all that apply. (n=144)



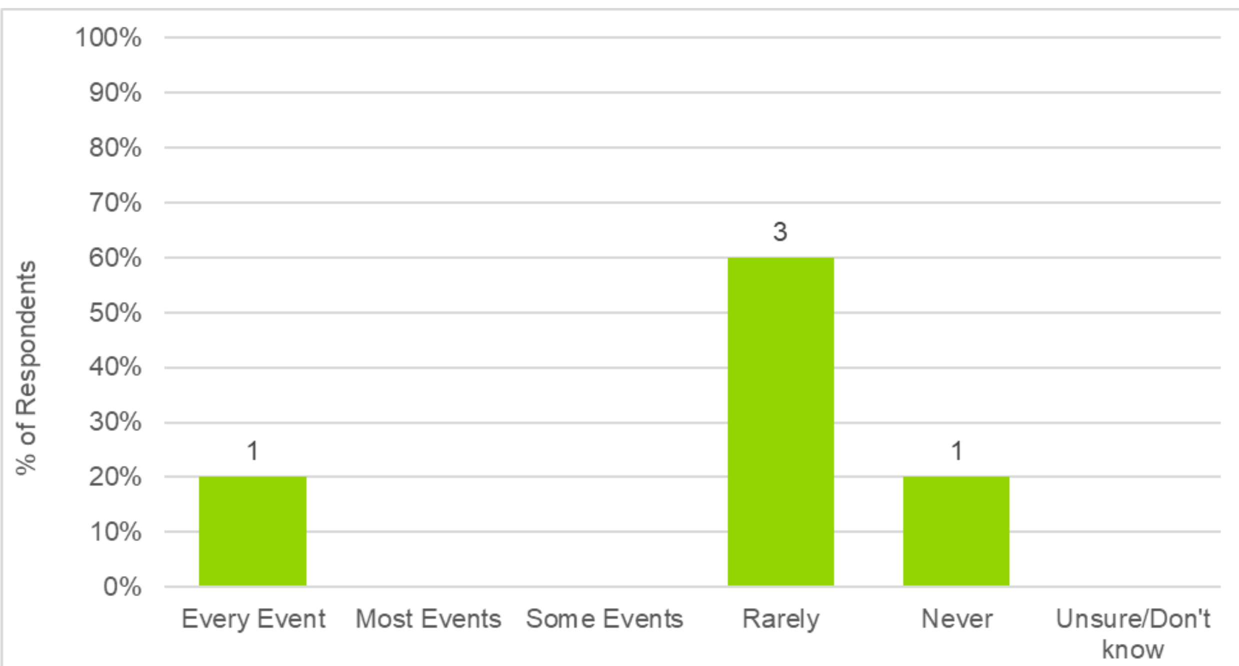
Source: Guidehouse

ET8. On Event days in winter 2020-2021, did you ever "opt-out" or override your home charging station setting to stop the program from adjusting your charging during the Event, either through the app or on the device itself? (n=144)



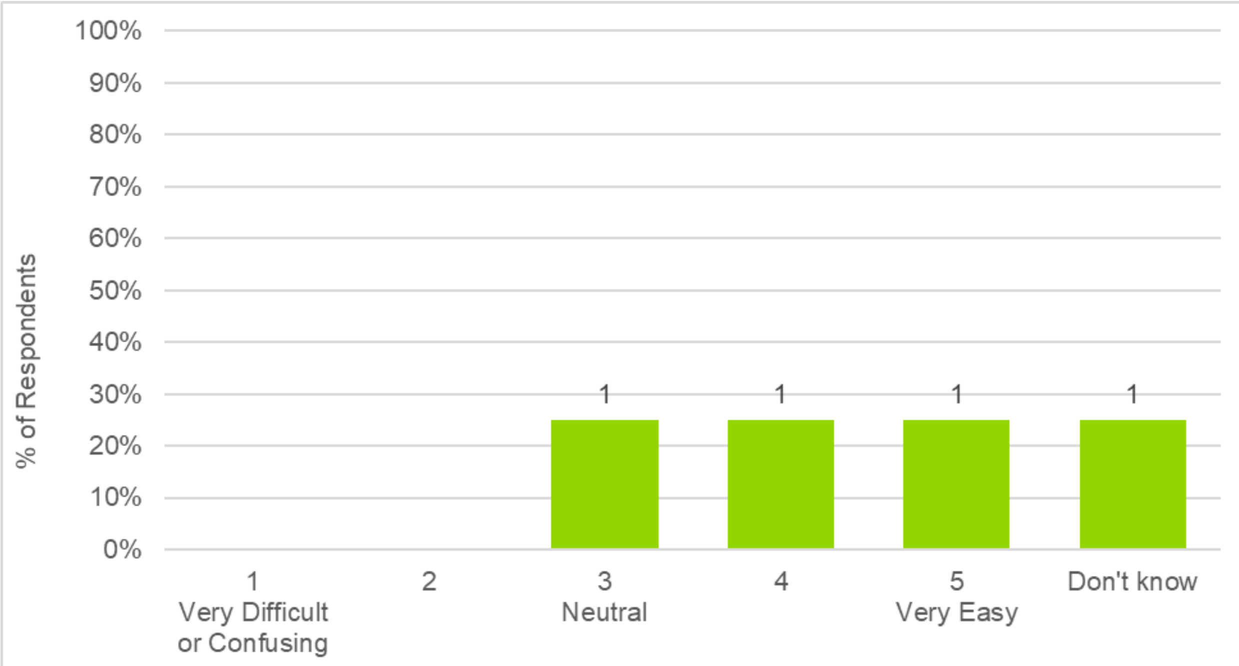
Source: Guidehouse

ET9. How often would you say you chose to override the scheduled Event charging setting once the Event was in-progress? (n=5)



Source: Guidehouse

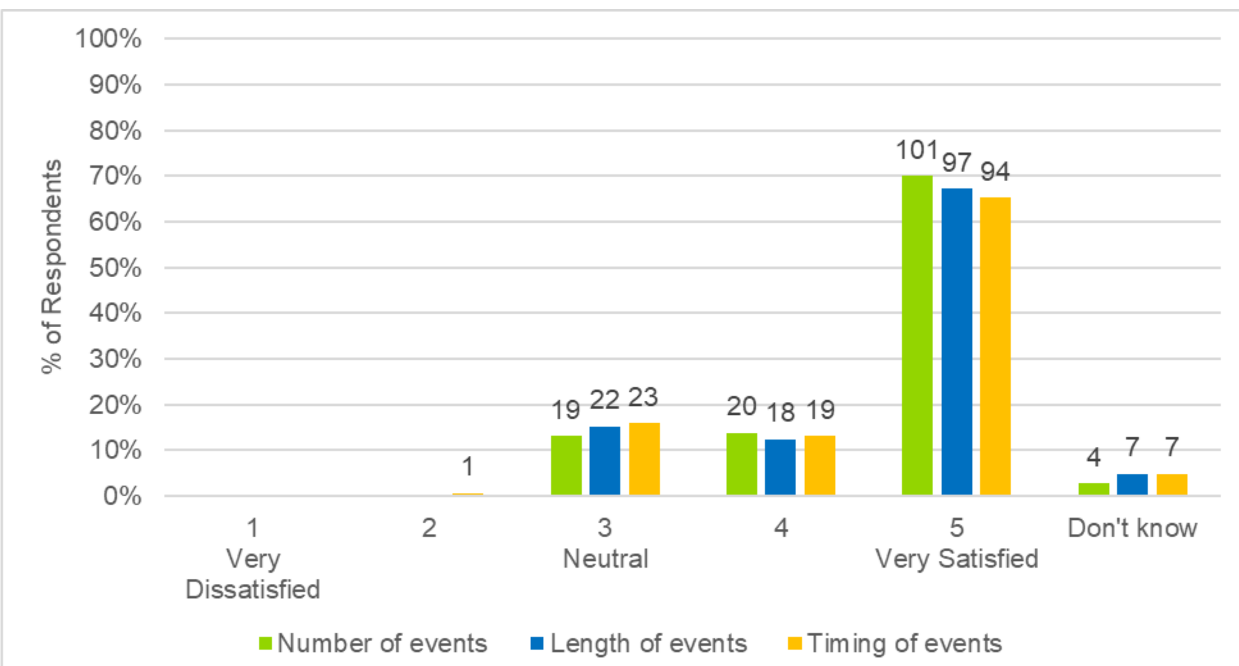
ET11. How easy was it to opt-out of or override Events? (n=4)



Source: Guidehouse

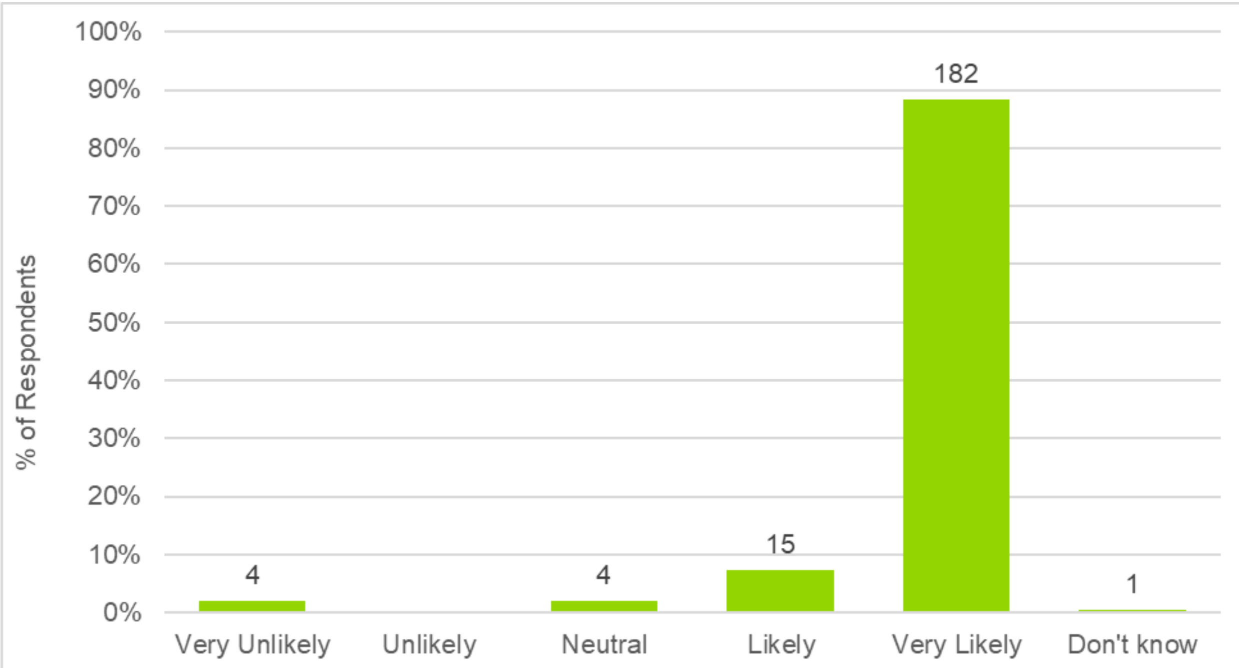
B.3.6 Program Satisfaction

S1. How would you rate your satisfaction with the number of events, length of events, and timing of events for the Eversource's ConnectedSolutions EV Home Charger Demand Response Program to-date? (n=144)



Source: Guidehouse

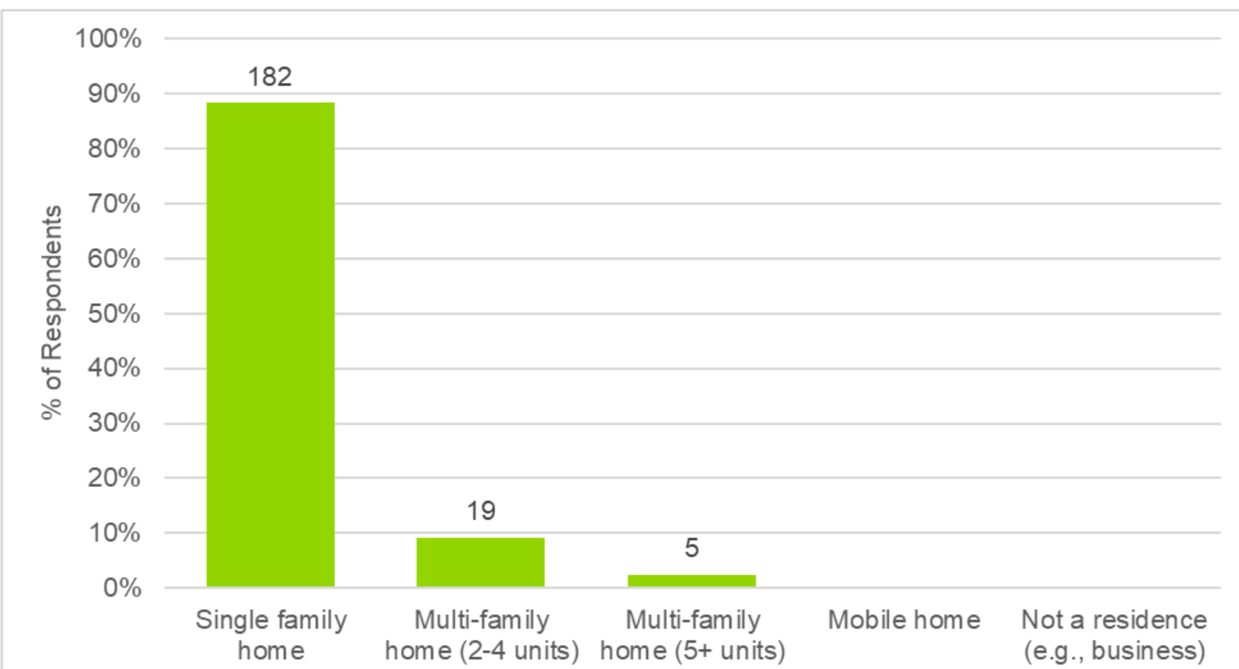
S5. How likely are you to continue to participate in Eversource's ConnectedSolutions EV Home Charger Demand Response Program?



Source: Guidehouse

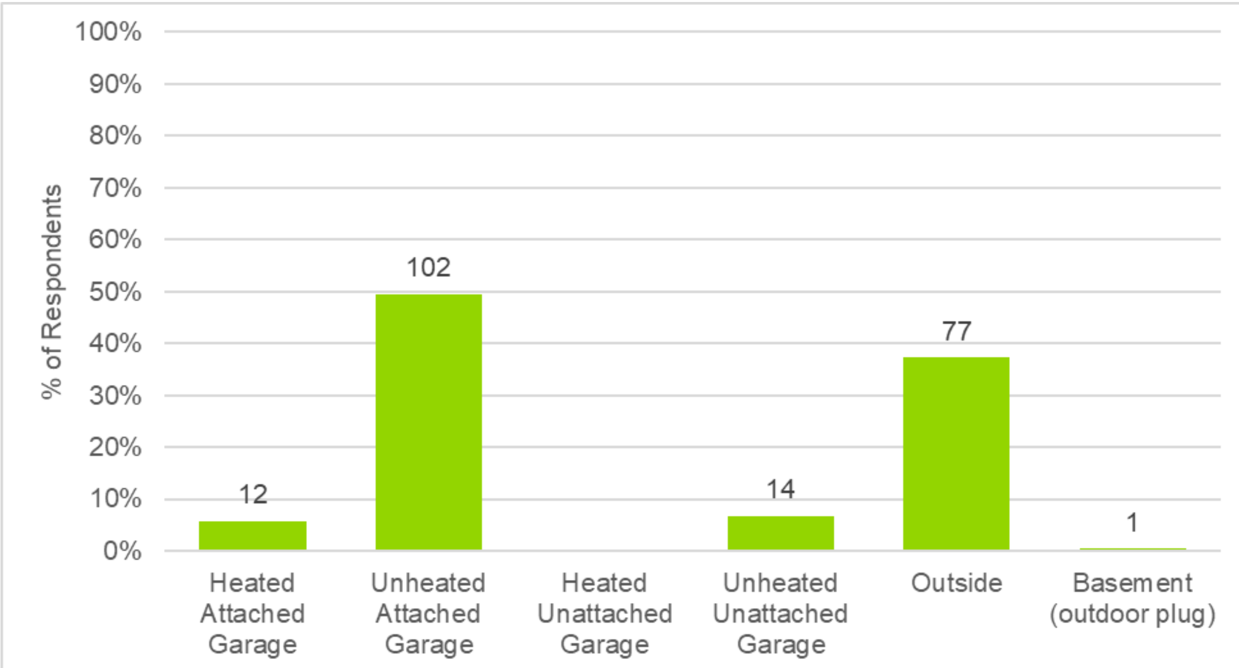
B.3.7 Demographics

D1. Which of the following best describes the property type where your home charging station is located? (n=206)



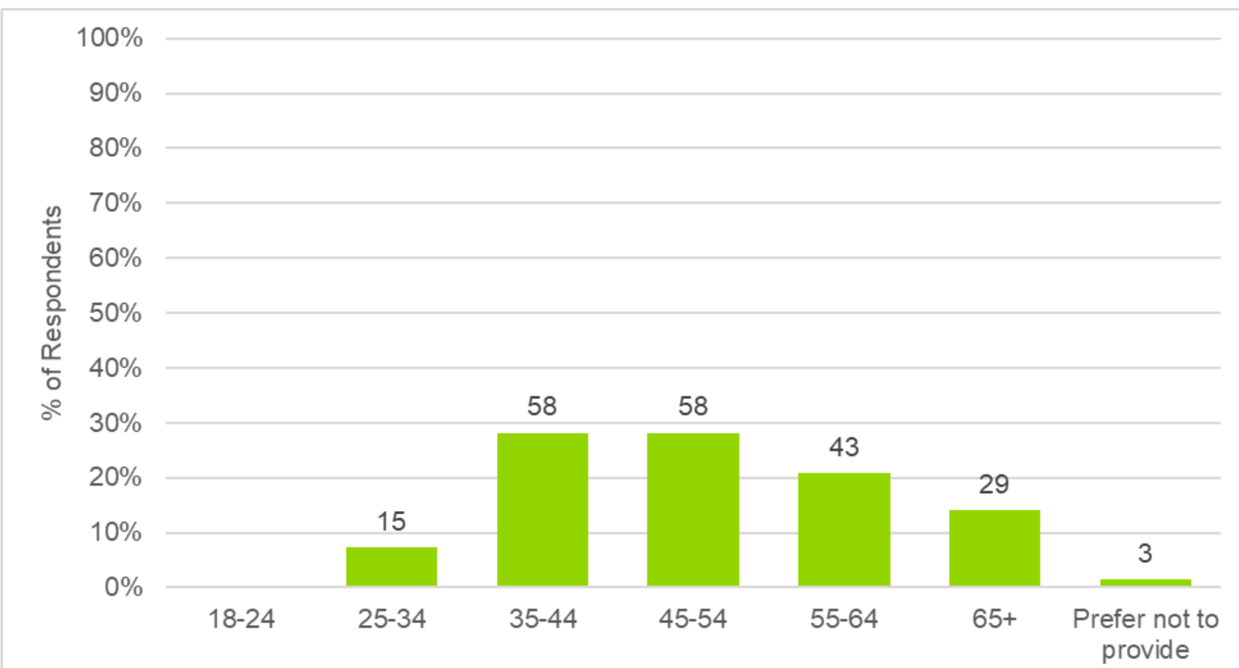
Source: Guidehouse

D1_a. Which of the following best describes the location of your home charging station? (n=206)



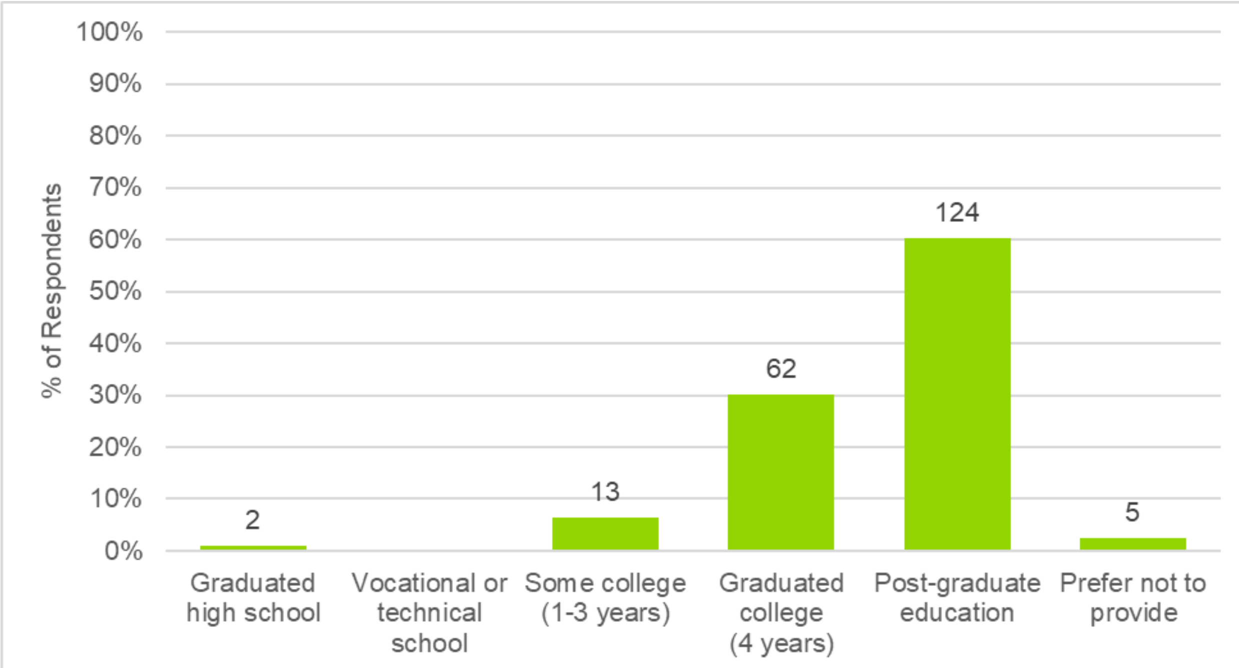
Source: Guidehouse

D2. Which of the following age categories do you fall into? (n=206)



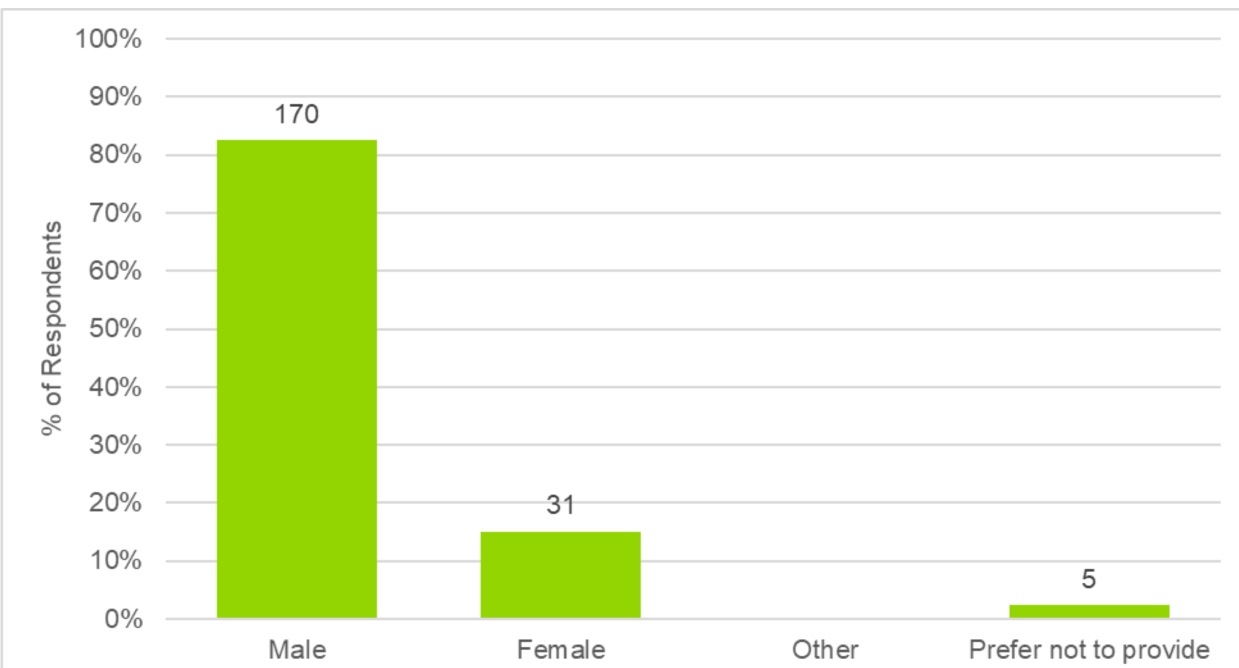
Source: Guidehouse

D3. What is the last grade of school you completed? (n=206)



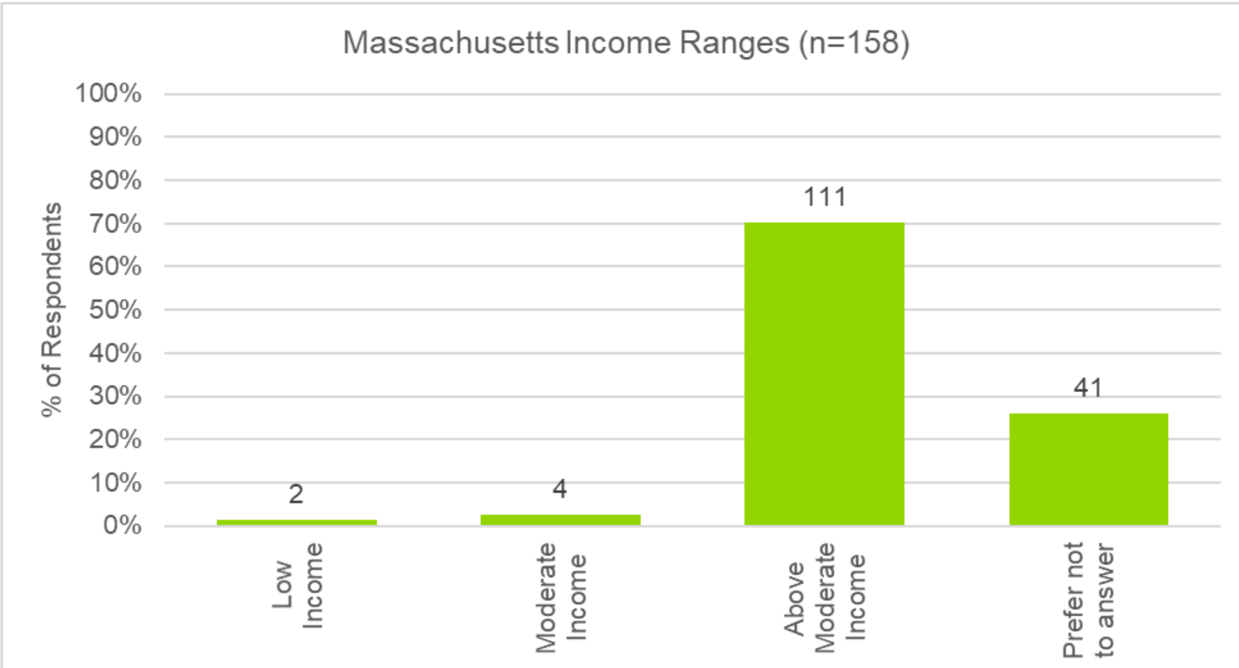
Source: Guidehouse

D4. Which category best describes your gender?

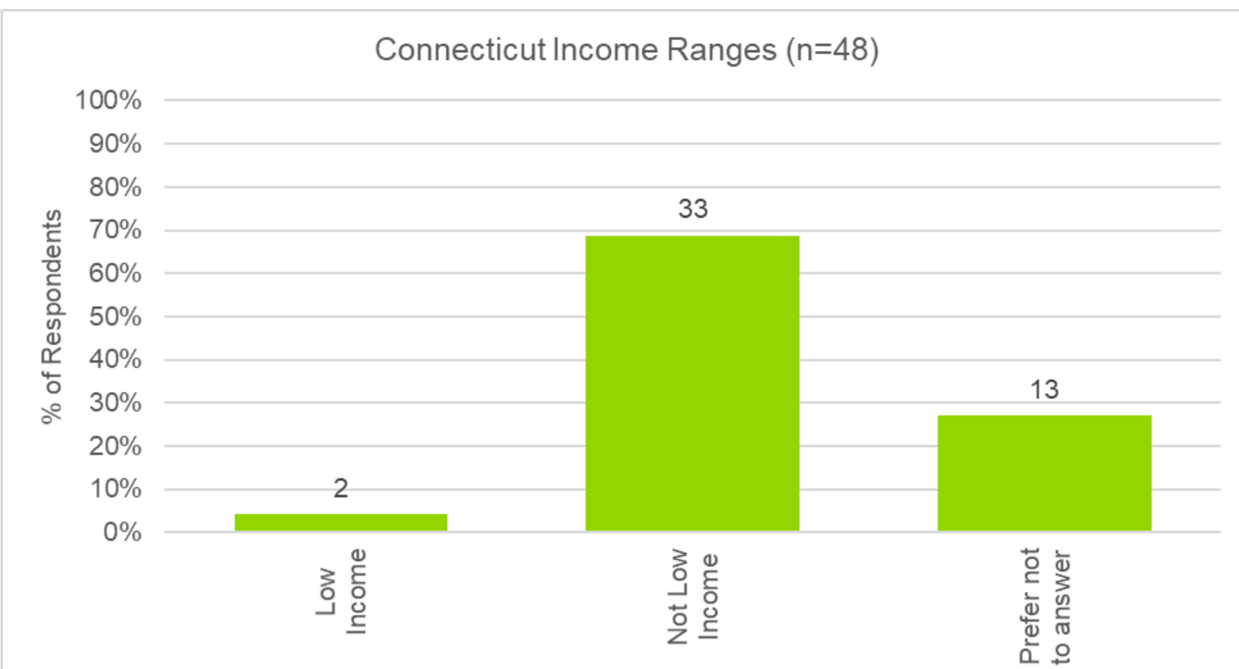


Source: Guidehouse

D5. What was your estimated total annual household income in the winter 2020-2021 before taxes (in other words, your gross household income)? (n=206)



Source: Guidehouse

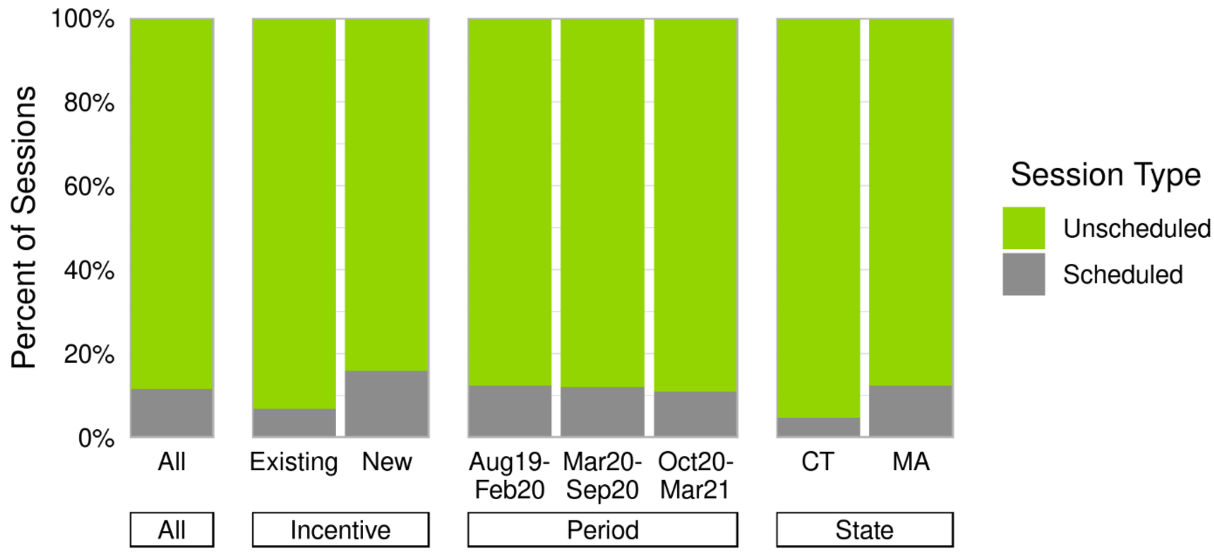


Source: Guidehouse

Appendix C. Assessment of Charging Profiles – Supplemental Results

Figure 5-1 depicts the percent of weekday charging sessions that were scheduled or unscheduled, broken out by several categories. 12% of all charging sessions from August 2019 through March 2021 were scheduled sessions, and ranged from 11-12% for the three time periods analyzed in Section 4.2. Customers in Massachusetts had more scheduled sessions than those in Connecticut, with 12% and 5% of their sessions being scheduled, respectively.

Figure 5-1. Percent of Sessions by Session Type on Weekdays

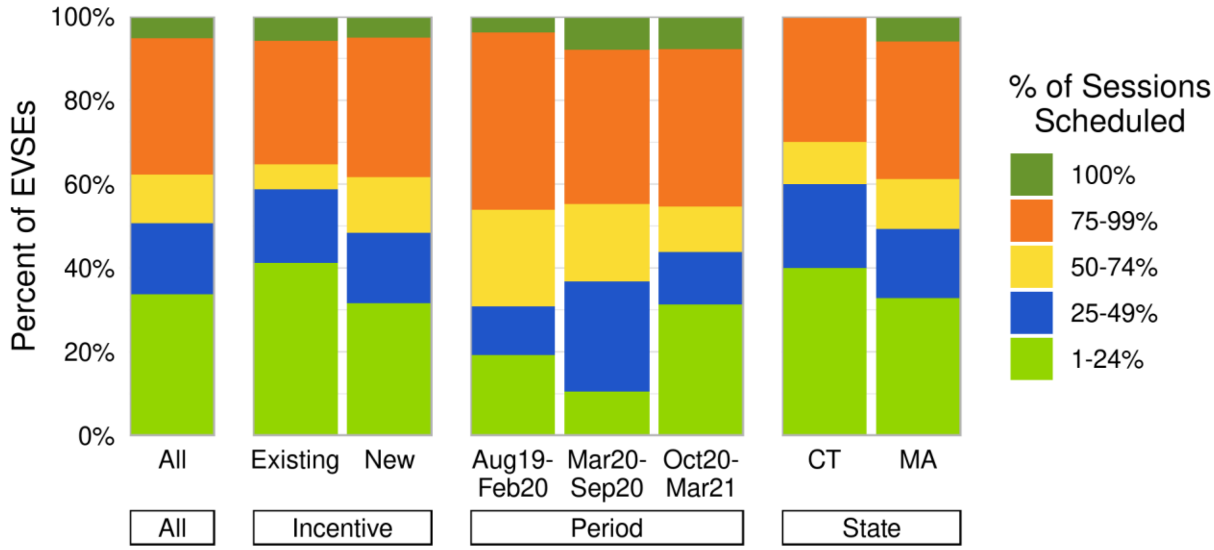


Note: Depending upon date of enrollment, devices are considered "New" if their activation date was on or after March 1st or September 1st of a given year, and "Existing" if not.

Source: Guidehouse analysis of EVSE vendor data

25% of the enrolled devices with data had at least one scheduled weekday session. Figure 5-2 categorizes these devices by the percent of their weekday charging sessions that were scheduled. Approximately 49% of devices had a set schedule for at least half of their weekday charging sessions, and 5% scheduled all of their charging sessions. Customers that are frequently or always scheduling their charging sessions may never align with a DR event and may be program free riders.

Figure 5-2. Percent of EVSEs by Scheduled Session Frequency on Weekdays



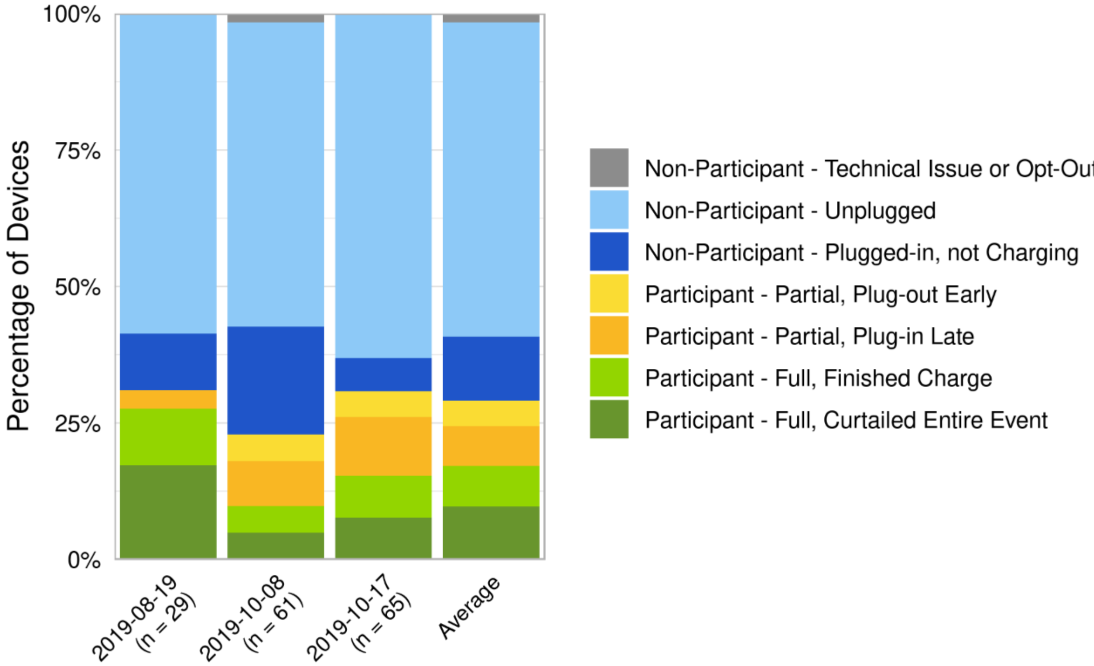
Note: Depending upon date of enrollment, devices are considered "New" if their activation date was on or after March 1st or September 1st of a given year, and "Existing" if not.

Source: Guidehouse analysis of EVSE vendor data

Appendix D. Event Participation – Supplemental Results

Figure 5-3., Figure 5-4., and Figure 5-5. show the participation breakdown by event and averages across each impact analysis period. Participation was consistent across events within an impact analysis period. The first event ever called on August 19, 2019 appeared to have an abnormally high percentage of full participants, but this is likely skewed by the small amount of devices enrolled at that time.

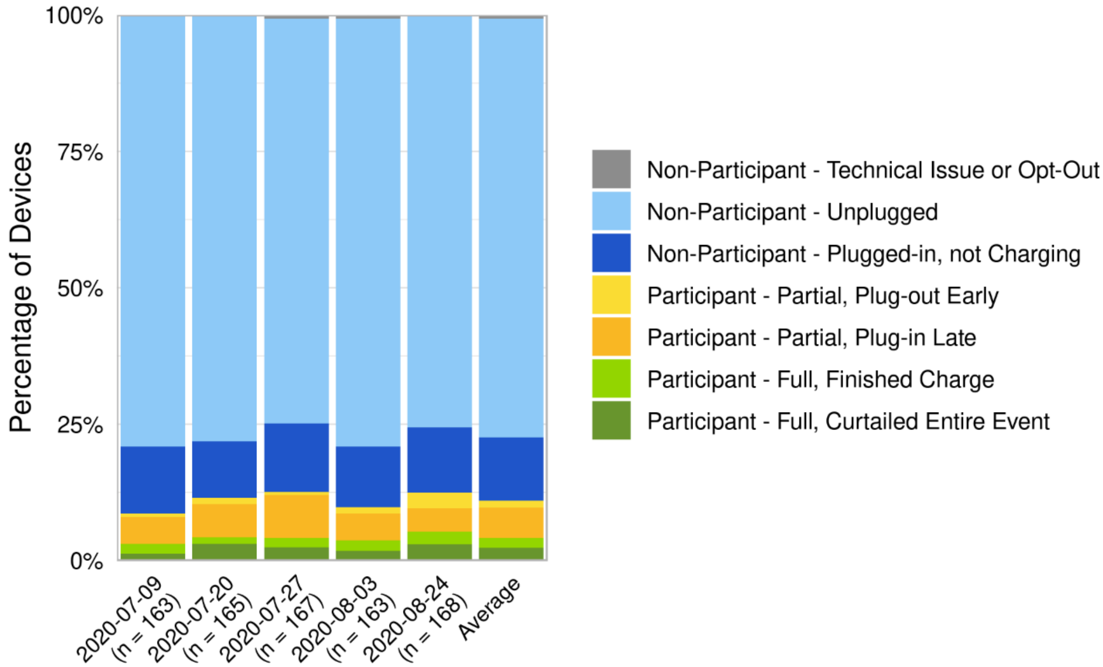
Figure 5-3. Event Participation in August 2019 – October 2019 Impact Analysis Period



Note: "n = " represents the number of devices with data on that event day.

Source: Guidehouse analysis of EVSE vendor data

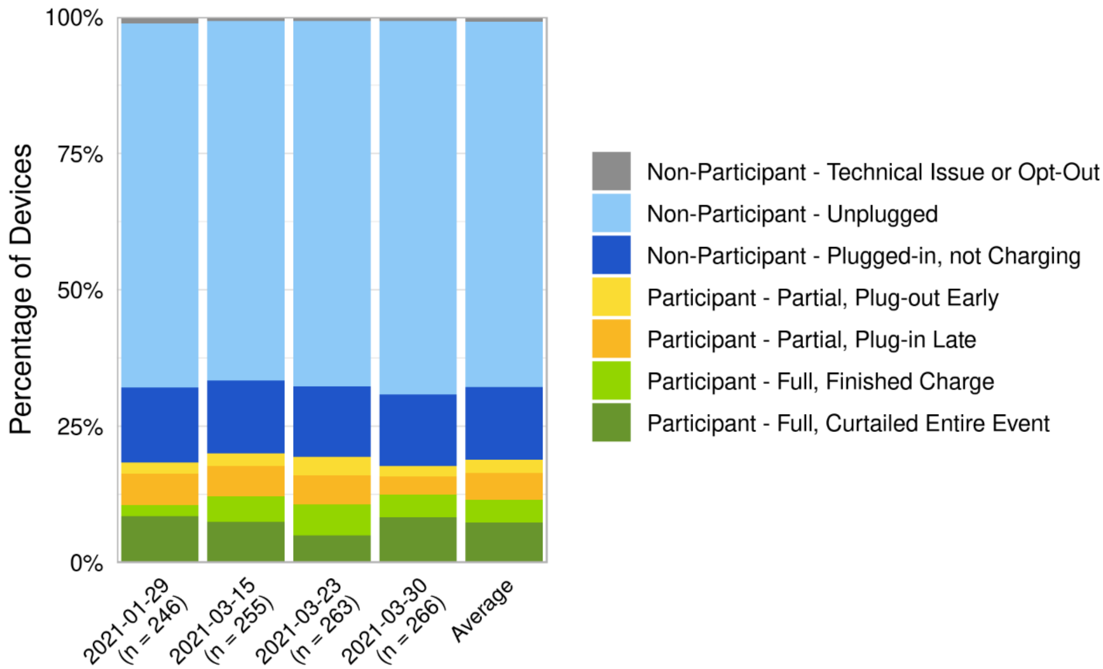
Figure 5-4. Event Participation in June 2020 – September 2020 Impact Analysis Period



Note: “n = “ represents the number of devices with data on that event day.

Source: Guidehouse analysis of EVSE vendor data

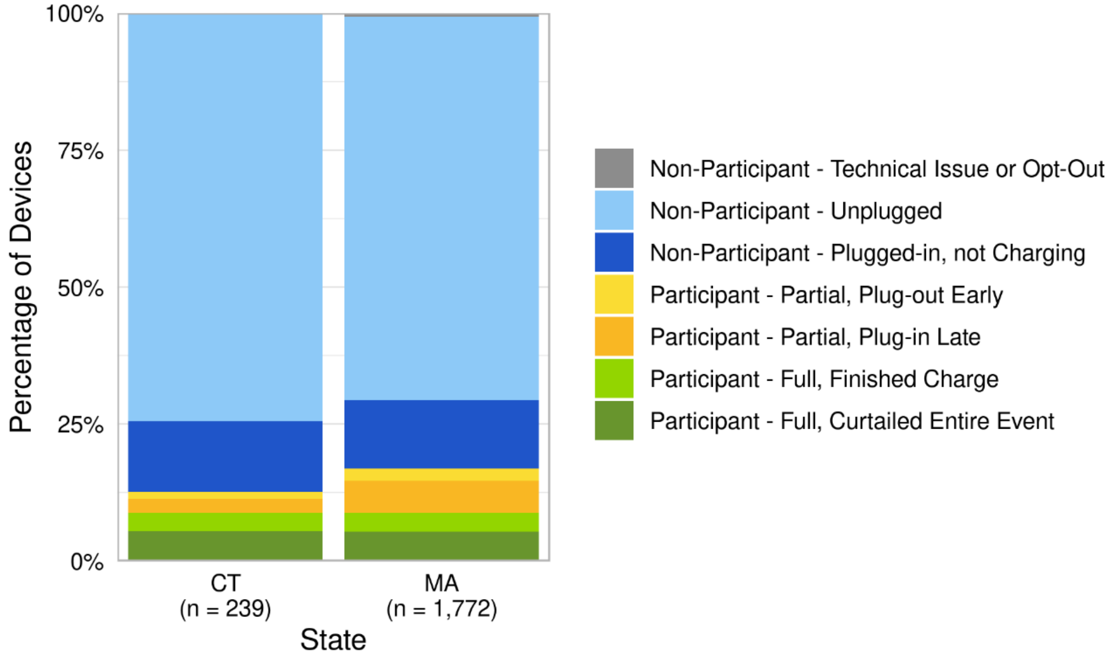
Figure 5-5. Event Participation in October 2020 – March 2021 Impact Analysis Period



Source: Guidehouse analysis of EVSE vendor data

Figure 5-6. shows the average participation by state across all events where devices were enrolled. There is a small difference in partial participation between states, though full participation was similar: MA has 8% partial participation and 9% full participation and CT has 4% partial participation and 9% full participation.

Figure 5-6. Average Participation by State



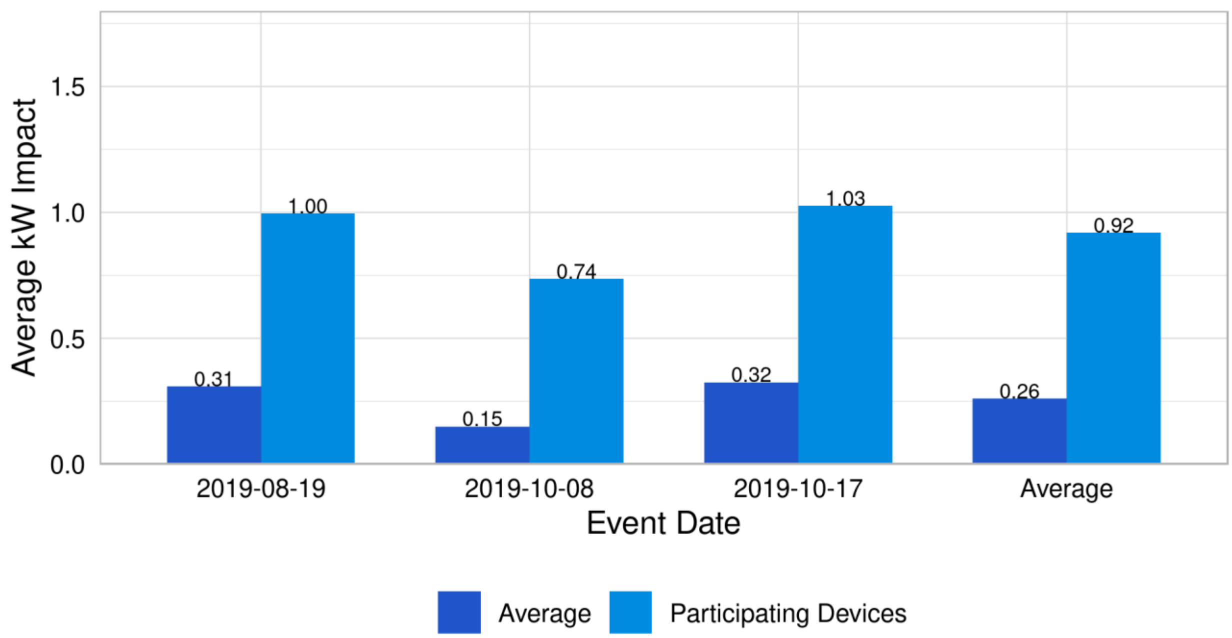
Note: “n = “ represents the number of devices with data on that event day.

Source: Guidehouse analysis of EVSE vendor data

Appendix E. Impact Analysis – Supplemental Results

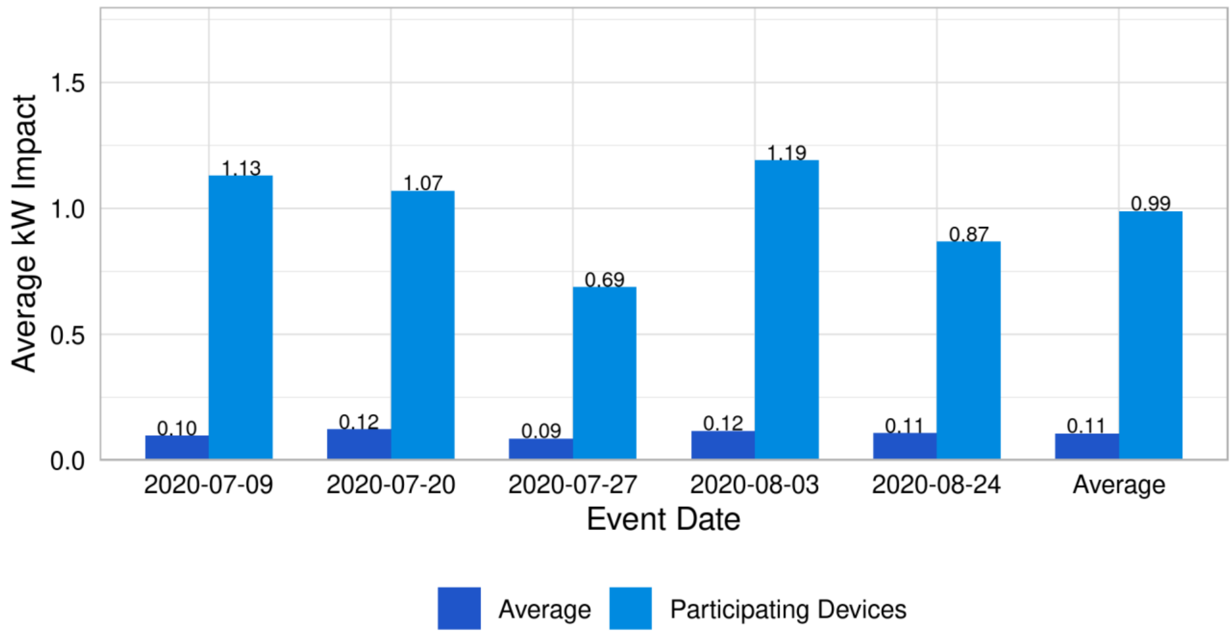
Figure 5-7., Figure 5-8., and Figure 5-9. show impacts calculated with the engineering approach by event for all devices and for participating devices. Participating devices in these figures include partial and full participants. The highest event impact across all impact analysis periods for participating devices was 1.75 kW and came from the event on January 29, 2021. The highest per-event impacts for participating devices in the August 2019–October 2019 and June 2020–September 2020 impact analysis periods were 1.03 kW on October 17, 2019 and 1.19 kW on August 3, 2020, respectively. Differences in event impacts for participating devices between impact analysis periods can be attributed to a variety of factors including the ratio of full to partial participants and changes in max observed power draw of participating EVSEs.

Figure 5-7. Impacts by Event in August 2019 – October 2019 Impact Analysis Period



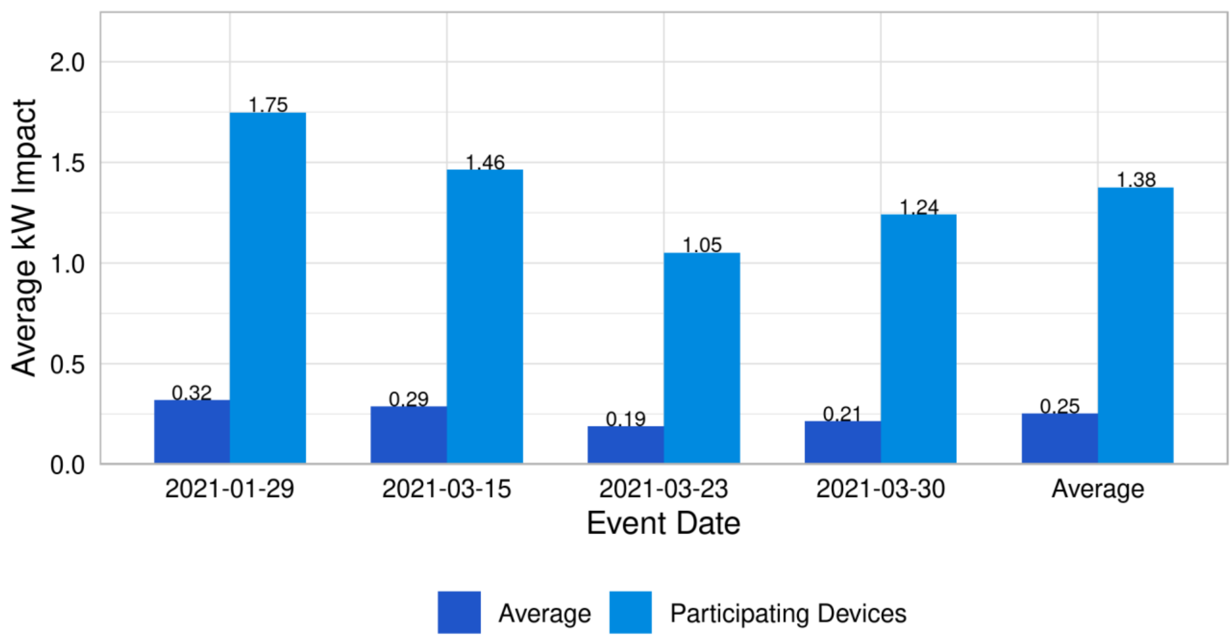
Source: Guidehouse analysis of EVSE vendor data

Figure 5-8. Impacts by Event in June 2020 – September 2020 Impact Analysis Period



Source: Guidehouse analysis of EVSE vendor data

Figure 5-9. Impacts by Event in October 2020 – March 2021 Impact Analysis Period

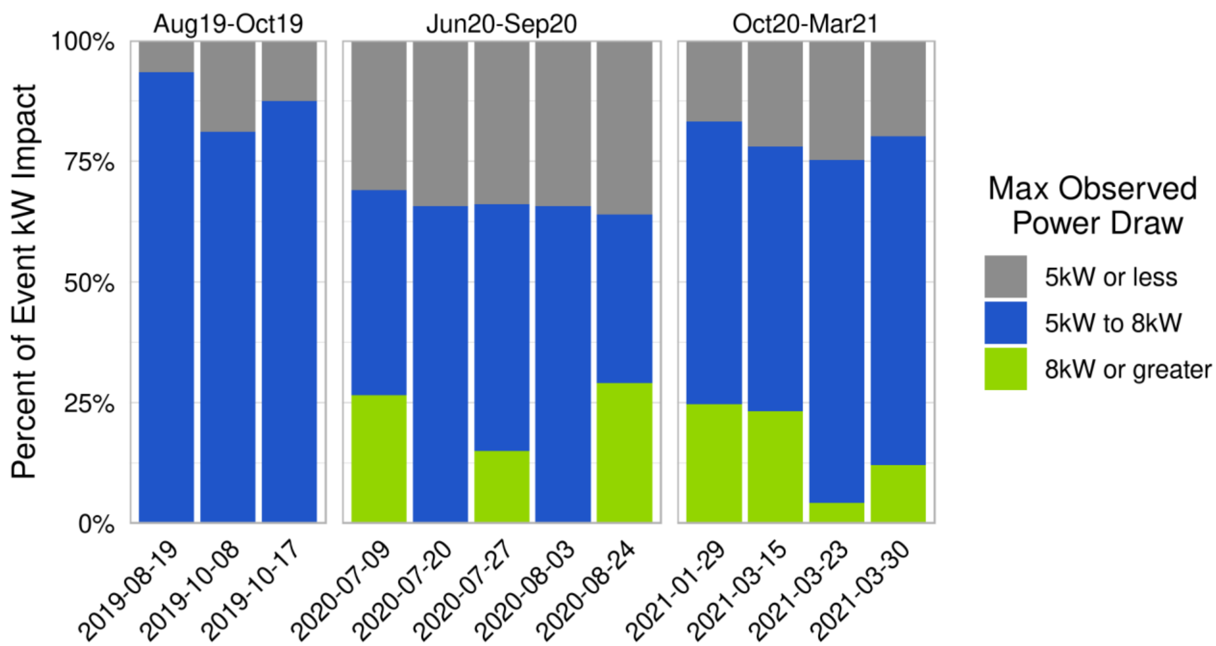


Source: Guidehouse analysis of EVSE vendor data

Figure 5-10.Figure 5-10. shows the event level contribution of participating devices by their maximum observed power draw. The highest event impact of participating devices was 1.75 kW on January 29, 2021, during which devices with a maximum observed power draw greater than 8 kW made up 7% of the participating devices and 25% of the impacts. The October 2020–

March 2021 event with the lowest impacts among participating devices (1.05 kW) was the March 23, 2021 event, where participating devices with a maximum observed power draw over 8 kW only made up 4% of the event impacts.

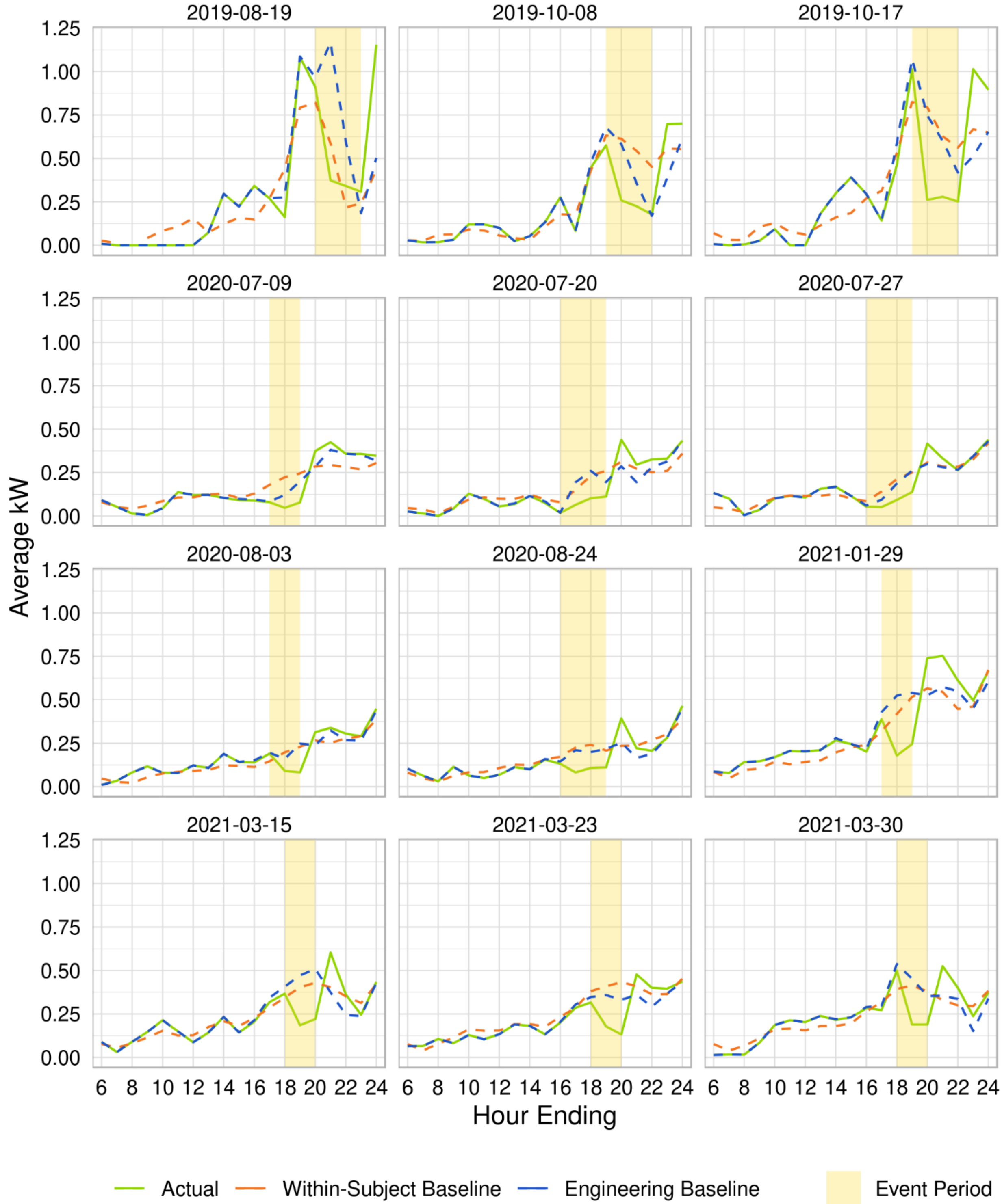
Figure 5-10. Impact Contribution by Max Observed Power Draw and Event



Source: Guidehouse analysis of EVSE vendor data

Figure 5-11 shows the modeled baselines for the within-subject and engineering methodologies in addtion to the actual load reduction during the event. From the plots below, there is some evidence of snapback in the hours following an event in the first three events and the final four events. However, the first three events had event end times closer to the default schedule start time (11 p.m.), which could mean that apparent snapback charging after an event was inflated by scheduled charging sessions.

Figure 5-11. Event Baselines



Source: Guidehouse analysis of EVSE vendor data

Eversource Off-Peak Charging Offering for Tesla Owners Evaluation

Prepared for
Eversource
Study No.: MA-21-DR06-EV-OFFPEAK

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Reference No.:
211517
April 19, 2022

Guidehouse

Guidehouse

Offering Overview

Offering Summary

Beginning in summer 2021, Eversource offered incentives for Eversource Tesla owners to encourage them to shift charging to off-peak hours of 11 p.m. and 7 a.m. Eversource initially provided this offering as a part of the ConnectedSolutions (CS) portfolio and branded it ConnectedSolutions Off-Peak Charging for Tesla Owners. Subsequently it is considered an offering outside of the ConnectedSolutions portfolio. In this report, the Eversource Off-Peak Charging Offering for Tesla Owners is referenced as “the offering”, “the program”, or “CS”. The offering aimed to reduce peak demand of electric vehicle (EV) charging load by way of an off-peak charging rebate. The offering was open to Eversource residential customers in Massachusetts who owned a Tesla.

Participating customers received an incentive upon program enrollment, a rebate on electricity usage during off-peak hours, and a monthly bonus incentive for avoiding charging during the hours of 5 p.m. to 8 p.m. The primary objectives of this evaluation were to understand demand reductions and energy impacts resulting from rebates for off-peak charging, to understand customer charging patterns, and to assess the customer experience in the program. As a comparison group, Guidehouse assessed data from customers who were enrolled in Rolling Energy Resources (RER)[1] referred to as RER participants or nonparticipants for this evaluation. This evaluation covered Eversource’s offering from July through September 2021.

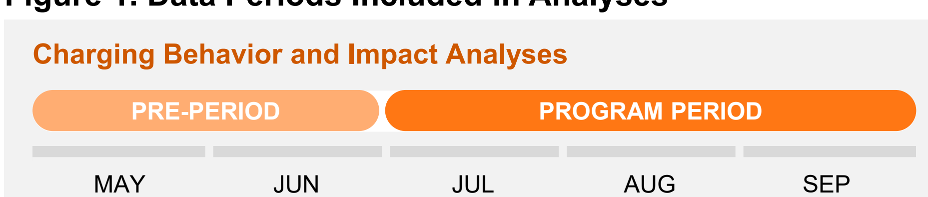
Table 1. Off-Peak Offering Summary Highlights

	Program Attributes	2021 Category		Program Attributes	2021 Category
Program Participants	**State**	Massachusetts	Key Vendors	**Technology Provider**	FleetCarma (Division of Geotab)
	Customer Segment	Residential customers		**Eligible manufacturers**	Tesla
	Target Enrollment	200[2]			

	Program Attributes	2021 Category
Program Design	**Demand Reduction**	• Rebate on electricity costs for charging during off-peak hours (11 p.m.–7 a.m. EDT)
	Rebate	• $50 enrollment incentive • Jun-Sep: $0.05/kWh ($0.03/kWh Oct-May) during off-peak hours • $10 monthly bonus for avoiding charging 5 p.m. to 8 p.m. • Applies to all locations within Eversource Massachusetts service territory
	Communications/ Information	• FleetCarma app and dashboard informed and reminded participant to charge during off-peak periods and provided access to charging data for on- and off-peak charging • The SmartCharge Rewards Portal provided participants with information about and access to their rebate incentives

Figure 1 shows the pre- and program periods for the Charging Behavior and Impact Analyses during the summer of 2021. These periods are the same for both CS and RER participants.

Figure 1. Data Periods Included in Analyses



Source: Guidehouse

[1] Rolling Energy Resources (RER) is a vendor of EV charging data derived from EV onboard computers, accessed via their native APIs. Guidehouse utilized data from battery EVs (BEVs) enrolled with RER and sharing data with RER to facilitate comparisons to CS participants.

[2] Four marketing emails from Eversource were sent on: April 1, 2021, April 20, 2021, May 18, 2021, and June 1, 2021.

Source for Figure: Guidehouse analysis of CS and RER EV telematics data

Guidehouse

Evaluation Methods

CS Off-Peak Charging Offering Evaluation Methods

PARTICIPANT SURVEYS

Guidehouse administered a survey to all offering participants (CS participants) enrolled as of July 1, 2021 in order to obtain information on how the offering influenced participant driving and charging behavior during the summer months. The survey ascertained participants' acceptance of program design and delivery features.

The survey was also administered to nonparticipants (RER participants). Responses from RER participants informed impact analysis methodology and served as a valuable source of information in comparing CS participants' self-reported feedback on program influence.

DATA MANAGEMENT

Guidehouse received raw interval telemetry and charging session data from FleetCarma. Guidehouse performed quality assurance/quality control (QA/QC) of the EV telematics data and other data sources at the outset of the offering. Guidehouse cleaned and formatted the EV telematics for the usage assessment and impact analysis.

ASSESSMENT OF CHARGING PROFILES

Guidehouse utilized EV telemetry collected from CS participants and RER participants to assess charging profiles. Guidehouse analyzed various metrics for CS participants and RER participants through the period spanning May to September 2021, which included the pre-program (May 1–June 30) and program (July 1–September 30) periods.

IMPACT ANALYSIS

Guidehouse estimated demand and energy impacts during both on- and off-peak hours across the evaluation period using a comparison group approach. Guidehouse modeled CS participants relative to RER participants using a difference-in-differences modeling approach to assess how much charging shifted from on- to off-peak periods.

REPORTING

Reporting included a draft presentation, a draft report, and a final report. Report contents include survey findings, assessment of charging profiles, and impact analysis results.

Source: Guidehouse

Guidehouse

Findings: Customer Experience Research

EV CHARACTERISTICS & CHARGING BEHAVIOR

- Most respondents have a Level 2 charger at home, with CS participants mainly using Tesla chargers.
- The majority of respondents were motivated to purchase an EV to help the environment.
- Fewer CS participants charged their EV until full and more connected their EV to their home charger (regardless of charging or not) during off-peak periods (11 p.m. to 7 a.m.) compared to RER participants.
- Most CS participants scheduled charging times using an app compared to only a small portion of RER participants.
  - 57% of CS and 13% of RER participants who own Teslas and use Tesla chargers scheduled charging times using an app.
  - Common scheduled start times for CS participants was at or after 11 p.m. on weekdays.
- Most CS participants reported location and availability of public chargers as barriers to public charging, and all respondents used workplace charging minimally.

Figure 2. Household Charging Device Usage

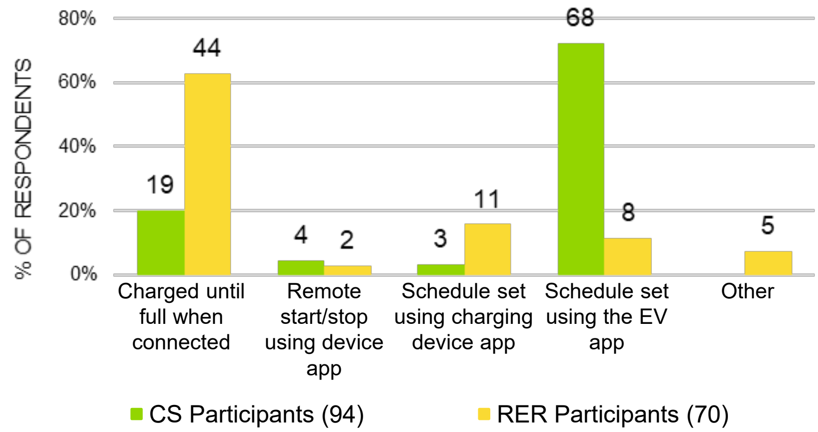
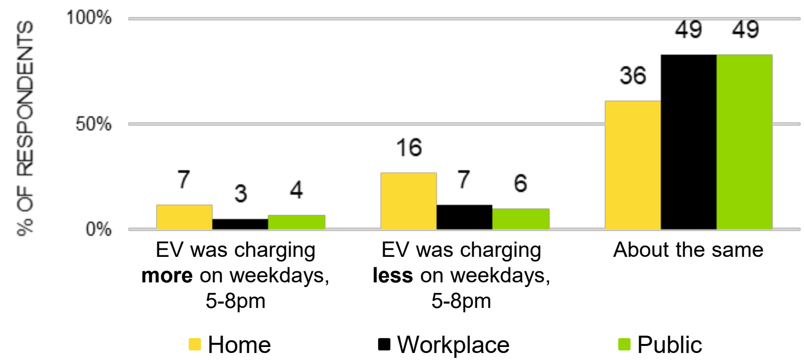


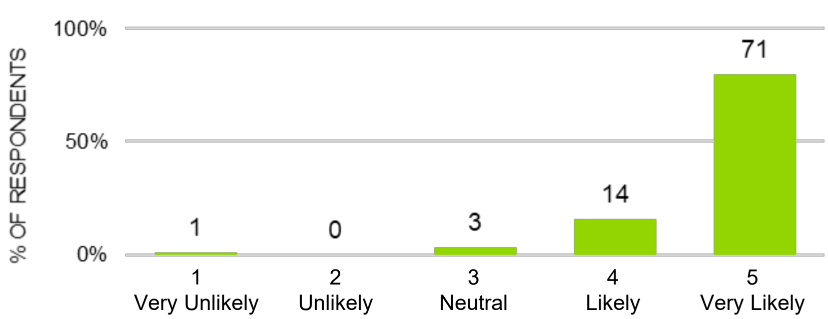
Figure 3. Typical EV Charging on Weekday On-Peak Hours



PROGRAM INFLUENCES

- Program incentives were most commonly cited as the top reason for CS participant enrollment.
- ~70% of CS participants viewed the SmartCharge Rewards Portal and found it valuable, and many said that the energy use information had an influence in determining their EV charging schedule for summer 2021.
- CS participants were more influenced by rewards and monthly bonuses than energy use information when determining their EV's charging schedule for summer 2021.

Figure 4. Likelihood of Continued Program Participation



PROGRAM SATISFACTION

- Almost all of the CS participants (96%) reported that they are likely to continue participating in the program in the future.
- 89% of CS participants were satisfied with the enrollment process
- Most CS participants were satisfied with the SmartCharge Rewards Portal, timing of on- and off-peak periods, and program communication and incentives.

Source for Figures: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

Guidehouse

Findings: Assessment of Charging Profiles

KEY FINDINGS

- **CS participants conducted most of their charging during off-peak hours (11 p.m.–7 a.m.).** This pattern was observed during the pre-period (May 1–June 30) and the program treatment period (July 1–September 30).
- **Many enrolled EVs appear to have shifted their charging from peak hours (7 a.m.–11 p.m.) to off-peak hours (11 p.m.–7 a.m.).** Despite CS participants conducting more of their charging during off-peak hours prior to program start, EVs appear to have shifted additional charging from peak hours to off-peak hours after the program began. (Note: From Customer Experience Research findings, 32% of CS participants and only 13% of RER participants charged more during off-peak hours in summer 2021 than in summer 2020).
- **30% of customers used scheduled charging in some capacity from May 2021–September 2021.** Nearly all scheduled charging occurred during off-peak hours (11 p.m.–7 p.m.), with most scheduled sessions beginning between 11 p.m. and 12 a.m. Among these customers, there was an increase in scheduled charging during off-peak hours during the program treatment period (July 1–September 30).

Figure 5. Percent of Energy Consumed by Hour, Pre- and Post-July 1 (CS Participants)

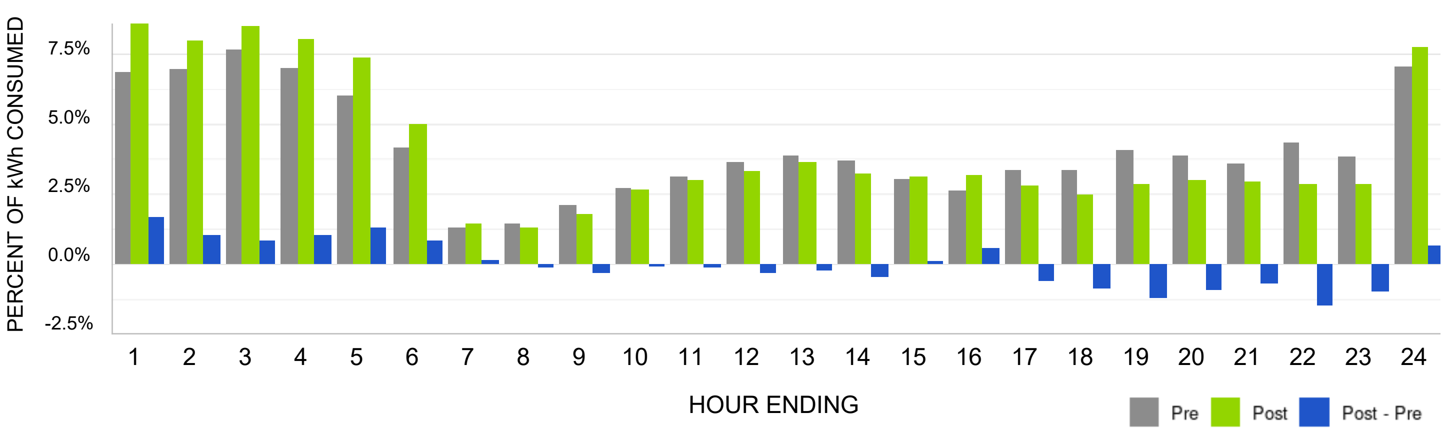
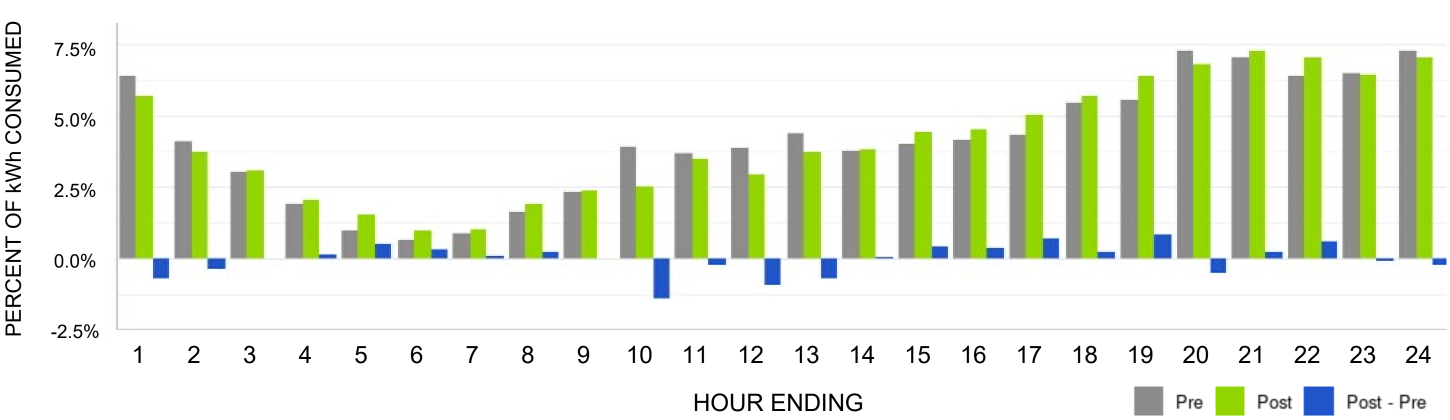


Figure 6. Percent of Energy Consumed by Hour, Pre- and Post-July 1 (RER Participants)



Source for Figures: Guidehouse analysis of CS EV telematics data

Guidehouse

Findings: Impact Analysis

PEAK AND OFF-PEAK PERIOD IMPACTS

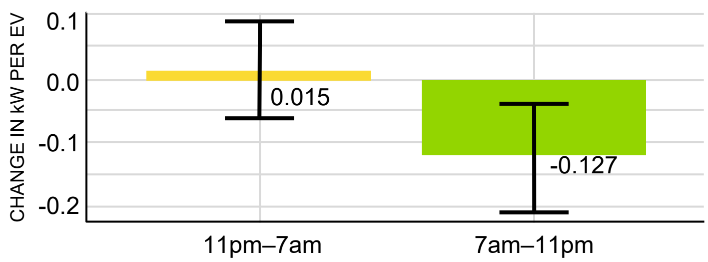
- **Average reductions in demand between the hours of 7 a.m. and 11 p.m. were 0.13 kW per EV.** Daily energy savings between the hours of 7 a.m. and 11 p.m. were 1.85 kWh per EV per day. There was not a statistically significant change in demand or energy between the hours of 11 p.m. and 7 a.m. Reductions in kW demand during peak hours is consistent with findings from charge profile analysis, which indicated that CS participants shifted charging downward during peak hours, particularly during super-peak hours (5 p.m. to 8 p.m.) that had an additional incentive for avoiding charging. This shift in charging from early-evening hours was not only a goal of the offering, but also a measured program impact.

Table 2. Demand Impacts per EV by Period

Impact Analysis Metric	Time Period	Est. Change
Average Half-Hourly kW Reduction per EV	7 a.m.–11 p.m.	-0.127 kW**
	11 p.m.–7 a.m.	0.015 kW
Average Daily kWh Savings per EV	7 a.m.–11 p.m.	-1.852 kWh**
	11 p.m.–7 a.m.	0.130 kWh

* Indicates significance at 90% confidence, ** Indicates significance at 95% confidence, *** Indicates significance at 99% confidence

Figure 7. Average kW Impact per EV by Period



* Bars indicate 90% confidence bounds associated with kW impact estimates

11pm–7am
7am–11pm

SUPER-PEAK PERIOD IMPACTS

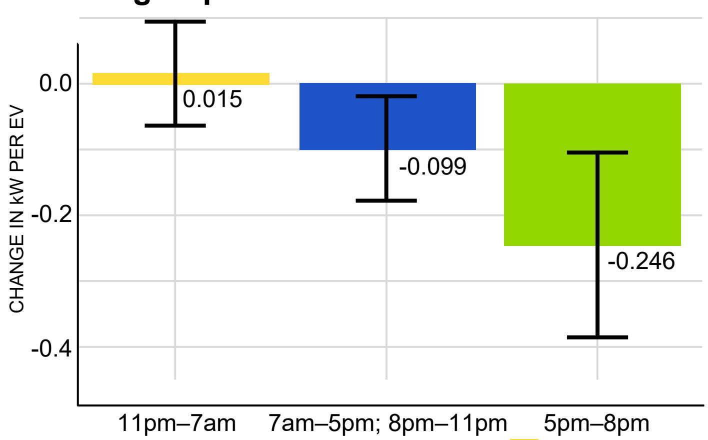
- **Average reductions in super-peak demand between the hours of 5 p.m. and 8 p.m. were 0.25 kW per EV.**[3] In addition to a $0.05/kWh rebate for charging during off-peak hours, CS participants were eligible for an additional $10/month bonus incentive if they avoided charging between the hours of 5 p.m. and 8 p.m. Daily energy savings during super-peak hours were 0.67 kWh per EV per day. For peak hours outside of the super-peak period, demand and energy impacts amounted to a 0.10 kW reduction in demand and 1.18 kWh in daily energy savings per EV. Changes in demand and energy for off-peak hours were not statistically different from zero. This suggests that much of the 0.13 kW per EV demand reduction assessed for 7 a.m.–11 p.m. could be attributed to super-peak demand reductions.

Table 3. Demand Impacts per EV by Period, Including Super-Peak

Impact Analysis Metric	Time Period	Est. Change
Average Half-Hourly kW Reduction per EV	7 a.m.–5 p.m.; 8 p.m.–11 p.m.	-0.099 kW**
	5 p.m.–8 p.m.	-0.246 kW***
	11 p.m.–7 a.m.	0.015 kW
Average Daily kWh Savings per EV	7 a.m.–5 p.m.; 8 p.m.–11 p.m.	-1.180 kWh**
	5 p.m.–8 p.m.	-0.673 kWh***
	11 p.m.–7 a.m.	0.130 kWh

* Indicates significance at 90% confidence, ** Indicates significance at 95% confidence, *** Indicates significance at 99% confidence

Figure 8. Average kW Impact per EV by Period, Including Super-Peak Hours



* Bars indicate 90% confidence bounds associated with kW impact estimates

11pm–7am
7am–5pm; 8pm–11pm
5pm–8pm

[3] This finding is comparable to the 0.27 kW reduction per vehicle between 5 p.m. and 9 p.m. observed in the first year of National Grid's Rhode Island Off-Peak Charging Rebate Pilot. Notably, that program was implemented as a randomized control trial. Evaluation results for the pilot can be found linked here: http://www.ripuc.ri.gov/eventsactions/docket/4770-NGrid-RY2%20Transportation%20Initiative%20Annual%20Report%20Combined%20(10.30.2020).pdf

Source for Tables & Figures: Guidehouse analysis of CS and RER EV telematics data

Guidehouse

Final Considerations

Table 4. Key Considerations from the Offering

Research Category	Considerations
Program Design	**CONSIDERATION 1:** Consider creating a program guidebook that educates customers about the benefits of charging during off-peak hours and a monthly report that showcases results from the offering and participant efforts. Continue offering a modest incentive that follows the off-peak charging schedule, but also consider if there is potential to begin off-peak hours earlier than 11 p.m.
	CONSIDERATION 2: Consider implementing additional checks for customers that enroll in future cycles of this offering. For instance, ensure that the customer enrolling in the program meets eligibility requirements for the program, as Guidehouse identified several customers who did not qualify for the program due to living outside of the eligible geographic area but who had still enrolled in the program.
	CONSIDERATION 3: Consider creating a program component, educational tool/info, to teach participants & recruiting audience how to make participation easier – info on using scheduled charging & how to make that happen.
Impacts	**CONSIDERATION 4:** Consider adding a requirement of one calendar year of pre-period data from participants in order to participate in the program. Employing a broader time window of pre-period data – for instance, one calendar year prior to program start – will help improve the accuracy of impact estimates.
	CONSIDERATION 5: As the offering continues or a program based upon this offering is supported, consider tracking and measuring differences in charging behavior and impacts across seasons. Results for the summer season (July 1–September 30) may not be able to be extrapolated to other seasons due to differences in incentive structure and potential differences in driving behavior across seasons.
	CONSIDERATION 6: To more accurately assess how driving behavior changes across seasons, consider obtaining trip data for all enrolled CS participants.

ABOUT GUIDEHOUSE

Guidehouse is a leading global provider of consulting services to the public and commercial markets with broad capabilities in management, technology and risk consulting. We help clients address their toughest challenges with a focus on markets and clients facing transformational change, technology-driven innovation and significant regulatory pressure. Across a range of advisory, consulting, outsourcing, technology/analytics services, we help clients create scalable innovative solutions that prepare them for future growth and success. Headquartered in Washington DC, the company has more than 7,000 professionals in more than 50 locations. Guidehouse is a Veritas Capital portfolio company, led by seasoned professionals with proven and diverse expertise in traditional and emerging technologies, markets and agenda-setting issues driving national and global economies. For more information, please visit **www.guidehouse.com**.

Eversource Off-Peak Charging Offering for Tesla Owners Evaluation

Final Report

Prepared for:

Eversource

Submitted by:

Guidehouse Inc.
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(781) 270-8300

Reference No.: 211517
April 19, 2022

Table of Contents

1. Introduction

Beginning in summer 2021, Eversource offered incentives for Eversource Tesla owners to encourage them to shift charging to off-peak hours between 11 p.m. and 7 a.m. Eversource initially provided this offering as a part of the ConnectedSolutions (CS) portfolio and branded it the ConnectedSolutions for Tesla Owners for Off-Peak Charging. Subsequently it is considered an offering outside of the ConnectedSolutions portfolio. Within this evaluation report, the Eversource Off-Peak Charging Offering for Tesla Owners is referenced as “the offering”, “the program”, or “CS”.

The offering aimed to reduce peak demand of EV charging load by way of an off-peak charging rebate. The offering was open to Eversource residential customers in Massachusetts who owned a Tesla.[1] Participating customers received a rebate on electricity costs for charging during the hours of 11 p.m. to 7 a.m. and additional payments if they avoid charging during the super-peak period of 5 p.m. to 8 p.m.

This evaluation report describes Guidehouse’s customer experience research, assessment of charging profiles, and analysis of impacts.[2] As a comparison group, Guidehouse compared data from CS nonparticipants who are currently enrolled in Rolling Energy Resources (RER).[3] This evaluation covers Eversource’s offering implemented in Massachusetts from July 2021 through September 2021. Subsequent sections of this report detail Guidehouse’s methodology, data sources used, and key findings. As part of this evaluation, Guidehouse developed an interim memorandum summarizing the results of the 2021 process evaluation, which included a participant survey and an impact analysis of charging profiles.

1.1 Offering Summary

Eversource’s off-peak offering aimed to reduce EV charging during on-peak hours defined as 7 a.m. to 11 p.m. and especially during super-peak hours between 5 p.m. and 8 p.m. Participating customers received incentives upon program enrollment, a rebate on electricity usage during off-peak hours, and a monthly bonus incentive for avoiding charging during the hours of 5 p.m. to 8 p.m. Table 1-1 summarizes the characteristics of the offering.

Table 1-1. Off-Peak Charging Offering Summary

	Program Attributes	2021
Program Participants	**State**	Massachusetts
	Customer Segment	Residential customers who are Tesla owners
	Target Enrollment	200[4]

[1] This offering was limited to Tesla vehicles as it was not possible to enroll Tesla level 2 chargers in Eversource’s other EV managed charging program. If this managed charging approach is offered in the future, Eversource does not intend to constrain future offerings strictly to Teslas.

[2] In a future comparison memo, Guidehouse will compare the kW impacts per EV associated with this offering to Eversource’s Electric Vehicle Supply Equipment (EVSE) Direct Load Control offering and National Grid’s Electric Vehicle Direct Load Control program.

[3] Rolling Energy Resources (RER) is a vendor of EV charging data derived from EV onboard computers, accessed via their native APIs. Guidehouse utilized data from battery EVs (BEVs) enrolled with RER and sharing data with RER to facilitate comparisons to CS participants.

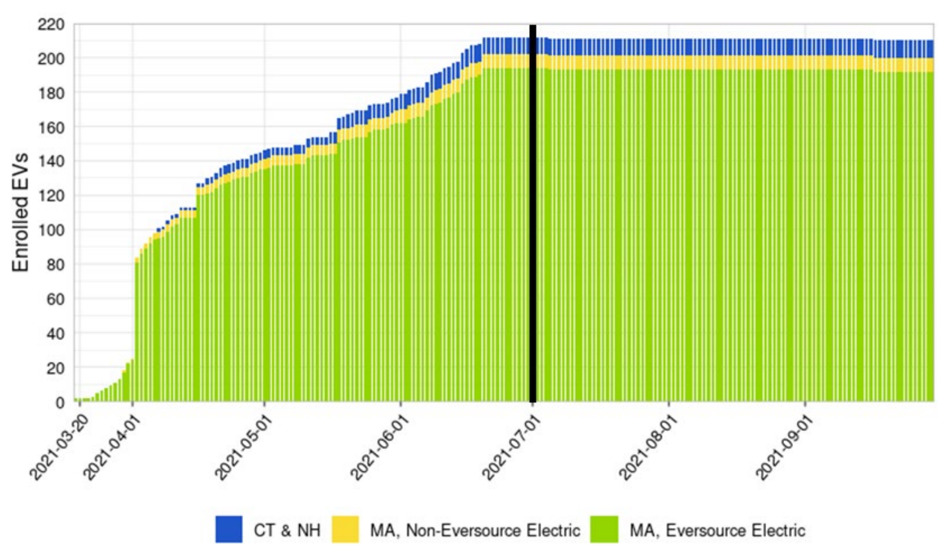
[4] Four marketing emails from Eversource were sent on: April 1, 2021, April 20, 2021, May 18, 2021, and June 1, 2021.

	Program Attributes	2021
Key Vendors	**Technology Provider**	FleetCarma (Division of Geotab)
	Eligible EV Manufacturers	Tesla
Program Design	**Demand Reduction Approach**	Rebate on electricity costs for charging during off-peak hours (11 p.m.–7 a.m. EST)
	Rebate	$50 enrollment incentive Jun-Sep: $0.05/kWh during off-peak hours Oct-May: $0.03/kWh during off-peak hours $10 monthly bonus incentive for avoiding charging between 5 p.m. and 8 p.m. EV can use any EVSE in Eversource's territory to receive the rebate
	Communications/ Information	Participants received information through FleetCarma app and dashboard reminding participants to charge during off-peak hours FleetCarma app and dashboard also provides access to charging data and indication of on-peak/off-peak charging The SmartCharge Rewards Portal provides participants with information about and access to their rebate incentives

Source: Guidehouse

Figure 1-1 shows enrollment in the offering from March through September 2021, with the treatment period start date denoted by a black vertical line. At the end of September, there were 199 customers and 210 EVs enrolled in the offering. Of these, 192 vehicles were associated with Eversource Electric Massachusetts customers. [5]

Figure 1-1. Off-Peak Offering Enrollment



[5] Guidehouse identified 19 ineligible customers that enrolled in the program. They were excluded from the charging profile analysis and impact analysis.

Source: Guidehouse analysis of CS EV enrollment data

1.2 Evaluation Objectives

The primary objectives of this evaluation were to understand demand reductions and energy impacts resulting from rebates for off-peak charging, to understand customer charging patterns, and to assess the customer experience of the program. These objectives are achievable through the investigation of several research questions relating to 1) customer segments, 2) DR impacts, and 3) program design and scalability. Table 1-2 lists these research questions.

Table 1-2. Off-Peak Charging Offering Evaluation Research Questions

Category	Research Question
Customer Segments	• What participant characteristics impact charging patterns? E.g., type of EVSE used, access to and use of workplace EVSE
Impacts	• What are typical charging patterns during on-peak periods and off-peak periods? • How does the off-peak charging rebate influence charging behavior? • What are the demand and energy impacts of the program during specific peak periods?
Program Design Indicators	• Are customers satisfied with the amount and type of information they are provided about the program through the FleetCarma app and website dashboard? • How likely are customers to continue to participate in the program in the future? • How should program parameters be modified to achieve greater savings or increase customer acceptance of the solution?

Source: Guidehouse

2. Evaluation Methods

The evaluation assessed the extent to which the offering achieves demand savings and customer acceptance. Table 2-1 summarizes the evaluation approach.

Table 2-1. Off-Peak Charging Offering Evaluation Methods

Task	Description
Participant Survey	Guidehouse administered a survey to all offering participants (hereinafter referred to as CS participants) enrolled as of July 1, 2021, to obtain information on how the program influenced participant driving and charging behavior during the summer months. The survey ascertained participants' acceptance of program design and delivery features. The survey was also administered to nonparticipants (hereinafter referred to as RER participants). Responses from RER participants informed impact analysis methodology and served as a valuable source of information in comparing CS participants' self-reported feedback and program influence. • Primary Data Collection: Post-summer survey • Data: Program participation
Data Management	Guidehouse received raw interval telemetry and charging session data from FleetCarma. Guidehouse performed quality assurance/quality control (QA/QC) of the EV telematics data and other data sources at the outset of the offering. Guidehouse cleaned and formatted the EV telematics for the usage assessment and impact analysis. • Primary Data Collection: N/A • Data: Program participation, EV telematics data, participant survey data
Assessment of Charging Profiles	Guidehouse utilized EV telemetry collected from CS participants and RER participants to assess charging profiles. Guidehouse analyzed various metrics for CS participants and RER participants through the period spanning May to September 2021, which included the pre-program (May 1–June 30) and program (July 1–September 30) periods. • Primary Date Collection: N/A • Data: Program participation, EV telematics data
Impact Analysis	Guidehouse estimated demand and energy impacts during both peak and off-peak hours across the evaluation period using a comparison group approach. Guidehouse modeled CS participants relative to RER participants using a difference-in-differences modeling approach to assess how much charging shifted from peak to off-peak periods. • Primary Data Collection: N/A • Data: Program participation, EV telematics data
Reporting	Reporting includes a draft presentation, a draft report, and a final report. The contents of reporting are: • Survey findings • Assessment of charging profiles • Impact analysis results

Source: Guidehouse

Table 2-2 displays the data periods included in the assessment of charging behavior and impact analyses.

1. Pre-program period (May 2021–June 2021)

2. Program period (July 2021–September 2021)

For the charging behavior analysis and impact analysis, Guidehouse harnessed data spanning May 1 through September 30 covering the pre-treatment and during program treatment time periods. Most program impacts were assumed to have occurred during the program treatment time period.[6]

Table 2-2. Data Periods Included in Charging Behavior and Impact Analyses

Analysis	2021				
	May	Jun	Jul	Aug	Sep
Charging Behavior Analysis	**Pre-Period** May 1–June 30		**Program Period** July 1–September 30		
Impact Analysis					

Source: Guidehouse

The remainder of this section details the evaluation approach for each of the items Table 2-2 lists.

2.1 Customer Experience Research

Guidehouse administered two online surveys in November 2021. One survey was administered to the CS participants. The other survey was administered to nonparticipants enrolled in the RER EV Metering Study sample as part of the Massachusetts Residential Building Use and Equipment Characterization Study (RER participants). The results from the RER participants were used as a baseline comparison to the CS participants. Survey invitations were sent by email and reminders were sent to survey participants between 3 and 5 days after the initial invite was sent. Table 2-3 summarizes the time period covered by the surveys, the EV manufacturers included, and completion rates for each survey. The response rate for RER participants (73%) was higher than for CS participants (47%), while the total number of completes was higher for CS participants (94% vs. 72%).

The surveys were administered to Massachusetts CS and RER participants who enrolled prior to July 1, 2021. All respondents received a $10 e-gift card for completing the survey.

Table 2-3. 2021 Post-Summer Survey Summary

Survey Topics	CS Participants	RER Participants
Time Period Covered	2021 summer (June–August)	2021 summer (June–August)
Survey Fielded	November 3–15, 2021	November 3–15, 2021
EV Manufacturer	Tesla	Tesla, Chevrolet, Hyundai, Nissan, Volkswagen, BMW, Ford, Chrysler, and Audi
Invites Sent*	200	99
Completes	98	72

[6] There is a risk that program participants shifted charging behavior as soon as they enrolled in the program but before the off-peak charging rebate began on July 1. As such, some of the program impacts may be contained in the pre-period spanning May 1 – June 30.

Survey Topics	CS Participants	RER Participants
Used Completes**	89 or 94†	72
Response Rate††	47%	73%

*Based on enrollment and incentives filed prior to 07/01/2021; counts include "Vehicle Connected" status only.
**Four CS participants were removed from the completes pool due to participation issues (3) or invalid data (1).
†Five CS participants were not presented with program-specific questions during the soft launch.
††Response rate is calculated as the ratio of completes used relative to invites sent.
Source: Guidehouse

Table 2-4 summarizes the topics covered in each survey. Certain topics were only included for CS participants (i.e., motivations for enrolling, program influence, and program satisfaction).

Table 2-4. 2021 Post-Summer Survey Topics

Survey Topics	Time Period Covered	CS Participants	RER Participants
Motivations and enrollment	2021 summer	All respondents	N/A
EV information	2020 and 2021 summer	All respondents	All respondents
EV characteristics and driving behavior	2021 summer	All respondents	All respondents
EVSE characteristics and charging behavior	2021 summer	All respondents	All respondents
Changes since summer 2020	Differences between summers 2021 and 2020	All respondents	All respondents
Program Influence	2021 summer	All respondents	N/A
Program Satisfaction	2021 summer	All respondents	N/A
Participant Demographics	N/A	All respondents	All respondents

Source: Guidehouse

Table 2-5 includes Guidehouse's activities for both the CS participant and RER participant surveys. Appendix A contains the survey instruments.

Table 2-5. Participant Survey Activities

Category	Activities
Survey Design and Programming	• Developed draft of survey instruments (maintain similarity in question structure across survey efforts) • Finalized survey instruments based on feedback from Eversource and EEAC Evaluation, Measurement, and Verification consultants • Programmed surveys • QA/QC of programmed surveys
Sample Preparation	• Received latest enrolled participant information (including contact information) • Prepared samples (e.g., remove those enrolled after July 1, 2021)

Category	Activities
Survey Implementation	• Provided Eversource call center with information about the survey effort • Sent survey to CS participants and RER participants • Monitored survey completions • Sent reminder emails • Provided $10 e-gift cards for respondents who completed the survey
Data Cleaning and Analysis	• Cleaned/recoded data in preparation for analysis (including cleaning and coding of verbatim/open-ended responses) • Analyzed data using appropriate tool (e.g., SPSS, R)

Source: Guidehouse

2.2 Assessment of Charging Profiles

Understanding how customers used their EVs informed the impact analysis and clarified differences in behavior between CS participants and RER participants. The assessment of charging profiles includes breakouts by the following four time periods and data combinations to distinguish the potential changes in behavior caused by program participation:

1. Pre-program period (May 2021–June 2021) for CS participants
2. Program period (July 2021–September 2021) for CS participants
3. Pre-program period (May 2021–June 2021) for RER participants
4. Program period (July 2021–September 2021) for RER participants

For this analysis, Guidehouse assessed metrics including average energy consumption by hour and period, average daily energy consumption, scheduled charging frequency, and the prevalence of Level 1 and Level 2 chargers.

2.3 Impact Analysis

Guidehouse estimated demand and energy impacts of program participation during off-peak hours (11 p.m. to 7 a.m.) and peak hours (7 a.m. to 11 p.m.) that occurred between July 1 and September 30 using a difference-in-differences regression approach.

2.3.1 Difference-in-Differences Regression Approach

The difference-in-differences regression approach employs a regression that estimates average demand or energy usage, which varies based on time of day (i.e., off-peak or peak hours), time period (i.e., prior to CS program or following beginning of CS program), and program participation status (i.e., CS participant or RER participant).

To estimate impacts, Guidehouse regressed demand on a set of time-specific fixed effects (e.g., day of week), an indicator for the time period of the day, an indicator of program participation status (e.g., treatment), and an indicator of whether the time is prior to or within the program treatment period. Equation 2-1 shows the model specification.

Equation 2-1. Model Specification

$$kW_{it} = \lambda_t + \beta_0 + \beta_1 Peak_t + \beta_2 Post_t + \beta_3 Treatment_i + \beta_4 Post_t\, Treatment_i + \beta_5 Post_t\, Peak_t + \beta_6 Peak_t\, Treatment_i + \beta_7 Peak_t\, Post_t\, Treatment_i + e_{it}$$

Where,

kW_{it}	is the demand for EV *i* during period *t*
λ_t	is a series of time-specific fixed effects for period *t;* these pick up temporal differences, such as day of week
$Post_t$	is a binary variable taking a value of 1 when *t* is in the post-period spanning July 1 through September 30 and 0 otherwise
$Peak_t$	is a binary variable taking a value of 1 when *t* is in the period not eligible for the off-peak rebate (i.e., *t* is in 7 a.m. to 11 p.m.) and 0 otherwise
$Treatment_i$	is a binary variable taking a value of 1 when EV *i* is enrolled in the off-peak offering and 0 when EV *i* is enrolled in the RER demonstration
ε_{it}	is the cluster-robust error term for EV *i* during period *t;* cluster-robust errors account for heteroskedasticity and autocorrelation at the household level

In this difference-in-differences specification, the change in kW attributed to program participation during off-peak hours is estimated via β_4, while the change in kW attributed to program participation during peak hours is estimated via $\beta_4 + \beta_7$

3. Data Sources and Data Review

This section describes the data sources used for this evaluation and the steps taken to prepare the data for analysis. The data sources used included survey data (described in Section 2.1), and data from Eversource, Geotab/FleetCarma, and RER.

3.1 Data from Eversource, Geotab/FleetCarma, and RER

- **CS EV enrollment data:** This data identified each vehicle enrolled in off-peak offering and provided key information about the vehicle's enrollment, including the date(s) the vehicle was accepted to the program, the date the vehicle unenrolled from the program (if applicable), the year, make, and model of the vehicle, and customer contact information. The program was limited to Tesla owners, so the CS enrollment data includes only Tesla vehicles.
- **RER EV enrollment data:** Like CS enrollment data, RER enrollment data identified each vehicle contained in its respective interval data. This data also included the year, make, and model of the vehicle, as well as customer information. RER data included nine different EV manufacturers.
- **CS EV telematics interval data:** This data contained energy and demand associated with times when a vehicle was plugged-in and charging. It was provided in 15-minute intervals for each EV enrolled in the program.
- **RER EV telematics interval data:** RER data contained similar information as CS data, including energy and demand. However, RER data was provided in 30-minute intervals.

Guidehouse used the interval, session, and telemetry data for the assessment of charging behavior and impact analyses. Prior to the analysis, the interval data was cleaned using the following steps:

- **Verify CS interval data covers analysis period:** Data was limited to analysis periods when an EV was enrolled. It was also limited to May 1-September 30 to allow for accurate comparisons between the periods before and after the July 1 program start date.
- **Flag and remove low quality or anomalous data points:** Interval data was modified to remove observations with erroneous data, such as observations where interval start was equal to interval end, or where start state of charge was greater than end state of charge.
- **Convert data to 30-minute interval data:** CS and RER data was provided in two different time interval durations. To allow for accurate charge profile analysis and impacts analysis, CS data was converted to 30-minute intervals to match the RER interval data format.

4. Analysis and Results

This section summarizes findings from the customer experience research, the assessment of charging profiles, and the impact analysis.

4.1 Customer Experience Research

The following subsection summarizes key findings related to customer experience research. As part of this evaluation, Guidehouse developed an interim memorandum summarizing the results of the 2021 post-summer survey for the CS participants and RER participants. This section includes the findings from the 2021 post-summer survey. In the figures in this section, the percent of respondents is on the y-axis and the respondent counts are above each bar.

4.1.1 Key Findings

- Helping the environment was the most commonly cited primary motivator to purchase an EV, while program incentives was most commonly cited as the top reason for enrolling in the program for CS participants.
- The majority of CS participants (89%) were satisfied with the enrollment process.
- Most respondents (88%) have a Level 2 charger at home, with 11% of CS participants and 77% of RER participants using ChargePoint, Enel X, Leviton, or Siemens chargers. Notably, proportionally fewer RER respondents with Teslas used ‘Other’ chargers (including Tesla chargers; 45%) than CS participants (89%).
- About half of both CS and RER participants reported their weekly mileage did not change from summer 2020 to 2021, and RER participants reported driving slightly fewer miles overall on weekdays in summer 2021.
- Fewer CS participants (20%) charged their EV until full and on average more (71%) connected their EV to their home charger (regardless of whether they were charging) during off-peak periods (11 p.m. to 7 a.m.) compared to RER participants (63% and 54%, respectively)
- Most CS participants (76%) scheduled charging times using an app compared to only a small portion of RER participants (27%). The most common scheduled start time for CS participants was at or after 11 p.m. on weekdays. Of the respondents who own Teslas and use ‘Other’ chargers (including Tesla chargers), 57% of CS participants scheduled charging times using an app compared to 13% of RER participants.
- Most CS participants reported location and availability of public chargers as barriers to public charging, and all respondents used workplace charging minimally.
- About 70% of CS participants viewed the SmartCharge Rewards Portal and found it valuable, and many reported a high score for the influence that energy use information had on determining their EV charging schedule for summer 2021.
- CS participants were more influenced by rewards and monthly bonuses than energy use information when determining their EV’s charging schedule for summer 2021.
- Almost all (96%) of CS participants reported that they are likely to continue participating in the program in the future.

- Most CS participants were satisfied with the SmartCharge Rewards Portal, timing of on- and off-peak periods, and program communication and incentives.

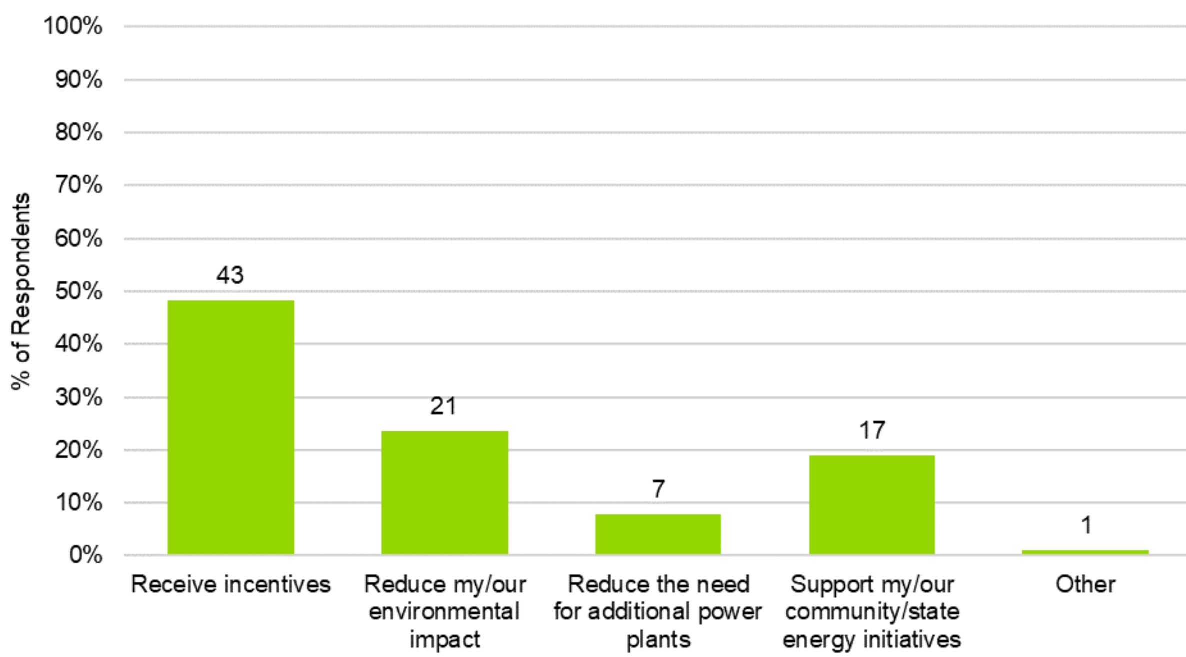
4.1.2 Participant Survey Results

The Key Findings summary above is based on the following sections that present an analysis of the 2021 post-summer survey (conducted in November 2021) data. As mentioned previously, certain survey topics were only presented to CS participants (i.e., motivations for enrolling, program influence, and program satisfaction). Appendix B includes the aggregated responses for every survey question.

4.1.2.1 Motivations and Enrollment

Guidehouse asked CS participants about their motivations as well as their experience enrolling in the program. Figure 4-1 shows these respondents cited receiving the program incentives as their top reason for enrolling in the program (43 respondents, 48%).

Figure 4-1. Top Motivation for Enrolling (n=89)



M1. What was your top motivation for enrolling in Eversource's ConnectedSolutions SmartCharge Rewards Program?

Note: Five out of the 94 CS participants were not presented with program-specific questions during the soft launch.

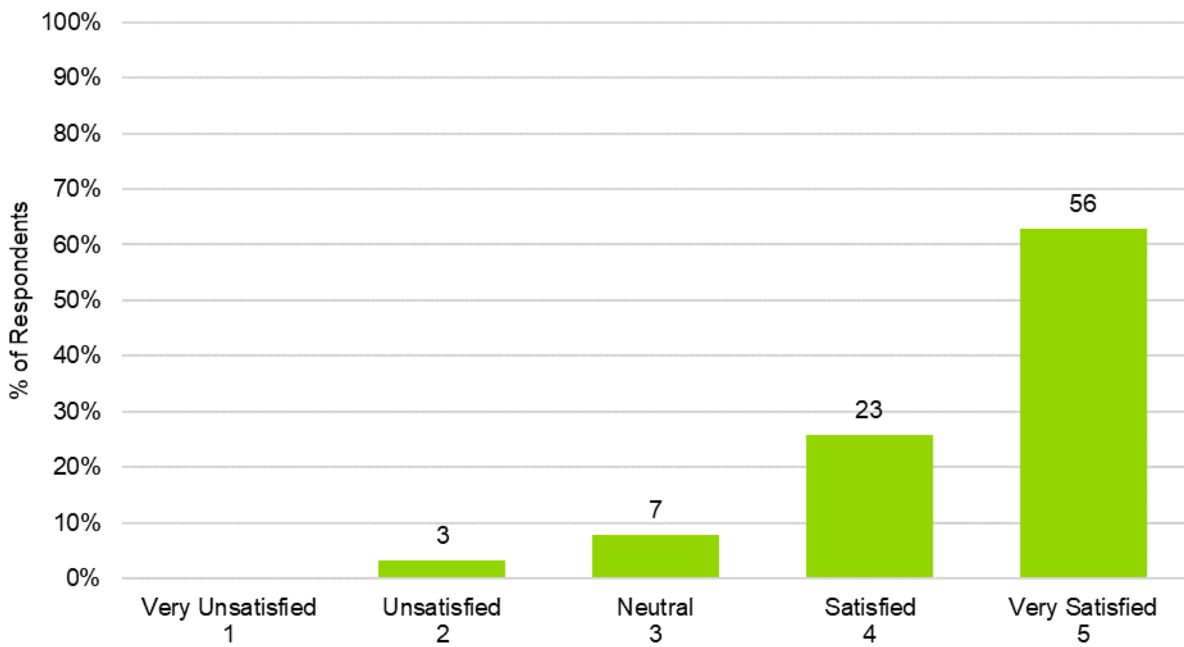
Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

The majority of CS participants (89%) were satisfied with the enrollment process (Figure 4-2). A few respondents encountered the following challenges in the enrollment process:

- Delays in successful enrollment and unclear guidelines (six)
- Difficulties connecting Tesla to rewards account (five)
- Difficulties creating rewards account (two)

- Issues installing or connecting to EVSE (two)

Figure 4-2. Satisfaction with the Enrollment Process (n=89)



M3. On a scale of 1 to 5, where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program?

Note: Five out of the 94 respondents were not presented with program-specific questions during the soft launch.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

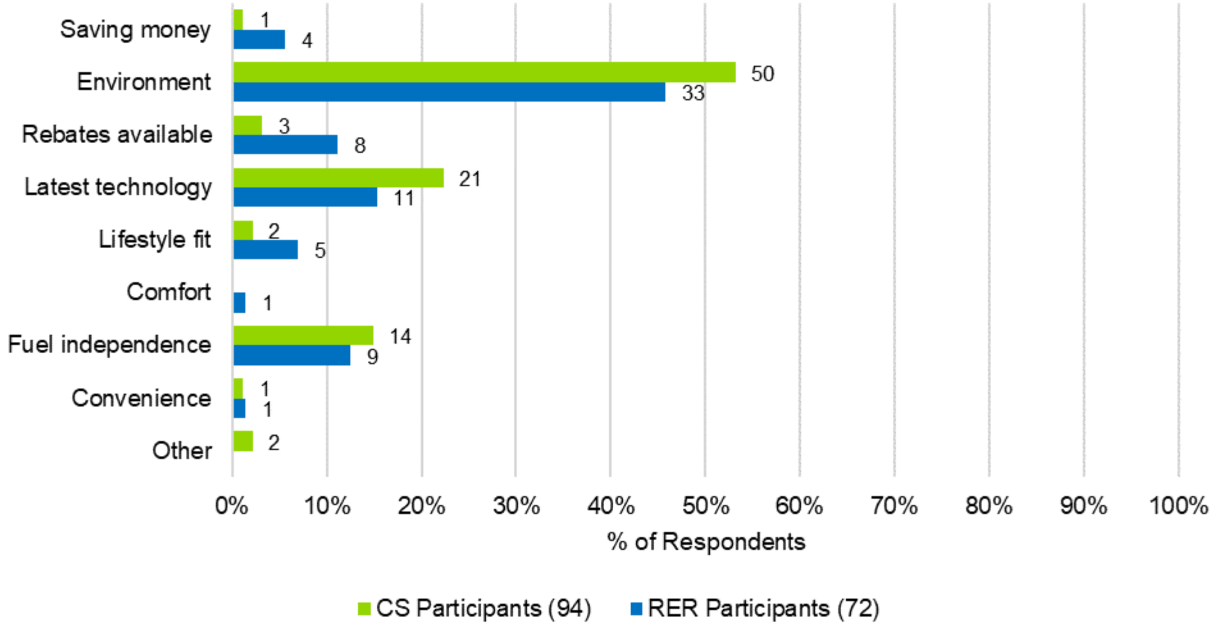
4.1.2.2 EV Characteristics and Driving Behavior

When asked to identify their top motivation for purchasing their EV(s), CS participants (50 participants, 53%) and RER participants (33 participants, 46%) most commonly cited that their motivation was to help the environment (Figure 4-3). The next-most commonly cited reasons for both participants were a desire for the latest technology and fuel independence.

Despite the environment being a primary motivator to purchase an EV, CS participants cited program incentives as their top reason for enrolling in the program (as Figure 4-1 shows).

Out of both CS participants and RER participants, 10 respondents own an additional BEV and nine respondents own an additional PHEV that was not enrolled in the program or RER study. Most of the CS participants (92 participants, 98%) and RER participants (67 participants, 93%) reported that their enrolled EV functioned as their primary form of transportation.

Figure 4-3. EV Purchase Motivation (n=166)

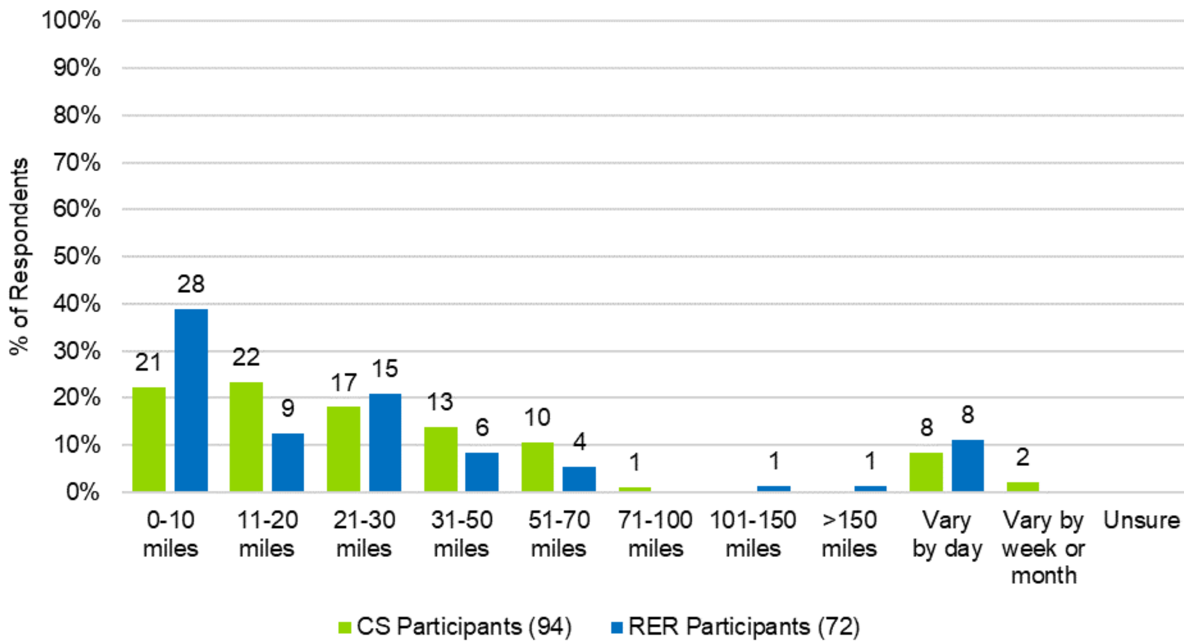


EV17. What was your household's top motivation for buying the EV?

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

In terms of daily mileage driven in their EV, a majority of CS participants (60 participants, 64%) and RER participants (52 participants, 72%) drove their EV 30 miles or less per day on average during typical summer 2021 weekdays, as Figure 4-4 demonstrates. Approximately half of the CS participants (45 participants, 48%) and RER participants (36 participants, 50%) stated that their weekday EV mileage did not significantly change from summer 2020 to summer 2021.

Figure 4-4. Average Miles Driven in EV on Typical Weekday in Summer 2021 (n=166)



EV19. On a typical summer 2021 weekday (Monday, Tuesday, etc.), on average, how many miles was this EV driven by you and other members of your household?

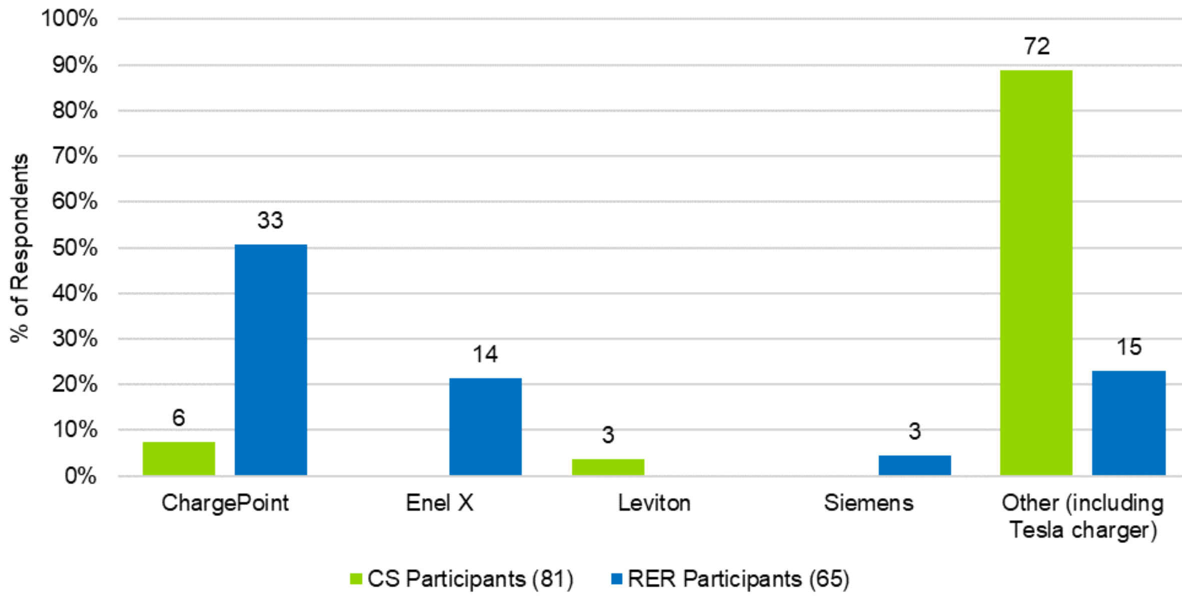
Note: Respondents with more than one EV were asked to answer questions about the EV whose driving and charging patterns they were most familiar with.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

4.1.2.3 EVSE Characteristics

Most CS participants (81 participants, 86%) and RER participants (65 participants, 90%) own a Level 2 charger at home. Figure 4-5 shows the distribution of these Level 2 chargers. Half of RER participants (33 participants, 51%) reported having a ChargePoint device at home, whereas CS participants (72 participants, 89%) reported owning a Level 2 charger that did not fit the list of brands in the survey. Since CS participants are by requirement all Tesla owners, it can be assumed that the majority of these ‘Other’ responses correspond to OEM-specific charging devices, namely Tesla.

Figure 4-5. Make of Level 2 Charger (n=146)



CB3. Please select the make of your Level 2 charger.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

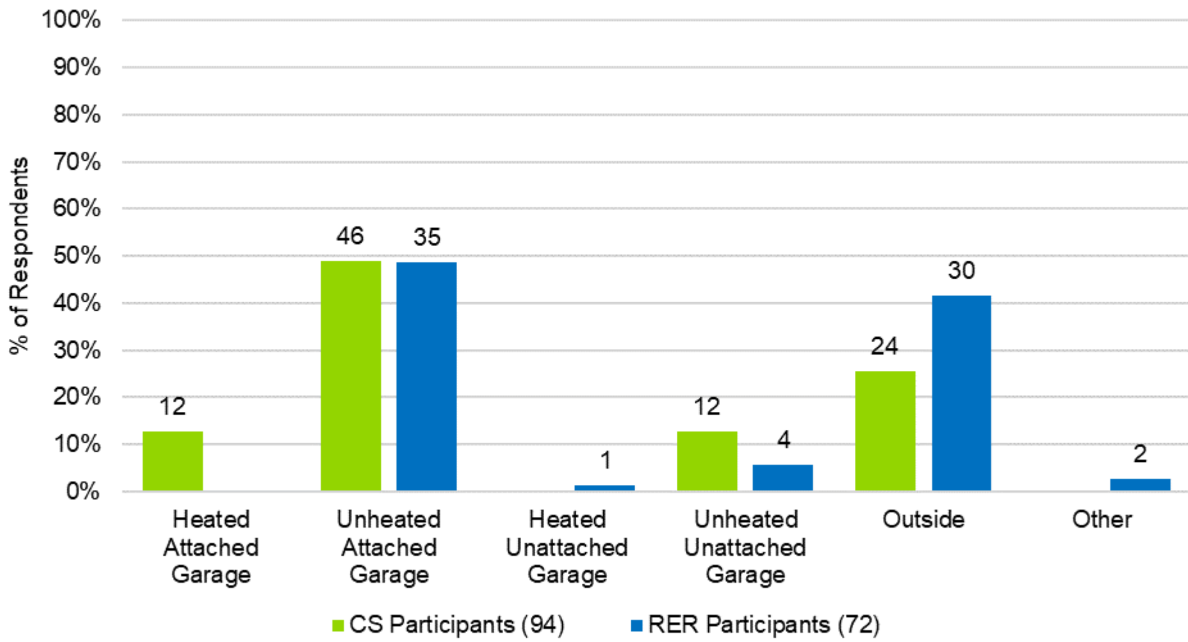
Per Figure 4-6, RER participants (30 participants, 42%) have a higher proportional frequency of storing their home charging device compared to CS participants (24 participants, 26%). Mainly CS participants (12, 13%) use a heated garage to store their home charging device in comparison to RER participants (1 participants, 1%). Most CS (46 participants, 49%) and RER participants (35 participants, 49%) store their home charging device in an unheated attached garage.

Although not a major factor in the summer, cold winter temperatures can affect charging in unheated garages and outdoors. Furthermore, prolonged exposure to extremely low or high temperatures can influence how effectively the Lithium-ion (Li) battery charges and reduce its longevity. The optimal charging temperature range for Li-batteries is between 15°C to 35°C (59°F to 95°F) even though Li-battery manufacturers usually list the charging temperature range as 0°C to 45°C (32°F to 113°F).[7,8]

[7]Aqwu, Daberechi, F. K. Opara, Nkwachukwu Chuwuchekwa, D. O. Dike, and L. Uzoechi. 2017. "Review of comparative battery energy storage systems (Bess) for energy storage applications in tropical environments." *IEE NIGERCON* 1000-1005.

[8]Motoaki, Yutaka, Wenqi Yi, and Shawn Salisbury. 2018. "Empirical analysis of electric vehicle fast charging under cold temperatures." *Energy Policy* 162-168.

Figure 4-6. Location of Home Charging Device (n=166)



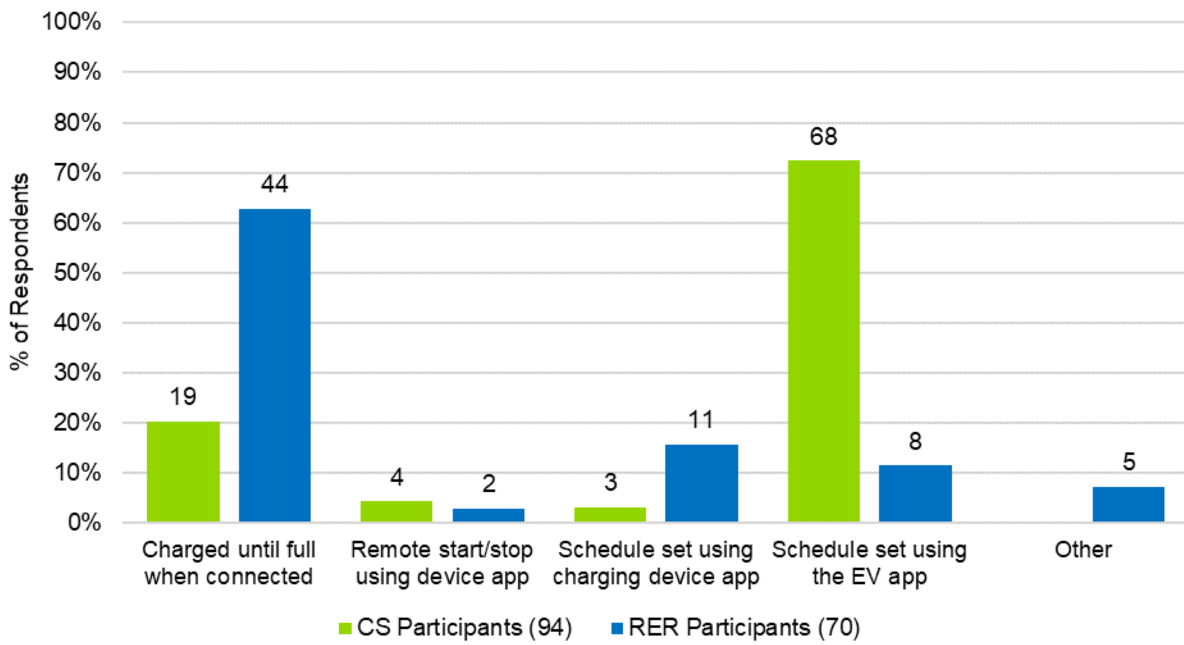
D2. Which of the following best describes the location of your home charging device?
Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

4.1.2.4 Charging Behavior and Changes Since Summer 2020

As shown in Figure 4-7, about 76% of CS participants (71) scheduled charging times using an app, compared to only 27% of RER participants (19). Of the respondents who own Teslas and use ‘Other’ chargers (including Tesla chargers), 57% of CS participants (54) scheduled charging times using an app compared to 13% of RER participants (3). Thus, Tesla owners in the RER participant group described less scheduling behavior in comparison to CS participants. This is possibly because the potential to receive incentives from the offering influences customers to schedule charging around peak-demand hours.

Approximately 20% of CS participants (19) reported connecting their EV to their home charging device whenever it is not in use and charging until full compared to 63% of RER participants (44). Of the 23 RER participants who own Teslas, 52% (12) connected their EV to their home charging device whenever it was not in use and charged until full. Although, this is not a significant difference compared to non-Tesla owners in the RER group.

Figure 4-7. Household Charging Device Usage (n=164)



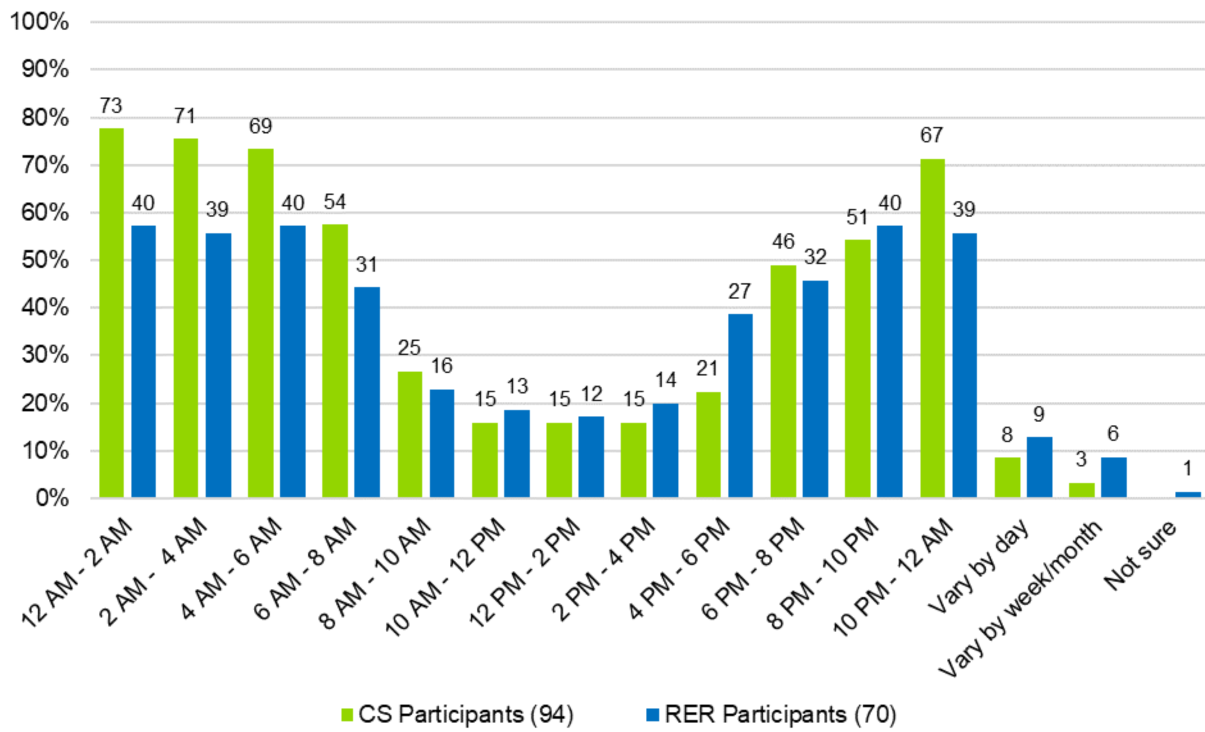
CB5. During summer 2021, which of the following best described your household's use of your home charging device for your EV?

Note: Two RER participants cited that they do not have a home charging device

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

The most common times for respondents' EVs to be connected to their home charging device, regardless of if the EV was charging or not, on a typical summer weekday in 2021 was between the hours of 6 p.m. and 8 a.m. As Figure 4-8 shows, CS participants (71%) on average reported connecting their EV to their home charger more during off-peak hours (11 p.m. to 7 a.m.) compared to RER participants (54%). Additionally, RER participants (42%) on average reported connecting their EV to their home charger during super peak hours (5 p.m. to 8 p.m.) more than CS participants (26%).

Figure 4-8. Typical Weekday Connection Times for Home Charging Device (n=164)



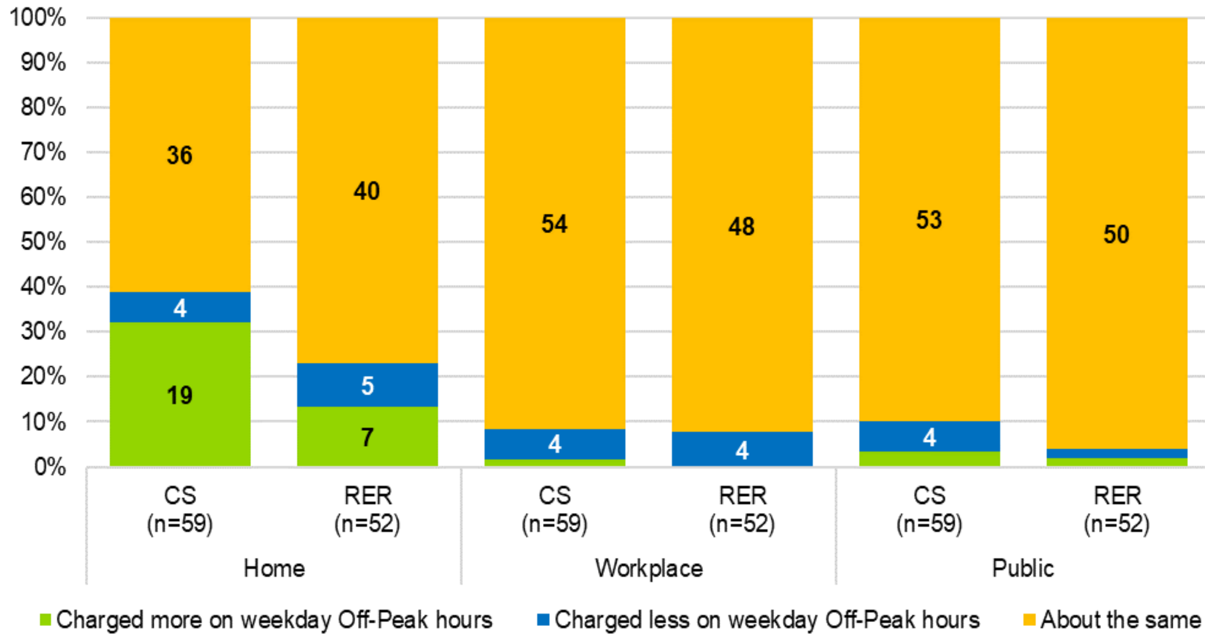
CB6. Please indicate the time ranges during which the EV was typically connected (regardless of charging or not) to your home charging device on weekdays (Monday–Friday) during summer 2021 (June–August).

Note: Two RER participants cited that they do not have a home charging device.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

A greater proportion of CS participants (19 participants, 32%) described an increase in off-peak (11 p.m. to 7 a.m.) charging during weekdays from summer 2020 to summer 2021 than RER participants (7 participants, 13%). This is likely because CS participants charge their EV around peak-demand hours to receive incentives through the offering. Workplace and public charging do not show the same disparity in usage across 2020 and 2021 between each participant type. Figure 4-9 details the full distribution in reported changes to weekday off-peak charging by charger location in summer 2021 compared to summer 2020.

Figure 4-9. Change in EV Charging for Weekday Off-Peak Hours in Summer 2021 Compared to Summer 2020 (n=111)

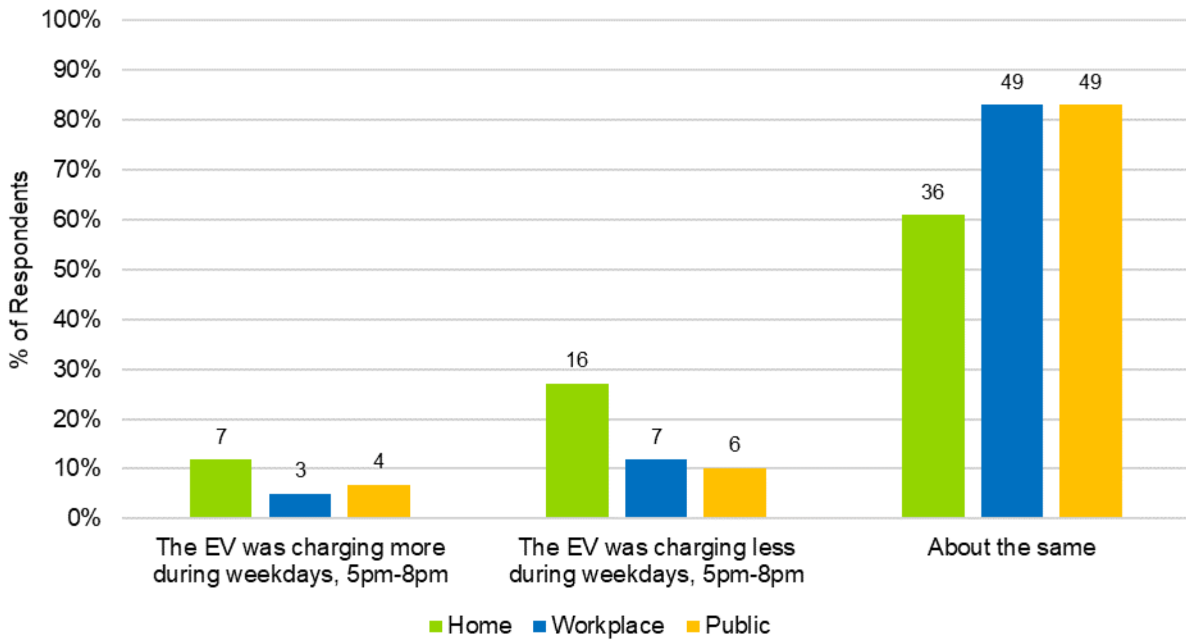


CS5. Compared to summer 2020, was this EV typically charging more, less, or the same amount in summer 2021 during the weekday hours of 11 p.m. to 7 a.m. relative to other hours? Please indicate how this varied by charging location.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

Per Figure 4-10, most CS participants charged their EV the same amount in summer 2020 compared to summer 2021 for all locations (Home: 26 participants, 61%; Workplace: 49 participants, 83%; Public: 49 participants, 83%) on weekdays from 5 p.m. to 8 p.m. (super-peak period). Thus, more CS participants reported changes to their charging behavior at home than at their workplace or public charging stations. More specifically, 27% of CS participants (16) charged at home less on weekdays from 5 p.m. to 8 p.m. in summer 2021 than they did in summer 2020. This is possibly because the potential to receive incentives from the offering influenced customers to charge around super-peak-demand hours.

Figure 4-10. Typical EV Charging on Weekday On-Peak hours (n=59)



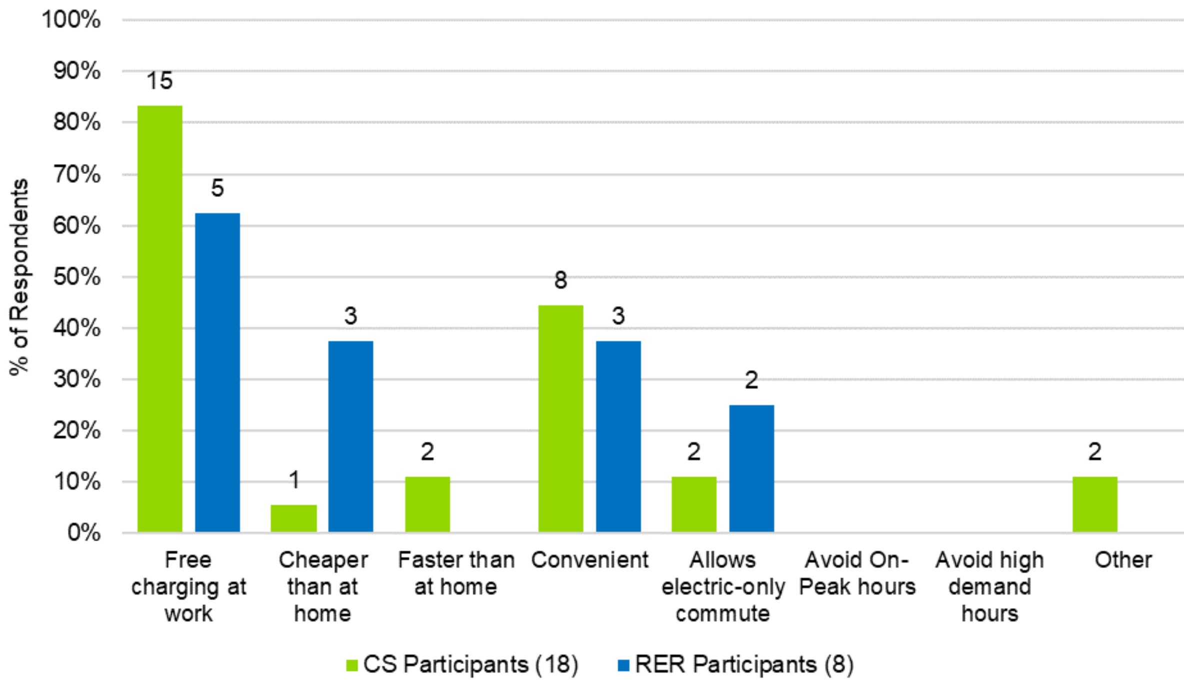
CS6. Compared to the summer 2020, was this EV typically charging more, less, or the same amount in summer 2021 during weekday hours of 5 p.m.–8 p.m. relative to other hours? Please indicate how this varied by charging location.

Note: Only participants were asked this question in the offering survey.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

Few respondents reported using workplace charging during the summer of 2021 (only 18 CS participants and eight RER participants). Most of these CS participants (15 participants, or 83%) are motivated to use workplace charging as it is free for them, as Figure 4-11 shows. On average, the majority of CS participants (76%) and RER participants (63%) charged at their workplace charging station between the hours of 8 a.m. and 2 p.m. on weekdays in summer 2021. Only 19% of CS participants and 6% of RER participants, on average, charged their EV at their workplace charging station between the hours of 4 p.m. and 8 p.m.

Figure 4-11. Motivations for Using Workplace Charging Stations (n=26)



CB14. What are your main motivations for using workplace charging stations? Select all that apply.

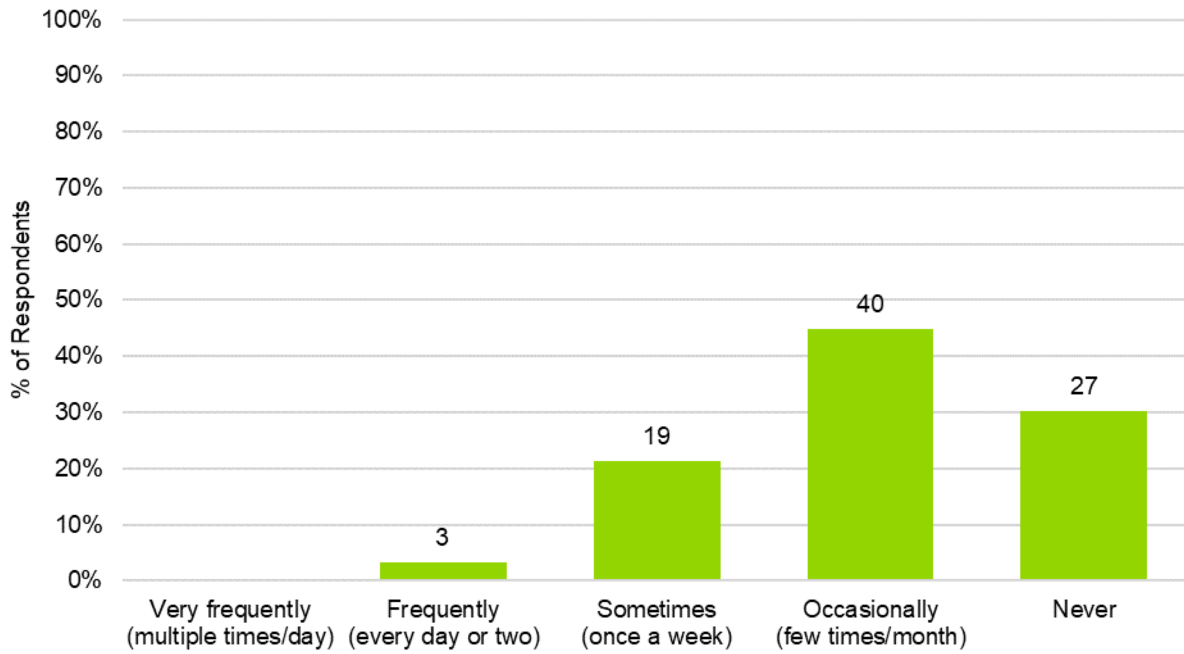
Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

4.1.2.5 Program Influences

Most CS participants (62 participants, 70%) stated that they use the SmartCharge Rewards Portal, with many viewing it on occasion (Figure 4-12). Of the respondents who viewed the portal, 30% of them had suggestions for improvement. These suggestions follow:

- Twelve CS participants want greater clarity on data and rewards as well as how or if electricity costs and savings change during on- and off-peak periods
- Four CS participants wish to view data outside of Eversource territory and other charging locations
- Three CS participants would like to receive emails or notifications of monthly data reports

Figure 4-12. Frequency of Viewing the SmartCharge Rewards Portal (n=89)



I1. Which of the following best describes how often you view the SmartCharge Rewards Portal provided by Geotab (FleetCarma)?

Note: Five out of the 94 respondents were not presented with program-specific questions during the soft launch. This question was only presented to participants of the offering survey.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

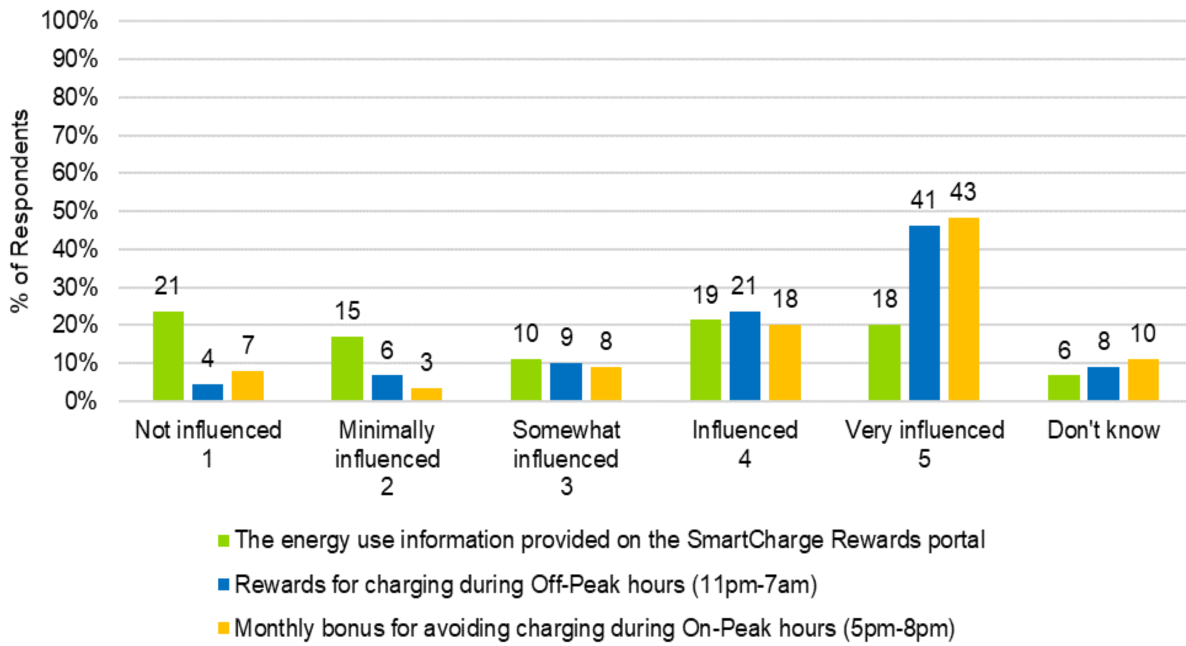
The more that CS participants viewed and engaged with the SmartCharge Rewards portal, the higher they scored the influence of energy use information on their EV charging schedule for summer 2021. In Figure 4-13, it appears that more CS participants reported that they were “not influenced at all” by the energy use information in determining their summer 2021 EV charging schedule. However, 12 of these 21 respondents also answered that they had never viewed the portal. Of the remaining nine respondents who were “not influenced at all” by the energy use information, one viewed the SmartCharge Rewards portal frequently, three viewed it sometimes, and five viewed it occasionally.

CS participants scored energy use information an average of three out of five. This average score increased to 3.4 for the CS participants who reported they use the portal (62 participants, or 70%) and increased to 3.5 for the CS participants who used the portal ‘Occasionally’ (40 participants, or 45%).

On average, CS participants rated rewards and monthly bonuses as more influential than energy use information in determining their EV’s charging schedule for summer 2021 (Figure 4-13). Regardless of portal use, it appears that the CS participants perceived the financial incentives to be more instrumental in changing their charging behavior than the energy use information.

Further, about 70% of CS participants reported that they were at least influenced by rewards and monthly bonuses in determining their EV’s charging schedule for the summer of 2021. On average, CS participants rated both the rewards and monthly bonuses a 4.1 out of five.

Figure 4-13. Program Influences on Charging Schedule (n=89)



I6. On a scale of 1 to 5, where 1 is “Not influenced at all” and 5 is “Very influenced,” how influenced was your EV’s charging schedule in summer 2021 by the following aspects of Eversource’s ConnectedSolutions SmartCharge Rewards Program?

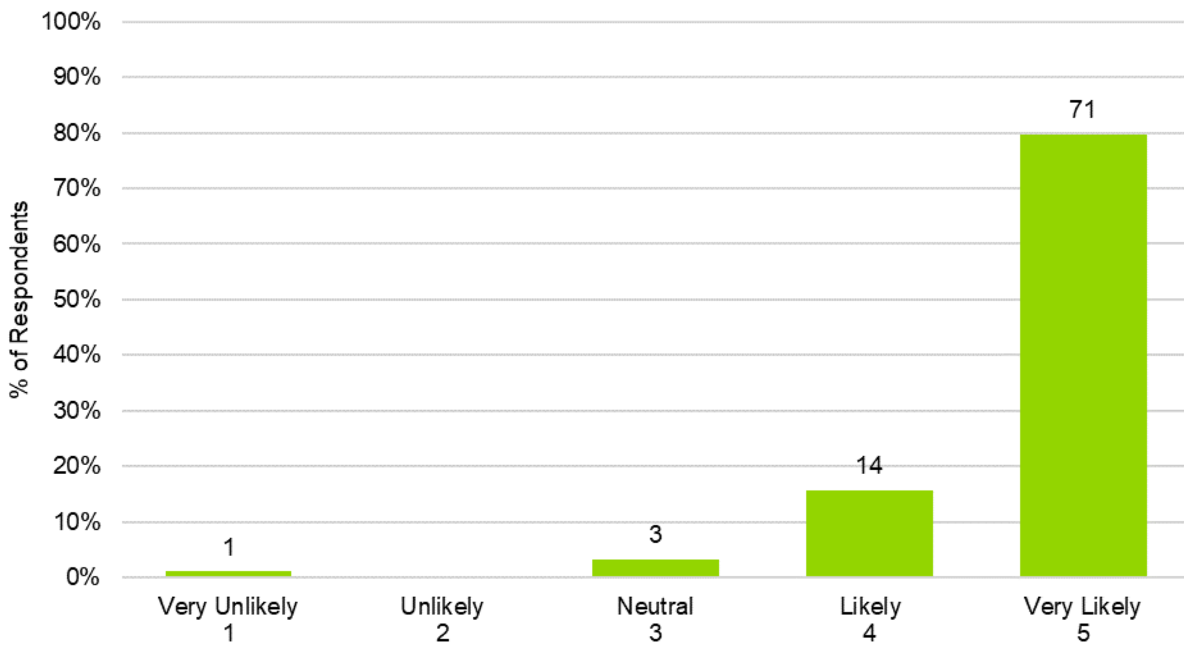
Note: Five out of the 94 respondents were not presented with program-specific questions during the soft launch. This question was only presented to participants of the offering survey.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

4.1.2.6 Program Satisfaction

Satisfaction with the program is very high, with 96% of participants reporting that they are likely to continue participating in the future (Figure 4-14).

Figure 4-14. Likelihood of Continued Program Participation (n=89)



S7. On a scale of 1 to 5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely are you to continue to participate in Eversource's ConnectedSolutions SmartCharge Rewards Program?

Note: Five out of the 94 respondents were not presented with program-specific questions during the soft launch. This question was only presented to participants of the offering survey.

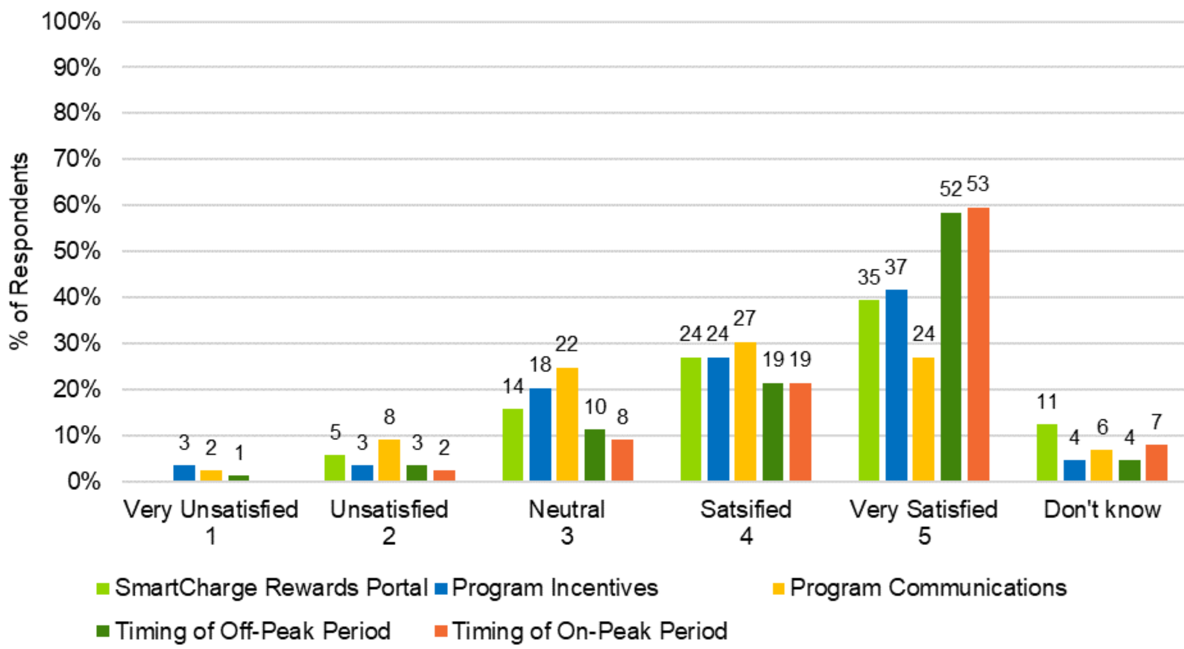
Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

Participants provided the following open-ended feedback about their experiences with the program:

- Twelve respondents recommended improving the incentive amount or changing the incentive structure.
- Six respondents suggested including clearer guidelines and data for the program.
- Other responses included partnering with more OEMs, securing personal information (i.e., ensuring that information gathered from the EV is not used for tracking or personal identification purposes), and offering other payment options.

Most participants were satisfied with the program portal, program communications, incentives, and the timing of on- and off-peak periods (Figure 4-15). Additionally, most participants were motivated by program incentives, and this may contribute to high participant satisfaction with program incentives.

Figure 4-15. Satisfaction with the Program Components (n=89)



S1. On a scale of 1 to 5, where 1 is "Very unsatisfied" and 5 is "Very satisfied," how would you rate your satisfaction with the following aspects of Eversource's ConnectedSolutions SmartCharge Rewards Program to-date?

Note: Five out of the 94 respondents were not presented with program-specific questions during the soft launch. This question was only presented to participants of the offering survey.

Source: Guidehouse analysis of 2021 Off-Peak Charging Offering Post-Summer Survey

In open-ended feedback about their experiences with the various components of the program, participants reported the following:

- **Program Incentives:** Extend off-peak hours and reduce strike restrictions
- **Program Portal:** Separate energy use by EV and charging location
- **Program Communications:** Clarify program objectives and send out monthly reports
- **Timing of On- and Off-Peak Periods:** Start off-peak periods earlier than 11 p.m. and offer reminders or educational content on how to avoid charging during on-peak periods

4.2 Assessment of Charging Profiles

This section consists of an assessment of CS participants' and RER participants' charging behavior during the May–September 2021 analysis period.

4.2.1 Key Findings

- **CS participants conducted most of their charging during off-peak hours (11 p.m.–7 a.m.).** This pattern was observed during the pre-period (May 1–June 30) and the program treatment period (July 1–September 30).
- **Many enrolled EVs appear to have shifted their charging from peak hours (7 a.m.–11 p.m.) to off-peak hours (11 p.m.–7 a.m.).** Despite CS participants conducting more

of their charging during off-peak hours prior to program start, EVs appear to have shifted additional charging from peak hours to off-peak hours after the program began. (Note in Figure 4-9 that 32% of CS participants charged more off-peak in summer 2021 than in summer 2020, while just 13% of RER customers charged more off-peak in summer 2021 than in 2020.)

- **30% of customers used scheduled charging in some capacity from May 2021–September 2021.** Nearly all scheduled charging occurred during off-peak hours (11 p.m.–7 p.m.), with most scheduled sessions beginning between 11 p.m. and 12 a.m. Among these customers, there was an increase in scheduled charging during off-peak hours during the program treatment period (July 1–September 30).

4.2.2 Charging Profile Analysis Results

Guidehouse's experience with EV data has shown that numerous metrics are helpful in characterizing charging behavior. Guidehouse investigated the charging behavior of enrolled devices over one impact analysis period, which included a pre-period and program treatment period. The pre-treatment period is defined as May–June 2021, and the program treatment period is defined as July–September 2021, as participants began receiving off-peak incentives on July 1.

CS EV interval data contained primarily Eversource electric customers in Massachusetts. However, some customers residing outside of Massachusetts or in non-Eversource territory enrolled in the offering. The assessment of charging profiles only included EVs in Eversource territory and in Massachusetts. Table 4-1 shows the number of EVs in each group.

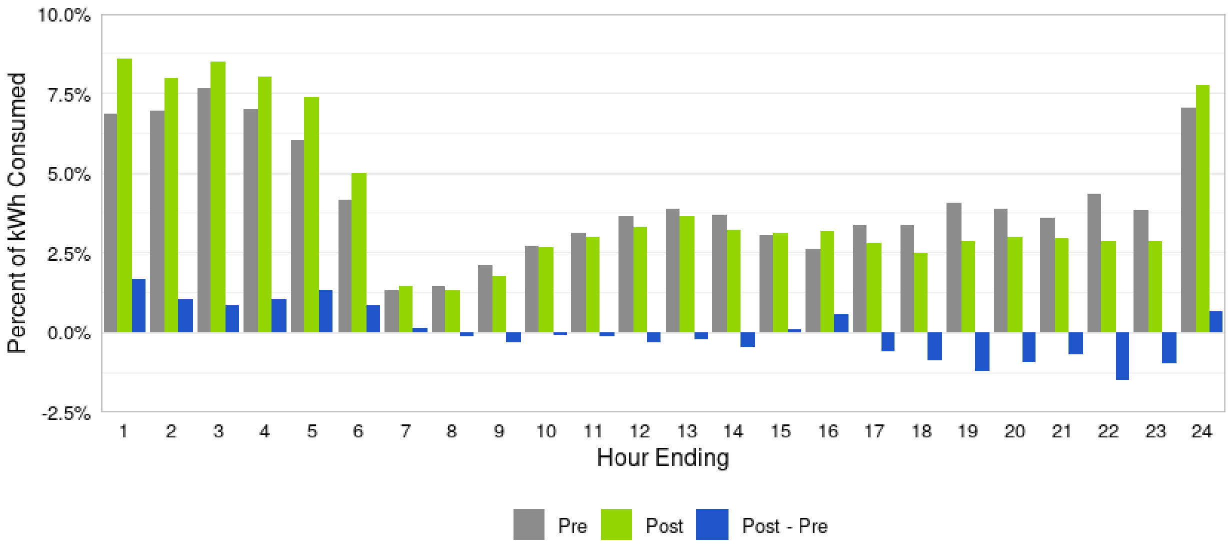
Table 4-1. Enrolled EVs with Data by Customer Segment

Customer Segment	Enrolled EVS with Data	Eligible for Program?
Massachusetts Customer with Eversource Electric Service	192	Yes
Massachusetts Customer with Other Electric Service	8	No
Connecticut or New Hampshire Customer with Eversource Electric Service	10	No

Source: Guidehouse analysis of CS EV enrollment data

Figure 4-16 shows the percentage of energy consumed by hour for CS EVs pre- and post-July 1 treatment, with blue bars showing the change in percentage from pre to post. This plot highlights two key findings. First, that CS participants charged much more during the off-peak period than the on-peak period as compared to RER participants; second, that CS participants shifted even more of their consumption to the off-peak period after July 1 treatment. Much of the shifted energy also came from the super-peak period between 5 p.m. and 8 p.m. (hour ending 18–20).

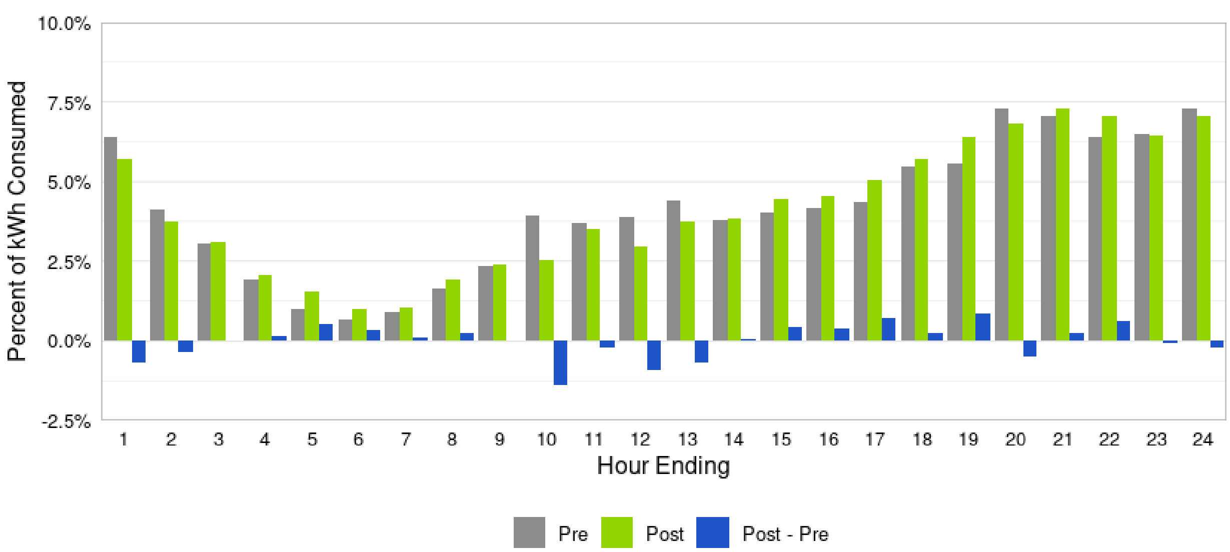
Figure 4-16. Percent of Energy Consumed by Hour, Pre- and Post-July 1 (CS Participants)



Source: Guidehouse analysis of CS EV telematics data

Figure 4-17 shows the percentage of energy consumed by hour for RER participants, with blue bars showing the change in percentage from pre to post. The single hour with the highest energy consumption across the full analysis period for RER participants was hour ending 21 (8 p.m.–9 p.m.). This compares to the highest energy consumption for CS participants being 1 a.m. – 2 a.m. There is also no clear trend between energy consumed pre- and post-July 1 treatment for RER participants. The breakdown of energy consumption for the RER participants shows marked differences in behavior between them and CS participants.

Figure 4-17. Percent of Energy Consumed by Hour, Pre- and Post-July 1 (RER Participants)



Source: Guidehouse analysis of RER EV telematics interval data

CS participants were limited to Tesla owners, while RER participants included multiple manufacturers. Given this, it is possible that differences in ease of scheduling between manufacturers played a role in the timing of energy consumption. Figure 4-18 shows RER energy consumption by hour for only participants with a Tesla, and illustrates that RER Tesla owners behaved in a manner more similar to other RER participants (Figure 4-17) than to CS participants (Figure 4-16).

Figure 4-18. Percent of Energy Consumed by Hour, Pre- and Post-July 1 (RER Participants, Tesla Only)

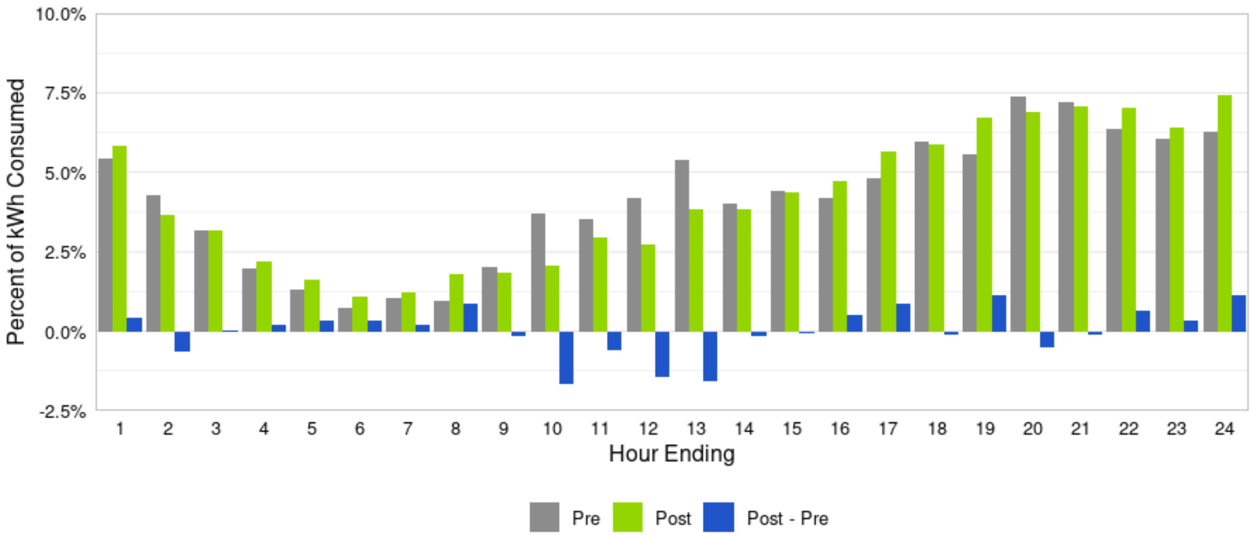


Table 4-2 examines differences in kWh consumption between the CS and RER participants across the pre-treatment and program treatment periods. The table lists the percentage of energy consumed in the peak and off-peak periods for each group across all months of the analysis. CS participants show an existing propensity for off-peak charging in the pre-period (46% of total kWh) compared to RER (25% of total kWh). CS participants also increased the percentage of kWh consumed during off-peak hours from the pre- to post-period by 8%, while RER participants showed no sizeable difference from pre to post.

Table 4-2. Percent of kWh Consumed in Off-Peak and Peak Periods

Period	Month	CS			RER			Difference *(CS Off – RER Off)**
		EVs	Off-Peak *11pm-7am*	Peak *7am-11pm*	EVs	Off-Peak *11pm-7am*	Peak *7am-11pm*	
Pre	May	149	*41%*	*59%*	69	*25%*	*75%*	*16%*
	June	188	*51%*	*49%*	78	*25%*	*75%*	*26%*
Post	July	183	*53%*	*47%*	77	*27%*	*73%*	*26%*
	August	181	*53%*	*47%*	75	*27%*	*73%*	*26%*
	September	188	*55%*	*45%*	74	*23%*	*77%*	*32%*
Pre	May– June	189	*46%*	*54%*	78	*25%*	*75%*	*21%*

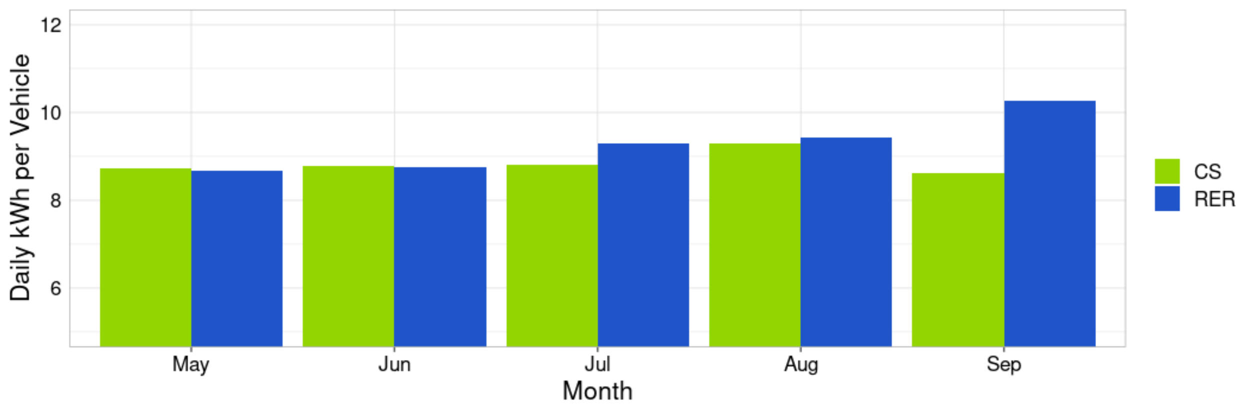
Period	Month	CS			RER			Difference (CS Off – RER Off)*
Post	July–September	191	*54%*	*46%*	77	*26%*	*74%*	*28%*

Note: Calculations shown in the Difference column may appear inaccurate due to rounding error.

Source: Guidehouse analysis of CS and RER EV telematics data

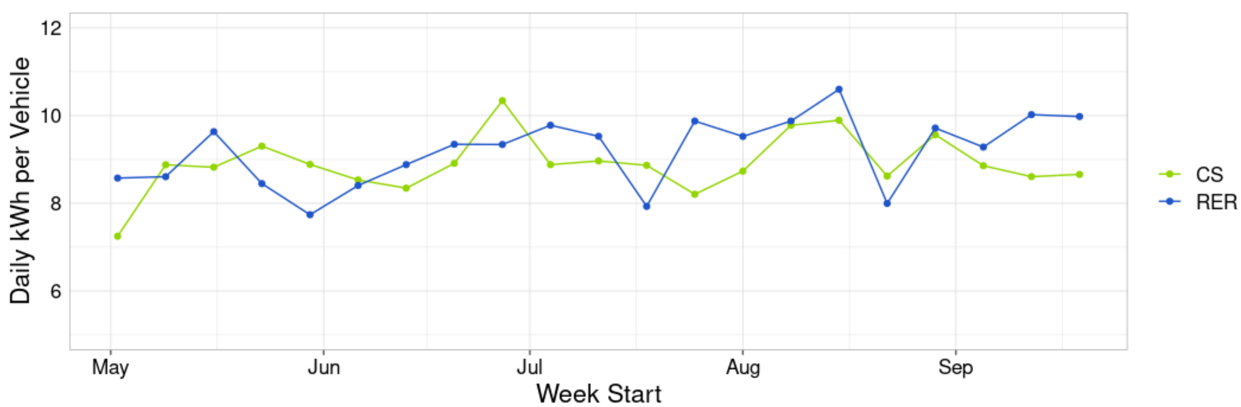
Figure 4-19 and Figure 4-20 show the average daily kWh consumed by month and by week across all enrolled CS participants and RER participants. CS and RER EVs showed a slow and steady increase in average daily kWh by vehicle across the analysis period.

Figure 4-19. Average Daily kWh by Month



Source: Guidehouse analysis of CS and RER EV telematics data

Figure 4-20. Average Daily kWh by Week*



*The first and last weeks of the analysis were removed from this figure as they only contained data from 1 and 4 days, respectively

Source: Guidehouse analysis of CS and RER EV telematics data

Table 4-3 details the average daily kWh by month. The table shows again that CS and RER participants increased daily kWh from the pre-treatment to program treatment period. Results also indicate that there is a notable decrease in CS participants' peak consumption, while off-peak consumption increased.

Table 4-3. Average Daily kWh, Off-Peak and Peak

Period	Month	CS			RER			Difference *(CS Off – RER Off)*
		Off-Peak *11pm-7am*	Peak *7am-11pm*	*Total*	Off-Peak *11pm-7am*	Peak *7am-11pm*	*Total*	
Pre	May	3.84	4.87	8.71	2.15	6.52	8.67	1.69
	June	4.47	4.31	8.78	2.21	6.55	8.76	2.26
Post	July	4.68	4.13	8.81	2.46	6.82	9.28	2.22
	August	4.99	4.30	9.29	2.57	6.85	9.42	2.42
	September	4.81	3.81	8.62	2.36	7.90	10.26	2.45
Pre	May–June	4.17	4.58	8.75	2.19	6.53	8.72	1.98
Post	July–September	4.82	4.07	8.89	2.47	7.17	9.64	2.35

Source: Guidehouse analysis of CS and RER EV telematics data

4.3 Impact Analysis

This section summarizes key findings related to the impact analysis conducted for this evaluation. Guidehouse assessed impacts of program participation for CS program participants during off-peak (11 p.m. to 7 a.m.) and peak hours (7 a.m. to 11 p.m.) using the difference-in-differences regression specification Section 2.3 summarizes.

4.3.1 Key Findings

- **Average reductions in demand between the hours of 7 a.m. and 11 p.m. were 0.13 kW per EV.** Daily energy savings between the hours of 7 a.m. and 11 p.m. were 1.85 kWh per EV per day. There was not a statistically significant change in demand or energy between the hours of 11 p.m. and 7 a.m. This is despite observed increases in the share of charging conducted during the hours of 11 p.m. to 7 a.m. between the pre-period and program treatment period.
- **Average reductions in super-peak demand between the hours of 5 p.m. and 8 p.m. were 0.25 kW per EV.**[9] Daily energy savings during super-peak hours were 0.67 kWh per EV per day. For peak hours outside of the super-peak period, demand and energy impacts amounted to a 0.10 kW reduction in demand and 1.18 kWh in daily energy savings per EV. Changes in demand and energy for off-peak hours were not statistically different from zero. This suggests that much of the 0.13 kW per EV demand reduction assessed for 7 a.m.–11 p.m. could be attributed to super-peak demand reductions.

[9] This finding is comparable to the 0.27 kW reduction per vehicle between 5 p.m. and 9 p.m. observed in the first year of National Grid's Rhode Island Off-Peak Charging Rebate Pilot. Notably, that program was implemented as a randomized control trial. Evaluation results for the pilot can be found linked here: http://www.ripuc.ri.gov/eventsactions/docket/4770-NGrid-RY2%20Transportation%20Initiative%20Annual%20Report%20Combined%20(10.30.2020).pdf

4.3.2 Impact Results

Table 4-4 shows the demand and energy impacts per enrolled EV by time period. The impact of program participation during off-peak hours spanning 11 p.m. to 7 a.m. was statistically insignificant. However, the impact of program participation during peak hours spanning 7 a.m. to 11 p.m. was a 0.13 kW reduction in demand and a 1.85 kWh daily energy savings per EV. Reductions in kW demand during peak hours is consistent with findings from charge profile analysis, which indicated that CS participants shifted charging downward during peak hours, particularly during super-peak hours (5 p.m. to 8 p.m.) that had an additional incentive for avoiding charging. This shift in charging from early-evening hours was not only a goal of the offering, but also a measured program impact.

Table 4-4. Demand Impacts per EV by Period

Impact Analysis Metric	Time Period	Estimated Change	Pre-Period Average	Percent Change
Average Half-Hourly kW Reduction per EV	7 a.m.–11 p.m.	-0.127 kW**	0.362 kW	-35.03%*
	11 p.m.–7 a.m.	0.015 kW	0.562 kW	2.68%
Average Daily kWh Savings per EV	7 a.m.–11 p.m.	-1.852 kWh**	4.982 kWh	-37.18%**
	11 p.m.–7 a.m.	0.130 kWh	4.232 kWh	3.07%

* Indicates significance at 90% confidence

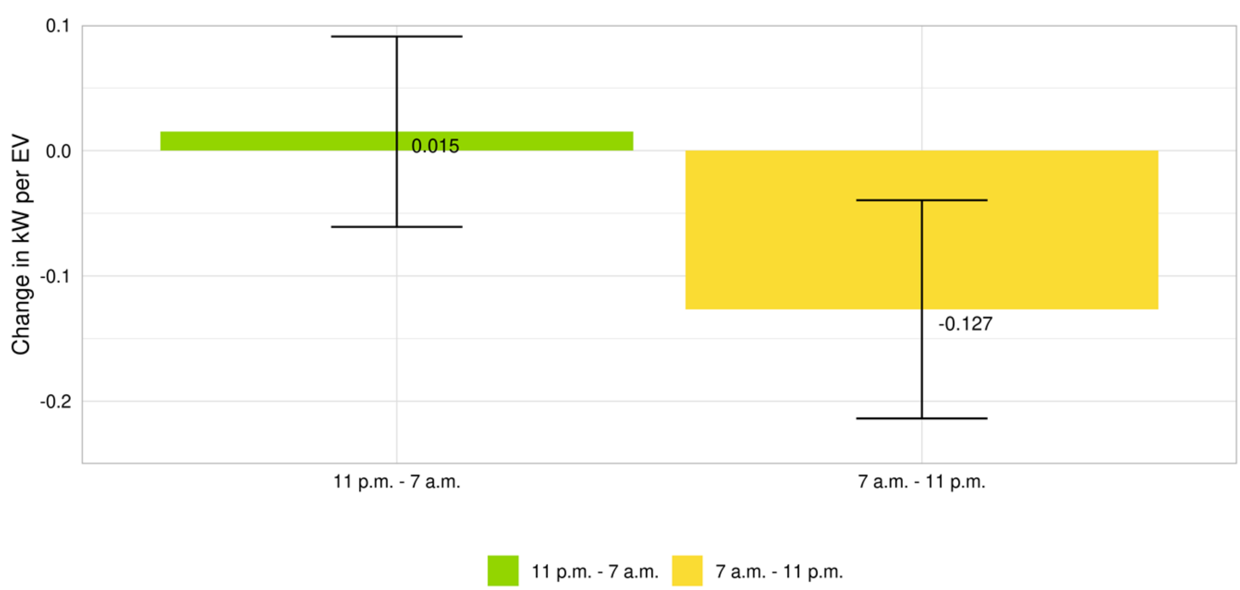
** Indicates significance at 95% confidence

*** Indicates significance at 99% confidence

Source: Guidehouse analysis of EV interval data

Figure 4-21 illustrates the kW impact per EV that participated in the off-peak offering during the period spanning July 1 through September 30 with 90% confidence bounds overlaid. Although off-peak period demand impacts of program participation were statistically insignificant, peak period demand impacts amounted to a 0.13 kW reduction in demand per participating EV.

Figure 4-21. Average kW Impact per EV by Period



Source: Guidehouse analysis of CS and RER EV telematics data

In addition to a $0.05/kWh rebate for charging during off-peak hours, CS participants are eligible for an additional $10/month bonus incentive if they avoided charging between the hours of 5 p.m. and 8 p.m. To explore the impact of this bonus incentive, Guidehouse split the peak period defined as 7 a.m. to 11 p.m. into two periods. The first period comprises peak hours spanning 7 a.m. to 5 p.m. and 8 p.m. to 11 p.m. The second period comprises super-peak hours spanning 5 p.m. to 8 p.m. Guidehouse then estimated demand and energy impacts of program participation within each off-peak, peak, and super-peak hours using a modified version of the regression summarized in Equation 2-1.

Table 4-5 shows the demand and energy impacts per enrolled EV by time period, this time including super-peak hours spanning 5 p.m. to 8 p.m. As was the case in results summarized above, the impact of program participation during off-peak hours spanning 11 p.m. to 7 a.m. was statistically insignificant. However, splitting the peak hours into two separate periods reveals that much of the demand reductions observed between 7 a.m. to 11 p.m. were observed between 5 p.m. to 8 p.m. More specifically, during super-peak hours there was a 0.25 kW reduction in demand and a 0.67 kWh daily energy savings per EV. For peak hours outside of the super-peak period, demand and energy impacts amounted to a 0.10 kW reduction in demand and 1.18 kWh in daily energy savings per EV.

Table 4-5. Demand Impacts per EV by Period, Including Super-Peak Hours

Impact Analysis Metric	Time Period	Estimated Change	Pre-Period Average	Percent Change
Average Half-Hourly kW Reduction per EV	7 a.m.–5 p.m.; 8 p.m.–11 p.m.	-0.099 kW**	0.348 kW	-28.49%**
	5 p.m.–8 p.m.	-0.246 kW***	0.422 kW	-58.36%***
	11 p.m.–7 a.m.	0.015 kW	0.562 kW	2.66%
Average Daily kWh Savings per EV	7 a.m.–5 p.m.; 8 p.m.–11 p.m.	-1.180 kWh**	3.893 kWh	-30.30%**
	5 p.m.–8 p.m.	-0.673 kWh***	1.089 kWh	-61.78%***
	11 p.m.–7 a.m.	0.130 kWh	4.232 kWh	3.07%

* Indicates significance at 90% confidence

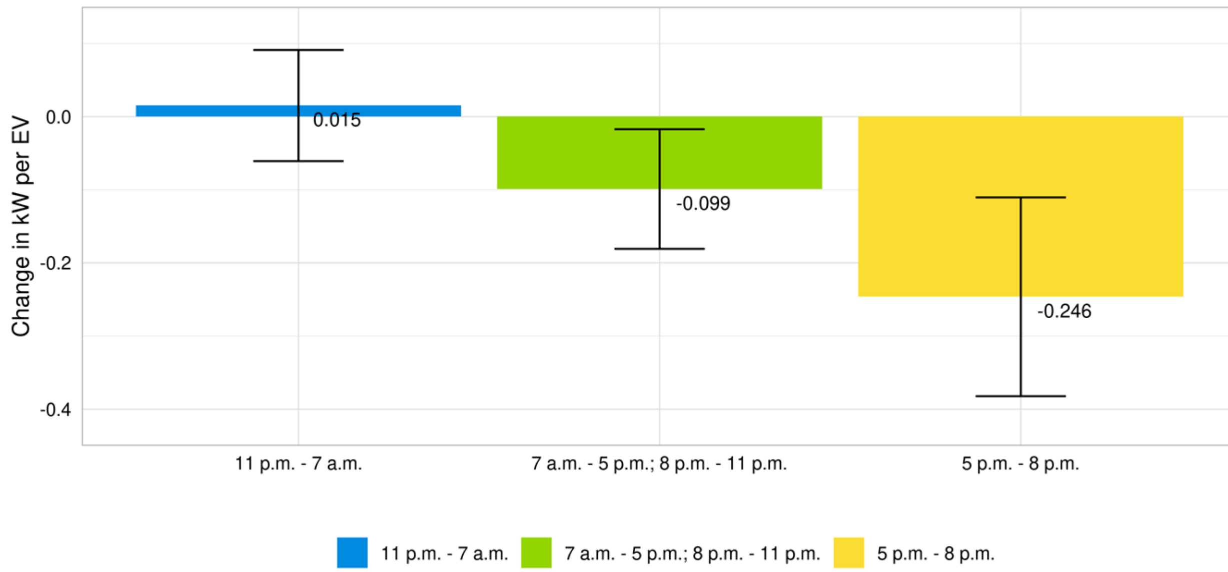
** Indicates significance at 95% confidence

*** Indicates significance at 99% confidence

Source: Guidehouse analysis of CS and RER EV telematics data

Figure 4-22 illustrates the kW impact per EV that participated in the off-peak offering during the period spanning July 1 through September 30 with 90% confidence bounds overlaid. Demand impacts of program participation were identified to fall primarily within the super-peak period spanning 5 p.m. to 8 p.m.

Figure 4-22. Average kW Impact per EV by Period, Including Super-Peak Hours



Source: Guidehouse analysis of CS and RER EV telematics data

5. Findings and Considerations

The following tables summarize key findings from each research activity, along with key considerations for the program.

Table 5-1. Key Findings – Customer Experience Research

Research Category	Findings
Motivations and Enrollment	Helping the environment was the most commonly cited primary motivator to purchase an EV, while program incentives was most commonly cited as the top reason for enrolling in the program.
	The majority of respondents (89%) were satisfied with the enrollment process.
EVSE Characteristics	Most CS (86%) and RER (90%) participants own a Level 2 charger at home, with the majority being OEM-specific chargers, especially for CS participants.
	RER participants have a higher proportional frequency of storing their home charging device outside, while mainly CS participants use a heated garage.
EV Characteristics and Driving Behavior	Out of both participant types, 10 own an additional BEV and nine own an additional PHEV that was not enrolled in the program or RER study.
	About half of both CS and RER participants reported that their weekly milage did not change from summer 2020 to 2021, and RER participants reported driving slightly fewer miles overall on weekdays in summer 2021.
Charging Behavior and Changes Since Summer 2020	Compared to only 27% of RER participants, 76% of CS participants scheduled charging times through an app. Common scheduled start times for CS participants was at or after 11 p.m. on weekdays in summer 2021.
	The most common times for respondents to have their EVs connected to chargers was on weekdays between 6 p.m. and 8 a.m.
	A smaller proportion of CS participants (20%) charged their EV until full, and a larger proportion (32%) charged their EV during off-peak hours (11 p.m. to 7 a.m.) compared to RER participants (62% and 13%, respectively).
	CS participants (31%) reported experiencing less barriers to public charging compared to RER participants (15%), and there was no significant difference between RER Tesla and non-Tesla owners. All respondents used workplace charging minimally during summer 2021 weekdays.
Program Influences	Most CS participants (70%) viewed the SmartCharge Rewards portal and of those who viewed the portal, 30% provided suggestions for improvement.
	CS participants were more influenced by rewards and monthly bonuses than energy use information in determining their EV's charging schedule for summer 2021.
Program Satisfaction	Most CS participants were, at least, satisfied with the SmartCharge Rewards portal (66%), timing of on- and off-peak periods (81% and 78%, respectively), and program communications (57%) and incentives (69%).
	Almost all (96%) of CS participants reported that they are likely to participate in the program again in the future.

Source: Guidehouse

Table 5-2. Key Findings – Charging Profile Analysis

Research Category	Findings
Charging Profile Analysis	**CS participants conducted most of their charging during off-peak hours (11 p.m.–7 a.m.).** This pattern was observed during the pre-period (May 1–June 30) and the program treatment period (July 1–September 30).
	Many enrolled EVs appear to have shifted their charging from peak hours (7 a.m.–11 p.m.) to off-peak hours (11 p.m.–7 a.m.). Despite CS participants conducting more of their charging during off-peak hours prior to program start, EVs appear to have shifted additional charging from peak hours to off-peak hours after the program began.
	30% of customers used scheduled charging in some capacity from May 2021–September 2021. Nearly all scheduled charging occurred during off-peak hours (11 p.m.–7 p.m.), with most scheduled sessions beginning between 11 p.m. and 12 a.m. Among these customers, there was an increase in scheduled charging during off-peak hours during the program treatment period (July 1–September 30).
	Across the full analysis period, **the single hour with the most energy consumed, on average, was 2 a.m.–3 a.m.** The 5 hours with the most energy consumed all fell between 11 p.m.–4 a.m., both pre- and post-treatment, primarily due to a concentration of scheduled charging sessions starting at 11 p.m.

Source: Guidehouse

Table 5-3. Key Findings – Impacts

Research Category	Findings
Impacts	**Average reductions in demand between the hours of 7 a.m. and 11 p.m. were a statistically significant 0.13 kW per EV.** Daily energy savings between the hours of 7 a.m. and 11 p.m. were a statistically significant 1.85 kWh per EV per day. There was not a statistically significant change in demand or energy between the hours of 11 p.m. and 7 a.m. This is despite observed increases in the share of charging conducted during the hours of 11 p.m. to 7 a.m. between the pre-period and program treatment period.
	Average reductions in super-peak demand between the hours of 5 p.m. and 8 p.m. were a statistically significant 0.25 kW per EV. Daily energy savings during super-peak hours were a statistically significant 0.67 kWh per EV per day. For peak hours outside of the super-peak period, demand and energy impacts amounted to a statistically significant 0.10 kW reduction in demand and a statistically significant 1.18 kWh reduction in daily energy savings per EV. This suggests that much of the 0.13 kW per EV demand reduction assessed for 7 a.m.–11 p.m. could be attributed to super-peak demand reductions.

Source: Guidehouse

Table 5-4. Key Findings – Considerations

Research Category	Considerations
Program Design	**Consideration 1:** Consider creating a program guidebook that educates customers about the benefits of charging during off-peak hours and a monthly report that showcases results from the offering and participant efforts. Continue offering a modest incentive that follows the off-peak charging schedule, but also consider if there is potential to begin off-peak hours earlier than 11 p.m.
Program Design	**Consideration 2:** Consider implementing additional checks for customers that enroll in future cycles of this offering. For instance, ensure that the customer enrolling in the program meets eligibility requirements for the program, as Guidehouse identified several customers who did not qualify for the program due to living outside of the eligible geographic area but who had still enrolled in the program.
Program Design	**Consideration 3:** Consider creating a program component, educational tool/info, to teach participants & recruiting audience how to make participation easier – info on using scheduled charging & how to make that happen.
Impacts	**Consideration 4:** Consider adding a requirement of one calendar year of pre-period data from participants to participate in the program. Employing a broader time window of pre-period data – for instance, one calendar year prior to program start – will help improve the accuracy of impact estimates.
Impacts	**Consideration 5:** As the offering continues or a program based upon this offering is supported, consider tracking and measuring differences in charging behavior and impacts across seasons. Results for the summer season (July 1–September 30) may not be able to be extrapolated to other seasons due to differences in incentive structure and potential differences in driving behavior across seasons.
Impacts	**Consideration 6:** To assess how driving behavior changes more accurately across seasons, consider obtaining trip data for all enrolled CS participants.

Source: Guidehouse

Appendix A. Participant Survey Instruments

A.1 2021 Participant Survey Instrument

[If CS Participant, display] Eversource thanks you for participating in ConnectedSolutions SmartCharge Rewards Program this year. In an effort to improve the program and its ability to reduce strain on the electricity grid during periods of peak demand, we have some questions related to your experiences in the program and your household's charging and driving behavior in general.

If you cannot complete the survey all at one time or if you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking on the link from the email you received.

[If RER Participant, display] The Massachusetts Program Administrators thank you for participating in the Rolling Energy Resources study this year. In an effort to better plan for updates needed to the electric grid to continue to encourage electric vehicles in Massachusetts, we have some questions related to your household's charging and driving behavior.

If you cannot complete the survey all at one time or if you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking on the link from the email you received.

A.1.1 Motivations

M1. What was your top motivation for enrolling in Eversource's ConnectedSolutions SmartCharge Rewards Program?

[Response option order is randomized for each respondent]

a. Receive incentives
b. Reduce my/our environmental impact
c. Reduce the need for additional power plants
d. Support my/our community and/or state's energy initiatives
e. Other (Specify) **[Open ended]**

M2. How did you learn about Eversource's ConnectedSolutions SmartCharge Rewards Program? Select all that apply.

a. Eversource email
b. Eversource website
c. Eversource other (Specify) **[Open ended]**
d. Tesla email
e. Tesla website
f. Tesla app
g. Friend/family/neighbor
h. Other (Specify) **[Open ended]**
i. Not sure **[Mutually exclusive response]**

M3. On a scale of 1 to 5, where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program?

a. Very Unsatisfied – 1	**b.** 2	**c.** 3	**d.** 4	**e.** Very Satisfied – 5

M4. Did you encounter any challenges or difficulties during the enrollment process?

a. Yes, I encountered challenges during the enrollment process
b. No, I did not encounter any challenges during the enrollment process

[If M4 = a, continue; otherwise, skip to M6]

M5. During which enrollment step did you encounter challenges or difficulties? Select all that apply.

a. Entering my name and contact information to prove I am an Eversource customer
b. Entering the Model and Model Year of my Tesla
c. Creating a SmartCharge Rewards account
d. Connecting my Tesla account to my SmartCharge Rewards account
e. Other (Specify) **[Open ended]**

M6. How could the ConnectedSolutions SmartCharge Rewards Program enrollment process be improved?

a. **[Open ended]**
b. No improvements needed
c. Not sure

A.1.2 EV Characteristics and Driving Behavior

EV1. How many licensed drivers are there in your household? **[Numeric value prompt]**

EV2. According to our records, you currently have the following EV(s) enrolled in **[Display program name]**.

[Display make, model, and year of EV #1 from record]
[Display make, model, and year of EV #2 from record, if applicable]

Is this accurate?

a. Yes
b. No

[If EV2 = b, continue; otherwise, skip to EV4]

EV2_0. How many EVs do you have enrolled in **[Display program name]**?

a. 1
b. 2

[If EV2_0 = a, continue; otherwise, skip to EV3_2]

EV3. Please provide the make, model, and year of your enrolled EV. **[Make, model, and year of EV #1 are updated based on these selections]**

	Make and Model	**Year**
Enrolled EV #1	**[Dropdown]**	**[Dropdown]**

[If EV2_0 = b, continue; otherwise, skip to EV4]

EV3_2. Please provide the make, model, and year of your enrolled EV. **[Make, model, and year of EV #1 and EV #2 to be updated based on these selections]**

	Make and Model	**Year**
Enrolled EV #1	**[Dropdown]**	**[Dropdown]**
Enrolled EV #2	**[Dropdown]**	**[Dropdown]**

EV4. Does your household own any other EVs (that are not enrolled in **[Display program name]**)? This includes other all-battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). It does NOT include pure hybrid vehicles (i.e., those that do not require the battery to be charged via charging equipment). (Select all that apply)

a. Yes, our household owns an additional BEV(s) that is not enrolled in the program
b. Yes, our household owns an additional PHEV(s) that is not enrolled in the program
c. No, our household does not own any BEVs or PHEVs beyond what is enrolled **[Mutually exclusive response]**

[If EV4 = a, continue; otherwise, skip to EV10]

EV5. How many additional BEVs does your household own? **[Dropdown w/ values 0-4]**

[If EV4 = b, continue; otherwise, skip to EV15]

EV10. How many additional PHEVs does your household own? **[Dropdown w/ values 0-4]**

[If # of enrolled EVs = 2, continue; otherwise, skip to EV16]

EV15. Of the electric vehicles enrolled in **[Display program name]**, please identify the electric vehicle whose driving and charging schedule you are most familiar with.

a. **[Display make, model, and year of EV#1]**
b. **[Display make, model, and year of EV#2]**

[If # of enrolled EVs = 1, display] *Please answer the remaining questions thinking about the electric vehicle that is enrolled in the program.*

[If # of enrolled EVs = 2, display] Please answer the remaining questions thinking about this electric vehicle.

EV16. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during summer 2021 (June through August)?

a. Yes
b. No

EV17. What was your household's top motivation for buying the electric vehicle?

[Response option order is randomized for each respondent]

a. We/I wanted to save money
b. We/I wanted to help the environment
c. There were rebates available (Specify) **[Open ended]**
d. We/I wanted the latest technology
e. It fits with my/our lifestyle
f. For comfort reasons
g. Fuel independence
h. Convenience (not having to stop at gas station)
i. Other (Specify) **[Open ended]**

We now have some questions about how your household used the electric vehicle during the summer. Please answer the questions thinking about ***this past summer – i.e., June 2021 through August 2021.***

EV18. Which of the following best describes how your household *typically* used this electric vehicle on weekdays (Monday through Friday) during the summer of 2021 (June through August)?

a. I or another member of my household used it on a regular schedule (e.g., to and from work)
b. I or another member of my household used it as needed (e.g., to complete errands)
c. No one from my household used it on weekdays
d. Other (Please describe how your vehicle was typically used on weekdays) **[Open ended]**

EV19. On a *typical* summer 2021 weekday (Monday, Tuesday, etc.), on average, how many miles was this electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for the total miles driven on a typical summer weekday for 2021.

a. 0-10 miles
b. 11-20 miles
c. 21-30 miles
d. 31-50 miles
e. 51-70 miles
f. 71-100 miles
g. 101-150 miles
h. >150 miles
i. It varied significantly day-to-day or depending on the day of the week (Please describe) **[Open ended]**
j. It varied significantly depending on the week or month (Please describe) **[Open ended]**
k. Not sure

A.1.3 EVSE Characteristics and Charging Behavior

[If # of enrolled EVs = 1, display] Still thinking about the enrolled electric vehicle (**[Display make, model and year of EV #1]**), we now have some questions about how your household *charged* this electric vehicle during this past summer. Please answer the questions thinking about **this past summer – i.e., June – August 2021.**

[If # of enrolled EVs = 2 AND EV15 = a, display] Still thinking about the enrolled electric vehicle whose driving and charging schedule you are most familiar with (**[Display make, model and year of EV #1]**), we now have some questions about how your household *charged* this electric vehicle during this past summer. Please answer the questions thinking about **this past summer – i.e., June – August 2021.**

[If # of enrolled EVs = 2 AND EV15 = b, display] Still thinking about the enrolled electric vehicle whose driving and charging schedule you are most familiar with (**[Display make, model, and year of EV #2]**), we now have some questions about how your household *charged* this electric vehicle during this past summer. Please answer the questions thinking about **this past summer – i.e., June – August 2021.**

CB1. Approximately what percentage of your EV's charging this past summer took place at your home, work, public, or other charging stations? Don't worry about being precise, just take your best guess.

Charging Location	**% of EV charging**
CB1_1. My home charger	**[Numeric]** %
CB1_2. Workplace charger	**[Numeric]** %
CB1_3. Public charger	**[Numeric]** %
CB1_4. Other (Specify) **[Open ended]**	**[Numeric]** %

CB2. Which of the following best describes the electric vehicle charging device that you have at home?

a. Level 1 charger (i.e., a charger that plugs into a standard 120-volt outlet)
b. Level 2 charger (i.e., a charger that plugs into a high-output 220/240-volt outlet)
c. I do not have a charger for use at home

[If CB2 = b, continue; otherwise, skip to CB4]

CB3. Please select the make of your Level 2 charger. **[Dropdown]**

[If CB1_1 > 0%, continue; else, skip to CB11]

CB4. During summer 2021, when your electric vehicle was not being used and at home, was it typically connected to your home charging device?

a. Yes, I/we typically always had the EV connected to home charging device when not using the EV
b. No, I/we only connected the EV to home charging device at select times; please describe (e.g., when the EV battery had a certain % charge remaining) **[Open ended]**
c. Other (Specify) **[Open ended]**
d. Not sure

CB5. During summer 2021, which of the following best describes your household's use of your home charging device for your electric vehicle?

a. Whenever the EV was connected to our home charging device, it charged until it was fully charged
b. I/We used the home charging device app to remotely start and stop charging of the EV
c. I/We followed a charging schedule that I/we set using the home charging device app
d. I/We followed a charging schedule that I/we set using the EV's app
e. Other (Specify) **[Open ended]**

[If CB5 = c OR d, continue; otherwise, skip to CB6]

CB5_b. How was your electric vehicle's charging schedule determined?

a. I/We selected it
b. It is the default schedule
c. Other (Specify) **[Open ended]**
d. Don't know

CB6. Below, please indicate the time ranges during which the electric vehicle was ***typically connected (regardless of charging or not) to your home charging device*** on weekdays (Monday through Friday) during summer 2021 (June through August). Select all the time ranges that apply.

As an example, if you typically disconnected the electric vehicle at 7:30 AM to go to work and then you connected this electric vehicle again when you returned home at 5:30 PM (leaving it connected until the following morning), you would select all ranges between 12 AM and 8 AM, and between 4 PM and 12 AM.

a. 12 AM – 2 AM
b. 2 AM – 4 AM
c. 4 AM – 6 AM
d. 6 AM – 8 AM
e. 8 AM – 10 AM
f. 10 AM – 12 PM
g. 12 PM – 2 PM
h. 2 PM – 4 PM
i. 4 PM – 6 PM
j. 6 PM – 8 PM
k. 8 PM – 10 PM
l. 10 PM – 12 AM
m. It varied significantly day-to-day or depending on the day of the week (M-F). (Please describe) **[Open ended]**
n. It varied significantly depending on the week or month. (Please describe) **[Open ended]**
o. Not sure **[Mutually exclusive response]**

[If CB5 = b, continue; otherwise, skip to CB8]

CB7. At approximately what time did you typically start and stop charging your electric vehicle with your home charging device on weekdays in summer 2021? **[Open ended]**

[If CB5 = c or d, continue; otherwise, skip to CB9]

CB8. At approximately what time was your electric vehicle's charging typically scheduled to start and end on weekdays in summer 2021? **[Open ended]**

CB9. Compared to your household's use of your home charging device on weekdays, was the amount of time this electric vehicle was ***typically connected to your home charging device*** in summer 2021 different on weekends?

a. Yes, the EV was connected more on weekends
b. Yes, the EV was connected less on weekends
c. No / Not significantly

CB10. Compared to your household's use of your home charging device on weekdays, was the timing of when this electric vehicle was ***typically connected to your home charging device*** in summer 2021 different on weekends (e.g., shifted from being connected early evening through early morning to being connected all day when not in use)?

a. Yes (Please describe) **[Open ended]**
b. No or not significantly

CB11. Is this electric vehicle driven to a workplace that has workplace charging available? Please answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it.

a. Yes
b. No
c. Not applicable (e.g., full-time remote, retired)

[If CB1_2 > 0%, continue; otherwise, skip to CB15]

CB13. Below, please indicate when this electric vehicle was ***typically connected to a workplace charging station*** on weekdays (Monday through Friday) during the summer 2021 (June through August). Select all the time ranges that apply.

As an example, if you typically connected this electric vehicle to a workplace charging station around 3 PM and disconnected when you left to return home at 5:30 PM, you would select ranges 2 PM – 4 PM and 4 PM – 6 PM.

a. 12 AM – 2 AM
b. 2 AM – 4 AM
c. 4 AM – 6 AM
d. 6 AM – 8 AM
e. 8 AM – 10 AM
f. 10 AM – 12 PM
g. 12 PM – 2 PM
h. 2 PM – 4 PM
i. 4 PM – 6 PM
j. 6 PM – 8 PM
k. 8 PM – 10 PM
l. 10 PM – 12 AM
m. It varied significantly day-to-day or depending on the day of the week (Please describe) **[Open ended]**
n. It varied significantly depending on the week or month (Please describe) **[Open ended]**
o. Not sure **[Mutually exclusive response]**

CB14. What are your main motivations for using ***workplace charging stations***? Select all that apply**.**

a. My workplace charging is free
b. My workplace charging is cheaper than charging at home
c. My workplace charging is faster than charging at home
d. Workplace charging is convenient
e. Workplace charging allows me to commute fully in electric mode
f. **[If CS Participant, display]** I charge at workplace public charging stations to avoid charging during On-Peak hours (5PM - 8PM)
g. **[If RER Participant, display]** I charge at public charging stations to avoid charging during hours when electricity demand on the grid is the highest (“peak” hours)
h. Other (Specify) **[Open ended]**

[If CB11 = a, continue; otherwise, skip to CB16]

CB15. Are there are any barriers for you or your household members to use ***workplace charging stations*** to charge this electric vehicle? (select all that apply)

a. There is limited availability of workplace chargers
b. Workplace charging station time limits are a barrier
c. Workplace charging stations are not compatible with my EV
d. I have not experienced any barriers to using workplace charging stations **[Mutually exclusive response]**
e. Other (Specify) **[Open ended]**

[If CB1_3 > 0%, continue; otherwise, skip to CB17]

CB16. What are your main motivations for using ***public charging stations***? (select all that apply)

a. Public charging is cheaper than charging at home
b. Public charging is faster than charging at home
c. Public charging is convenient
d. Public charging allows me to commute fully in electric mode
e. **[If CS Participant, display]** I charge at public charging stations to avoid charging during On-Peak hours (5PM - 8PM)
f. **[If RER Participant, display]** I charge at public charging stations to avoid charging during hours when electricity demand on the grid is the highest ("peak" hours)
g. Other (Specify) **[Open ended]**

CB17. Are there are any barriers for you or your household members to use ***public charging stations*** to charge this electric vehicle? Select all that apply.

a. Public charging is more expensive than charging at home
b. There is limited availability of public chargers
c. Public charging stations are not always located near where I am going
d. Public charging station time limits are a barrier
e. Public charging stations are not always compatible with my EV
f. I have not experienced any barriers to using public charging stations **[Mutually exclusive response]**
g. I have not tried to use public charging stations **[Mutually exclusive response]**
h. Other (Specify) **[Open ended]**

A.1.4 Changes Since Summer 2020

Now we have some questions about how driving and charging changed, if at all, for the electric vehicle ***since summer of 2020***.

CS1. Compared to your household's use of your electric vehicle in the summer 2020, did the typical ***miles per day*** that this electric vehicle was driven on weekdays change in summer 2021?

a. Yes, we drove the EV more on weekdays in summer 2021
b. Yes, we drove the EV less on weekdays in summer 2021
c. No or not significantly
d. We bought the EV after the summer of 2020

[If CS1 ≠ d, continue; otherwise, skip to A1]

CS2. Compared to your household's use of this electric vehicle in the summer of 2020, did the ***timing*** of when this electric vehicle was typically driven on weekdays change in summer 2021?

a. Yes
b. No / Not significantly

[If CS2 = a, continue; otherwise; skip to CS3]

CS2a. Please describe how the timing of when this electric vehicle was typically driven on weekdays changed in summer 2021 compared to summer 2020 **[Open ended]**

CS3. Compared to the summer of 2020, was this EV typically charging more, less, or the same amount ***on weekdays*** in summer 2021? Please indicate how this varied by charging location.

	a. The EV was charging ***more on weekdays*** in summer 2021	**b.** The EV was charging ***less on weekdays*** in summer 2021	**c.** About the same
CS3_1. My home charger			
CS3_2. Workplace charger			
CS3_3. Public charger			

[If CS3_1 ≠ c OR CS3_2 ≠ c OR CS3_3 ≠ c, continue; otherwise, skip to CS5]

CS4. What accounts for the change in the amount of ***charging on weekdays*** between summer 2020 and summer 2021? **[Open ended]**

CS5. Compared to summer of 2020, was this EV typically charging more, less, or the same amount in summer 2021 ***during the weekday hours of 11 PM to 7 AM*** **[If CS Participant, display parenthetical]** ("Off-Peak" hours) relative to other hours? Please indicate how this varied by charging location.

	a. The EV was charging ***more*** during the weekday hours of 11 PM – 7 AM than during other hours in summer 2021	**b.** The EV was charging ***less*** during the weekday hours of 11 PM – 7 AM than during other hours in summer 2021	**c.** About the same
CS5_1. My home charger			
CS5_2. Workplace charger			
CS5_3. Public charger			

[If CS5_1 ≠ c OR CS5_2 ≠ c OR CS5_3 ≠ c, continue; otherwise, skip to CS6]

CS5a. What accounts for the change in the amount of ***charging on weekdays from 11 PM – 7 AM*** between summer 2020 and summer 2021? **[Open ended]**

[If CS Participant, continue; otherwise, skip to CS7]

CS6. Compared to the summer of 2020, was this EV typically charging more, less, or the same amount in summer 2021 ***during the weekday hours of 5 PM – 8 PM*** ("On-Peak" hours) relative to other hours? Please indicate how this varied by charging location.

	a. The EV was charging ***more*** during the weekday hours of 5 PM – 8 PM than during other hours in summer 2021	**b.** The EV was charging ***less*** during the weekday hours of 5 PM – 8 PM than during other hours in summer 2021	**c.** About the same
CS6_1. My home charger			
CS6_2. Workplace charger			
CS6_3. Public charger			

[If CS6_1 ≠ c OR CS6_2 ≠ c OR CS6_3 ≠ c, continue; otherwise, skip to CS7]

CS6a. What accounts for the change in the amount of ***charging on weekdays from 5 PM – 8 PM*** between summer 2020 and summer 2021? **[Open ended]**

CS7. What, if any, additional observations do you have to share related to how your household's use of this electric vehicle and/or charging stations changed between summer 2020 and summer 2021?

a. **[Open ended]**
b. No additional observations

A.1.5 Additional EVs in Household

[If # of enrolled EVs = 2 OR EV4 = a, continue; otherwise, skip to I1]

A1. Thank you for answering the previous questions thinking about the enrolled electric vehicle whose driving and charging schedule you are most familiar with.

You indicated that your household has more than one EV. Please describe how your household used the additional electric vehicle(s) in summer 2021 (e.g., driven approximately 5 miles per weekday, on average, mostly after 4 pm). **[Open ended, optional]**

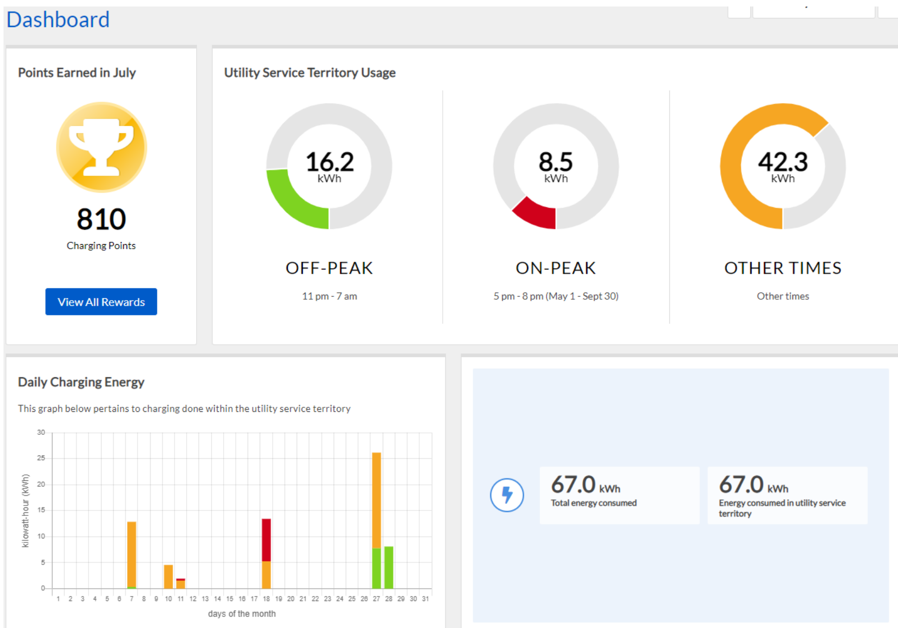
A2. Additionally, please describe how your household charges the additional electric vehicle(s). How do you manage home charging between EVs? **[Open ended, optional]**

A.1.6 Program Influences

[If CS Participant, continue; otherwise, skip to D1]

I1. Which of the following best describes how often you view the SmartCharge Rewards Portal (pictured) provided by Geotab (FleetCarma)?

a. Very frequently (multiple times a day)
b. Frequently (every day or two)
c. Sometimes (once a week)
d. Occasionally (once or twice a month)
e. Never



[If I1 ≠ e, continue; otherwise, skip to I5]

I2. On a scale of 1 to 5, where 1 is "Not at all valuable" and 5 is "Very valuable", how valuable is the following information provided on the portal?

	a. Not at all valuable	**b.** Minimally valuable	**c.** Somewhat valuable	**d.** Valuable	**e.** Very valuable	**f.** Don't know
	1	**2**	**3**	**4**	**5**	
I2a. Summary of rewards earned						
I2b. Overall energy (kWh) consumed when charging my EV in Eversource territory during Off-Peak, On-Peak, and Other Times						
I2c. Energy (kWh) consumed when charging my EV in Eversource territory during Off-Peak, On-Peak, and Other Times by day of the month						

	a. Not at all valuable	**b.** Minimally valuable	**c.** Somewhat valuable	**d.** Valuable	**e.** Very valuable	**f.** Don't know
I2d. Total energy (kWh) consumed when charging my EV vs. total energy (kWh) consumed when charging my EV in Eversource territory						

[If I2a = c-e OR I2b = c-e OR I2c = c-e OR I2d = c-e, continue; otherwise, skip to I4]

I3. Please describe what you find valuable about the information provided on the SmartCharge Rewards portal. **[Open ended]**

I4. Are there ways that the information provided on the SmartCharge Rewards portal could be improved?

a. Yes (Specify) **[Open ended]**
b. No

I5. Which of the following program incentives did you receive in the summer of 2021? Select all that you earned or benefited from at least once.

a. $50 incentive for enrolling in the program
b. $0.05/kWh for charging during Off-Peak hours (11 PM – 7 AM)
c. $10 monthly bonus for avoiding charging during On-Peak hours (5 PM – 8 PM)

I6. On a scale of 1 to 5, where 1 is "Not influenced at all" and 5 is "Very influenced", how influenced was your EV's charging schedule in summer 2021 by the following aspects of Eversource's ConnectedSolutions SmartCharge Rewards Program?

	a. Not influenced at all	**b.** Minimally influenced	**c.** Somewhat influenced	**d.** Influenced	**e.** Very influenced or Primary motivation	**f.** Don't know
	1	**2**	**3**	**4**	**5**	
I6a. The energy use information provided on the SmartCharge Rewards portal						
I6b. Rewards for charging during Off-Peak hours ($0.05/kWh)						
I6c. Monthly bonus for avoiding charging during On-Peak hours ($10/month)						

[IF QI6a = c, d, or e, CONTINUE. ELSE SKIP TO QI8]

I7. Please indicate how the ***energy use information provided on the SmartCharge Rewards portal*** affected your charging behavior during summer 2021 relative to what it would have been if the information was not provided.

Without the usage information, I would have… (select all that apply) **[Responses a and b are mutually exclusive; responses c and d are mutually exclusive; responses e and f are mutually exclusive.]**

a. Charged more during Off-Peak hours (11 PM – 7 AM)
b. Charged less during Off-Peak hours (11 PM – 7 AM)
c. Charged more during On-Peak hours (5 PM – 8 PM)
d. Charged less during On-Peak hours (5 PM – 8 PM)
e. I would have charged my EV more *outside* of Eversource's territory
f. I would have charged my EV more *within* Eversource's territory
g. Don't know

[If I6b = c-e, continue; otherwise, skip to I9]

I8. Please indicate how the ***$0.05/kWh reward for charging during Off-Peak hours*** affected your charging behavior during summer 2021 relative to what it would have been if rewards were not provided.

Without the Off-Peak Rewards, I would have… (select all that apply) **[Responses a and b are mutually exclusive; responses c and d are mutually exclusive; responses e and f are mutually exclusive]**

a. Charged more during Off-Peak hours (11 PM – 7 AM)
b. Charged less during Off-Peak hours (11 PM – 7 AM)
c. Charged more during On-Peak hours (5 PM – 8 PM)
d. Charged less during On-Peak hours (5 PM – 8 PM)
e. I would have charged my EV more *outside* of Eversource's territory
f. I would have charged my EV more *within* Eversource's territory
g. Don't know

[If I6c = c-e, continue; otherwise, skip to S1]

I9. Please indicate how the ***$10 monthly bonus for avoiding charging during On-Peak hours*** affected your charging behavior during summer 2021 relative to what it would have been if the bonus was not provided.

Without the bonus for avoiding charging during On-Peak hours, I would have… (select all that apply) **[Responses a and b are mutually exclusive; responses c and d are mutually exclusive; responses e and f are mutually exclusive]**

a. Charged more during Off-Peak hours (11 PM – 7 AM)
b. Charged less during Off-Peak hours (11 PM – 7 AM)
c. Charged more during On-Peak hours (5 PM – 8 PM)
d. Charged less during On-Peak hours (5 PM – 8 PM)
e. I would have charged my EV more *outside* of Eversource's territory
f. I would have charged my EV more *within* Eversource's territory
g. Don't know

A.1.7 Program Satisfaction

S1. On a scale of 1 to 5, where 1 is "Very unsatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the following aspects of Eversource's ConnectedSolutions SmartCharge Rewards Program to-date?

	a. Very Unsatisfied	**b.**	**c.**	**d.**	**e.** Very Satisfied	**f.** Don't know
	1	**2**	**3**	**4**	**5**	
S1a. The SmartCharge Rewards Portal						
S1b. Program incentives						
S1c. Program communications						
S1d. Timing of Off-Peak period (11 PM – 7 AM)						
S1e. Timing of On-Peak period (5 PM – 8 PM)						

[If S1a ≠ f, continue; otherwise, skip to S3]

S2. How could the ***SmartCharge Rewards Portal*** be improved?

a. **[Open ended]**
b. No improvements needed
c. Not sure

[If S1b ≠ f, continue; otherwise, skip to S4]

S3. How could ***program incentives*** be improved?

d. **[Open ended]**
e. No improvements needed
f. Not sure

[If S1c ≠ f, continue; otherwise, skip to S5]

S4. How could ***program communications*** be improved?

a. **[Open ended]**
b. No improvements needed
c. Not sure

[If S1d ≠ f, continue; otherwise, skip to S6]

S5. How could the ***timing of the Off-Peak period*** be improved?

a. **[Open ended]**
b. No improvements needed
c. Not sure

[If S1e ≠ f, continue; otherwise, skip to S7]

S6. How could the ***timing of the On-Peak period*** be improved?

a. **[Open ended]**
b. No improvements needed
c. Not sure

S7. On a scale of 1 to 5, where 1 is "Very Unlikely" and 5 is "Very Likely", how likely are you to continue to participate in Eversource's ConnectedSolutions SmartCharge Rewards Program?

a. Very Unlikely – 1	**b.** 2	**c.** 3	**d.** 4	**e.** Very Likely – 5

[If S7 = a or b, continue; otherwise, skip to S9]

S8. What change(s) to Eversource's ConnectedSolutions SmartCharge Rewards Program, if any, would encourage you to continue participating? **[Open ended, optional]**

[IF S7 = c-e, continue; otherwise, skip to D1]

S9. What recommendations would you make, if any, to help improve Eversource's ConnectedSolutions SmartCharge Rewards Program going forward? **[Open ended, optional]**

A.1.8 Demographics

You're almost done! We just have a few more questions.

D1. Which of the following best describes the property type where your home charging device is located?

a. Single family home
b. Multi-family home (2-4 units)
c. Multi-family home (5+ units)
d. Mobile home
e. Not a residence (business, workshop or other)
f. Other (Specify) **[Open ended]**

D2. Which of the following best describes the location of your home charging device?

a. In an attached heated garage
b. In an attached garage with no heat
c. In an unattached heated garage
d. In an unattached garage with no heat
e. Outside
f. Other (Specify) **[Open ended]**

D3. Which of the following age categories do you fall into?

a. 18-24
b. 25-34
c. 35-44
d. 45-54
e. 55-64
f. 65 or over
g. Prefer not to provide

D4. What is the last grade of school you completed?

a. Grade school or less (1-8)
b. Some high school (9-11)
c. Graduated high school (12)
d. Vocational/technical school
e. Some college (1-3 years)
f. Graduated college (4 years)
g. Post-graduate education
h. Prefer not to provide

D5. Which category best describes your gender?

a. Male
b. Female
c. Other
d. Prefer not to provide

D6. How many people occupied your home this summer 2021? Enter zero where appropriate.
[Responses are restricted to two digits]

Occupant Type	Number
D6_1. Children, under 18	**[Numeric]**
D6_2. Adults, 18 to 65	**[Numeric]**
D6_3. Adults, 65 and older	**[Numeric]**

D7. **[PIPE VLAUES FOR D7 BASED ON RESPONSE TO D6]** What was your estimated total annual household income in 2021 before taxes (in other words, your gross household income)? **[Example choices shown below are for if sum of D6 values = 1]**

a. Less than $19,600
b. $19,601 - $39,100
c. $39,101 - $45,600
d. $45,601 - $52,100
e. $52,101 - $58,700
f. $58,701 - $65,200
g. $65,201 - $71,700
h. $71,701 - $78,200
i. $78,201 - $97,800
j. $97,801 - $130,400
k. Greater than $130,400
l. Prefer not to answer

A.1.9 Closing

C1. We have reached the end of the survey. Do you have any additional comments regarding the Eversource ConnectedSolutions SmartCharge Rewards Program?

a. **[Open ended]**
b. None

C2. Thank you for taking the time to fill out this survey for the **[Display program name]**! Please provide your email address so we may email you a $10 eGift Card redeemable at a number of retailers including Amazon.com and Visa (to see your options, visit https://www.rewardsgenius.com/reward-catalog).

a. Enter email address **[Open ended]**
b. I prefer not to provide my email address

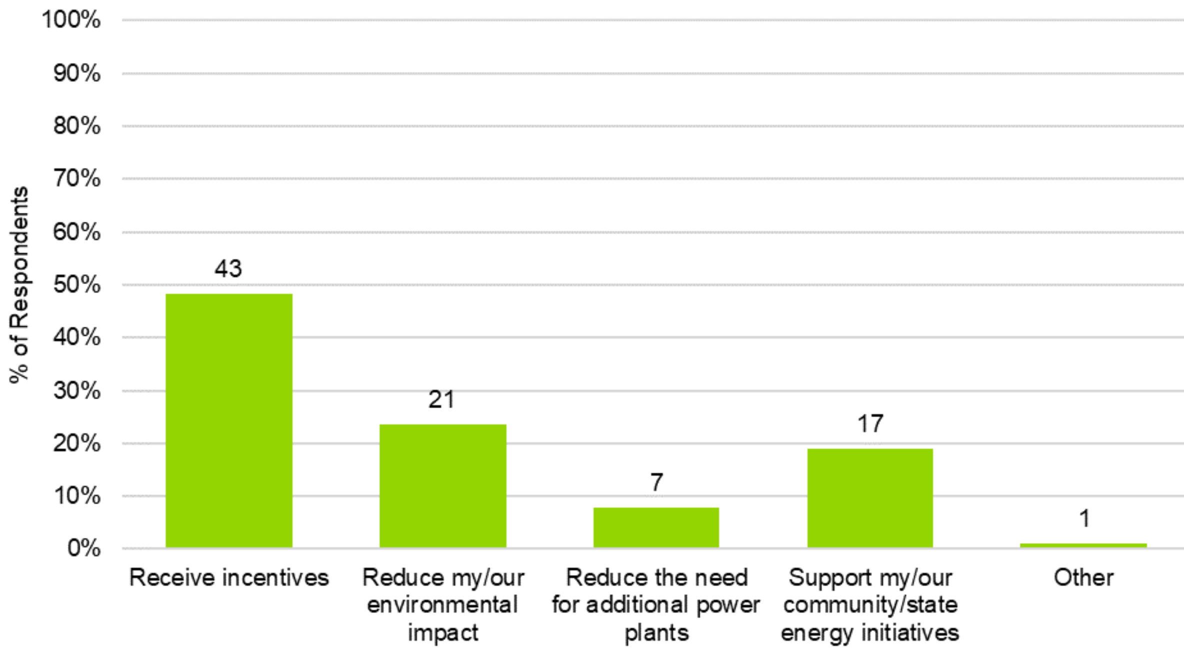
[Survey close] We thank you for your time spent taking this survey. Your response has been recorded.

Appendix B. Participant Survey Output

B.1 2021 Participant Survey Output

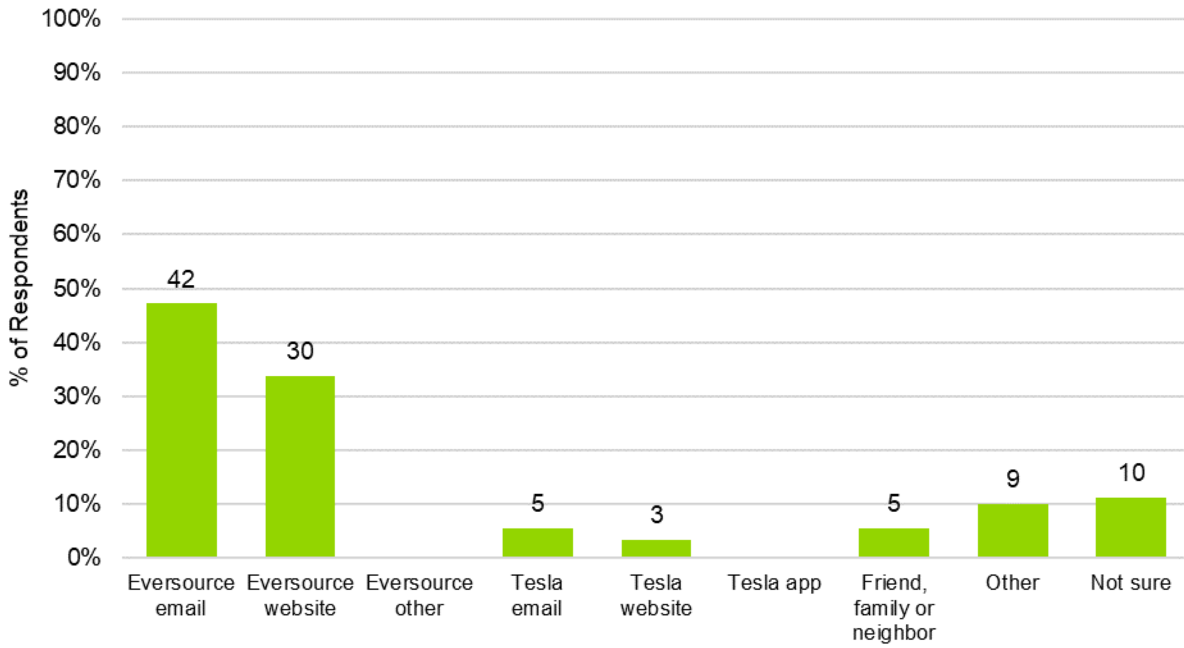
B.1.1 Motivations

M1. What was your top motivation for enrolling in Eversource's ConnectedSolutions SmartCharge Rewards Program? (n=89)



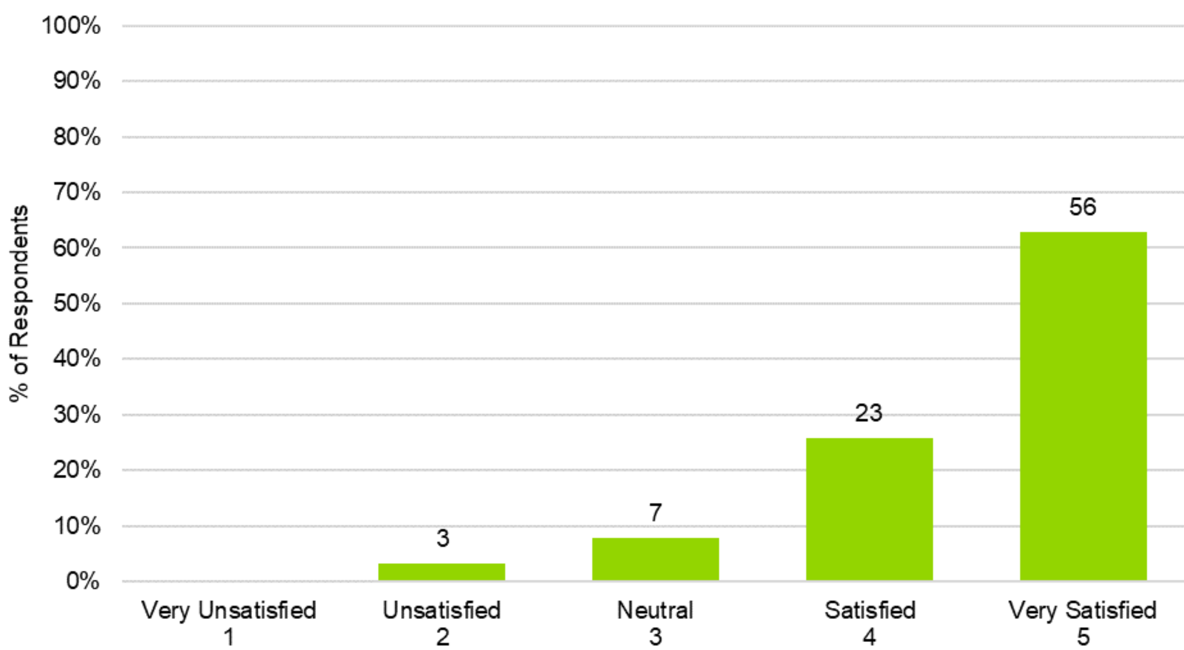
Source: Guidehouse

M2. How did you learn about Eversource's ConnectedSolutions SmartCharge Rewards Program? Select all that apply. (n=89)



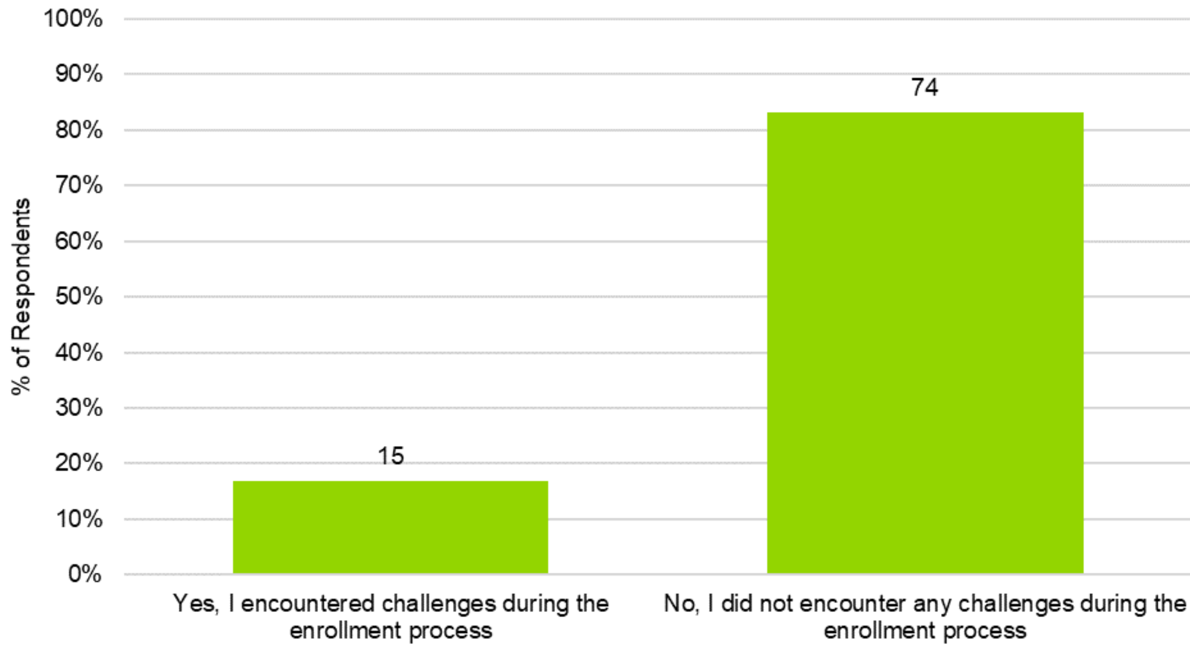
Source: Guidehouse

M3. On a scale of 1 to 5, where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the process of enrolling in the program? (n=89)



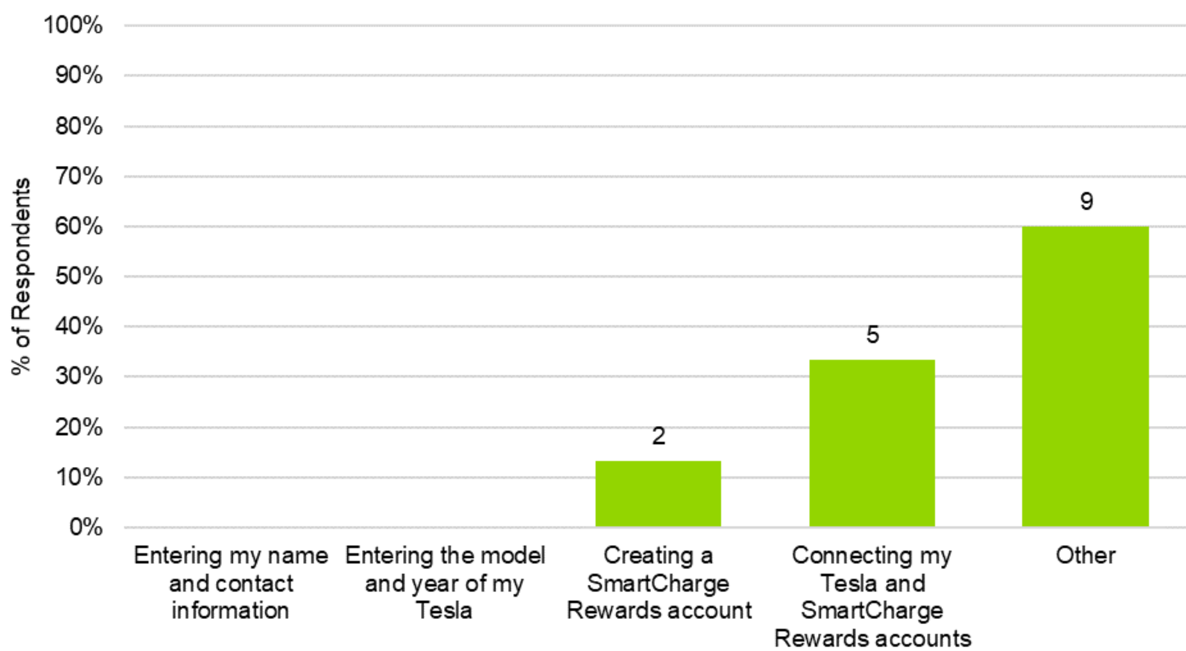
Source: Guidehouse

M4. Did you encounter any challenges or difficulties during the enrollment process? (n=89)



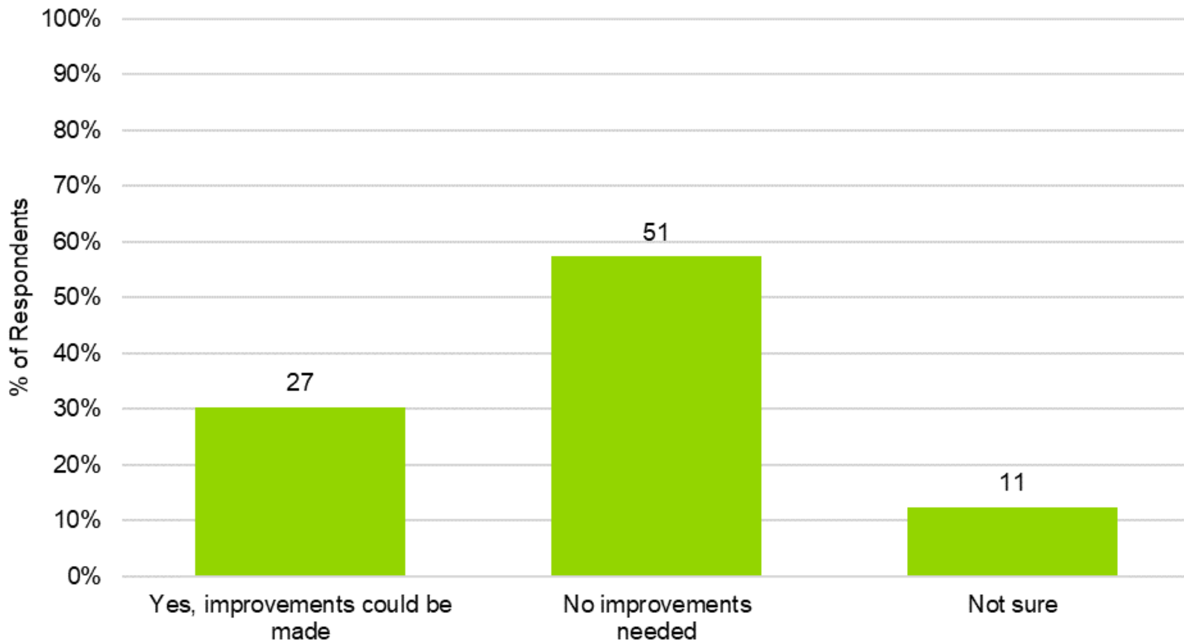
Source: Guidehouse

M5. During which enrollment step(s) did you encounter challenges or difficulties? Select all that apply. (n=15)



Source: Guidehouse

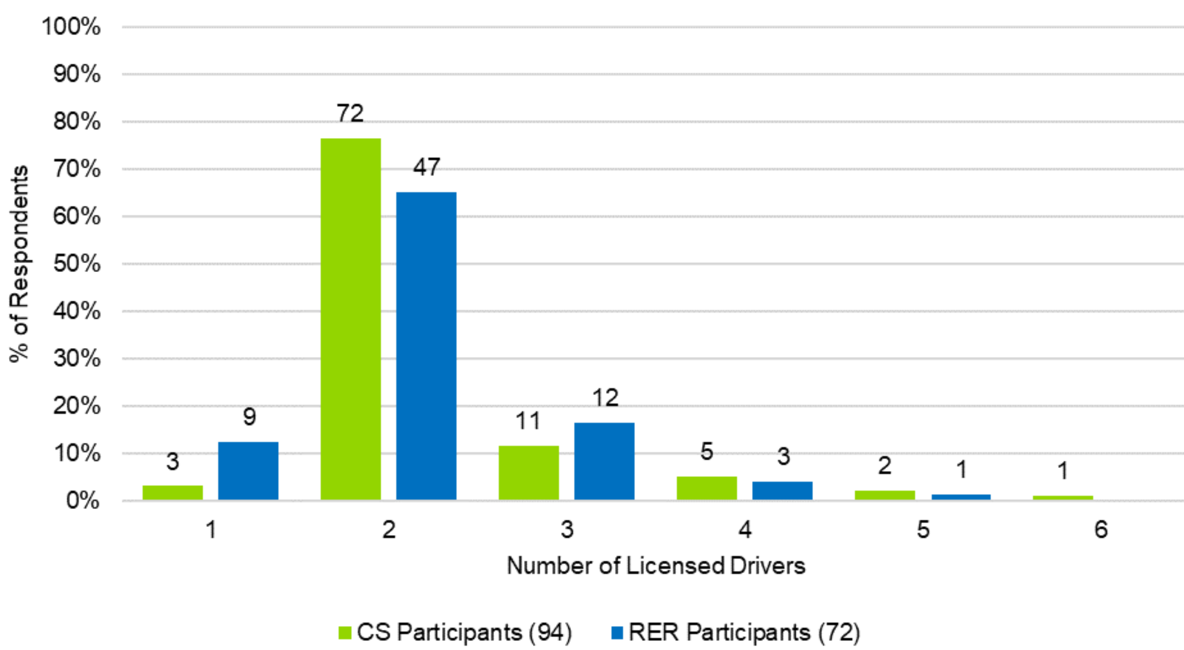
M6. How could the ConnectedSolutions SmartCharge Rewards Program enrollment process be improved? (n=89)



Source: Guidehouse

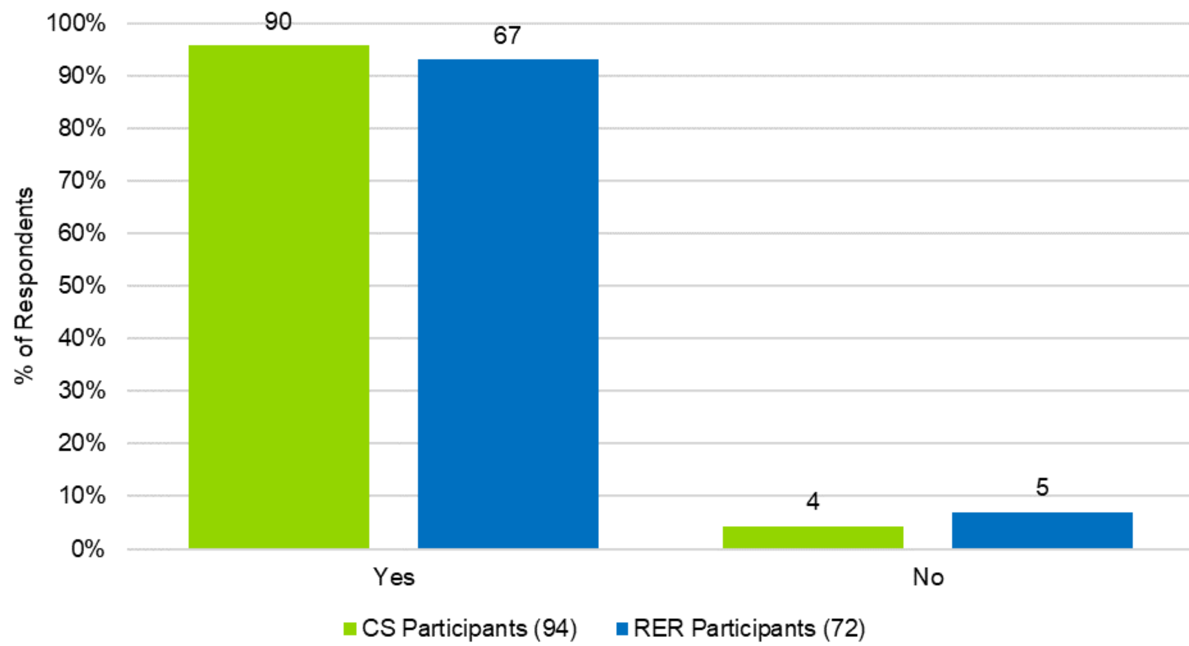
B.1.2 EV Characteristics and Driving Behavior

EV1. How many licensed drivers are there in your household? (n=166)



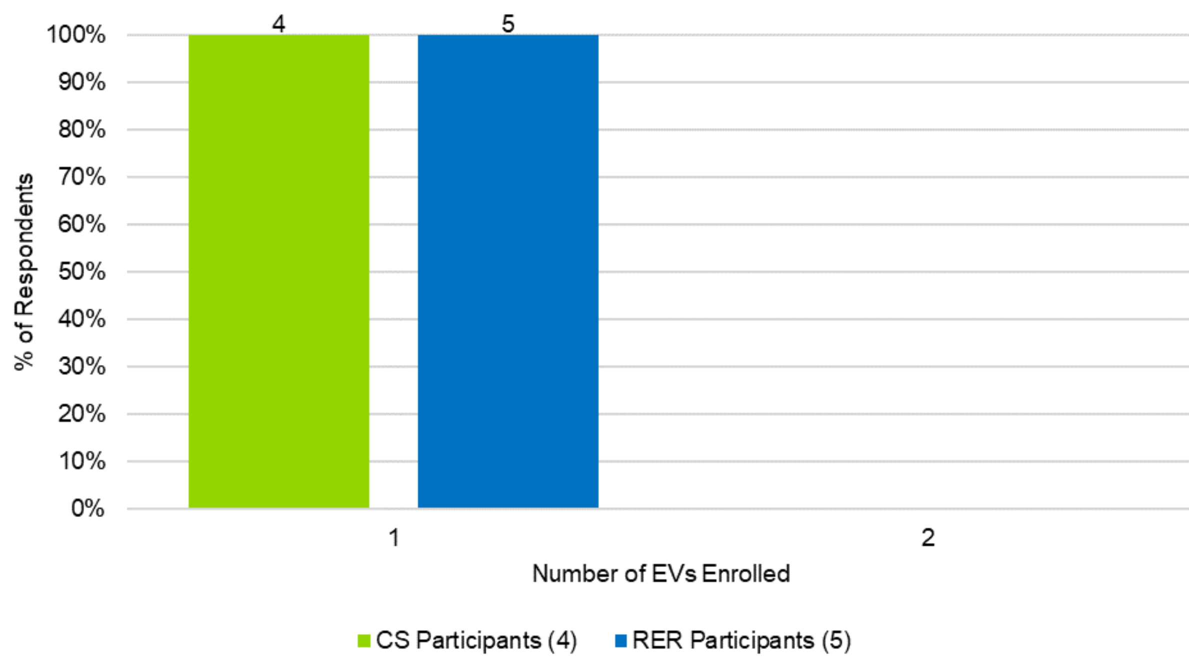
Source: Guidehouse

EV2. According to our records, you currently have the following EV(s) enrolled in **[Display program name]**. Is this accurate? (n=166)



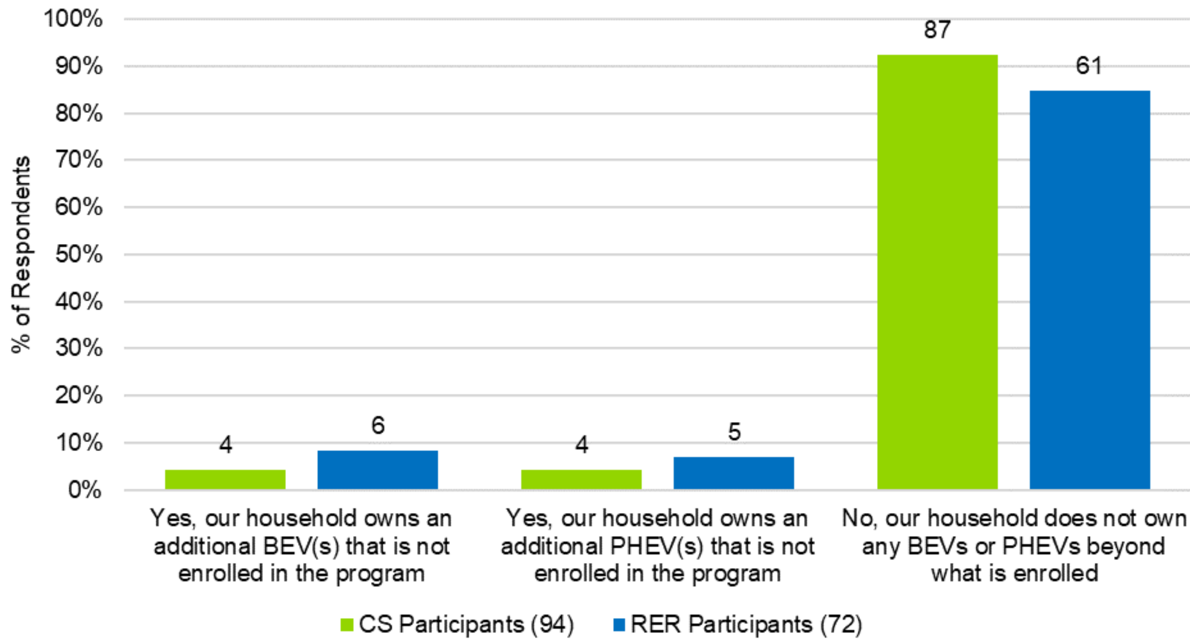
Source: Guidehouse

EV2_0. How many EVs do you have enrolled in **[Display program name]**? (n=9)



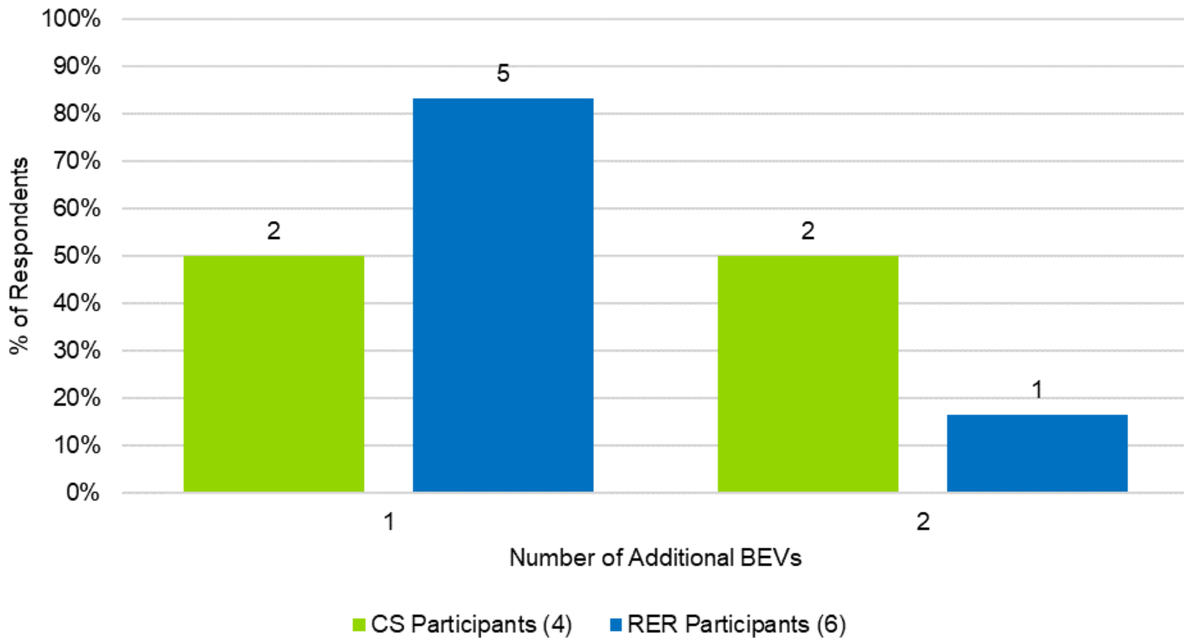
Source: Guidehouse

EV4. Does your household own any other EVs (that are not enrolled **in [Display program name]**)? (n=166)



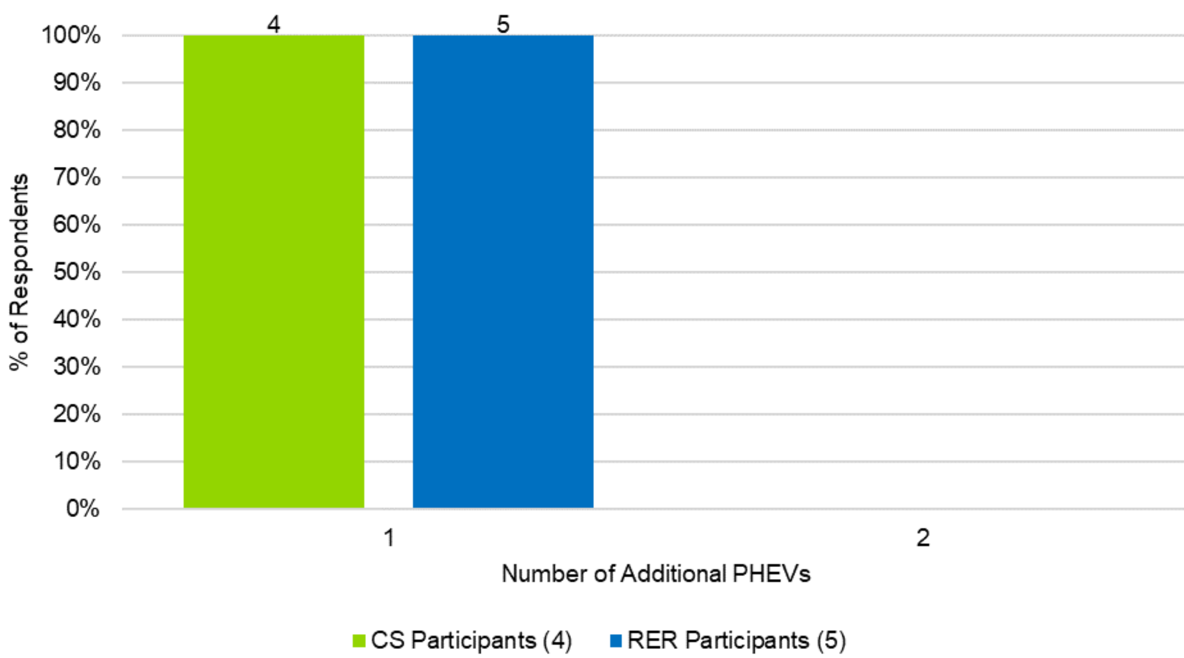
Source: Guidehouse

EV5. How many additional BEVs does your household own? (n=10)



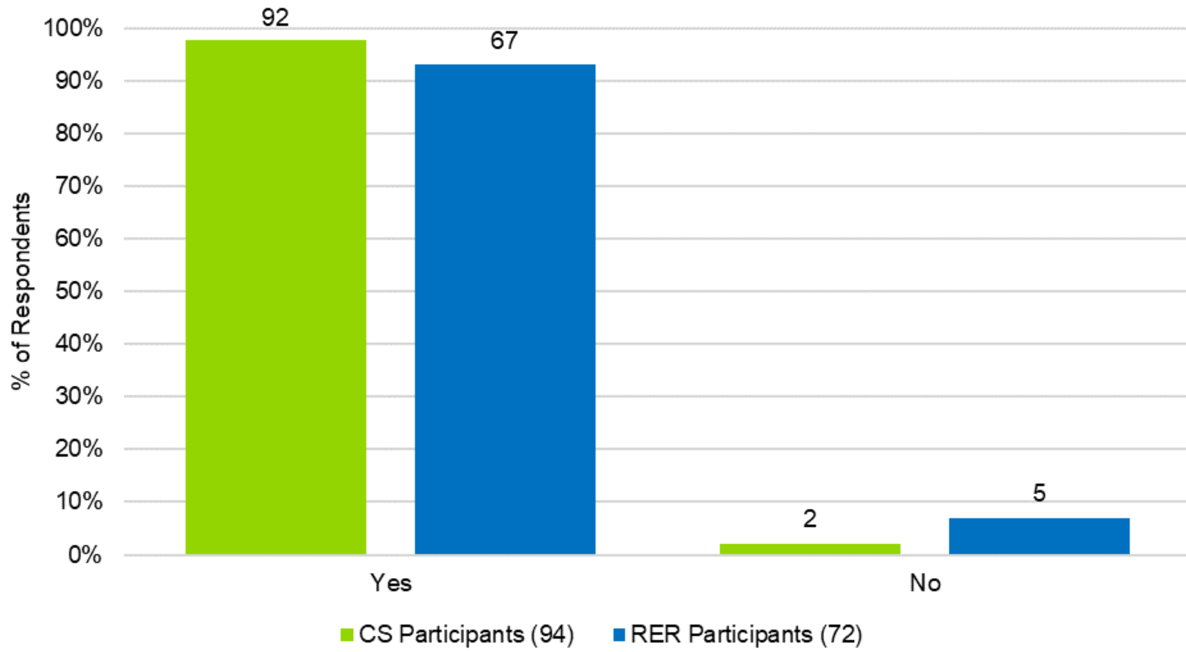
Source: Guidehouse

EV10. How many additional PHEVs does your household own (n=9)



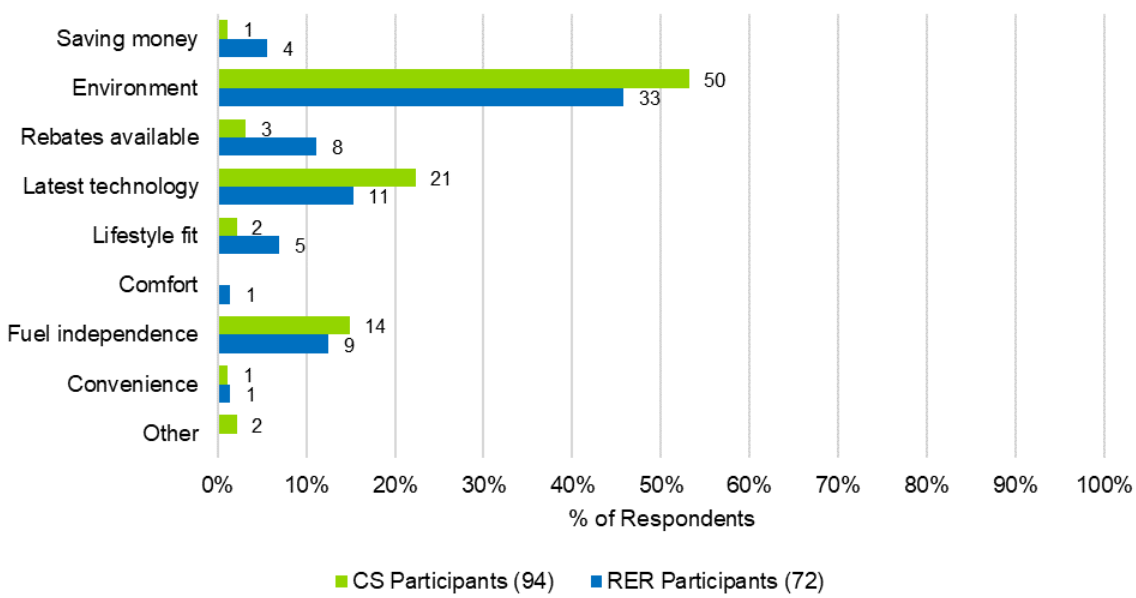
Source: Guidehouse

EV16. Did this electric vehicle serve as the primary form of transportation for at least one member of the household on weekdays during summer 2021 (June through August)? (n=166)



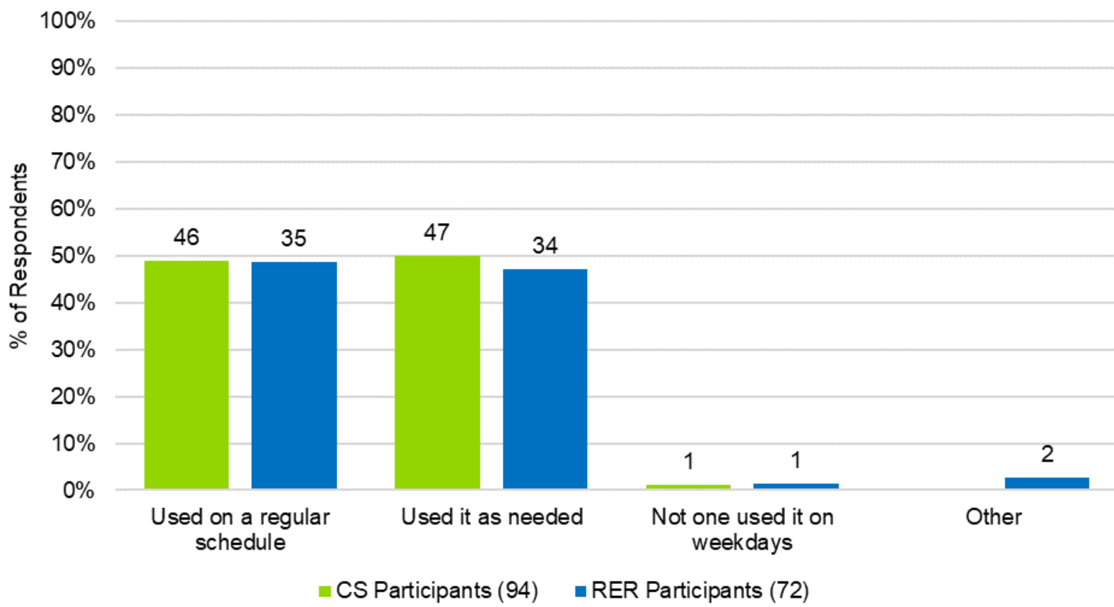
Source: Guidehouse

EV17. What was your household's top motivation for buying the electric vehicle? (n=166)



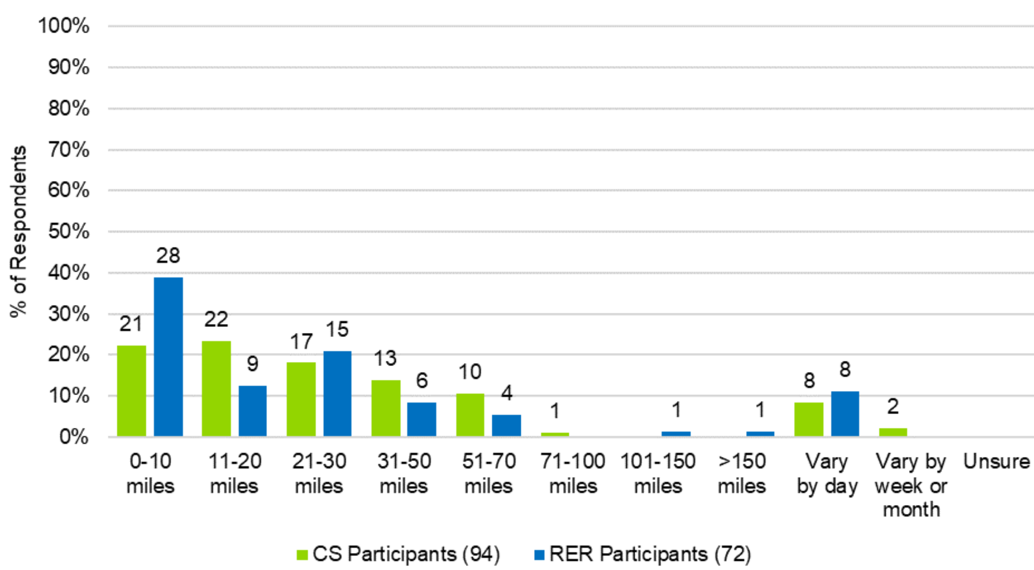
Source: Guidehouse

EV18. Which of the following best describes how your household typically used this electric vehicle on weekdays (Monday through Friday) during the summer of 2021 (June through August)? (n=166)



Source: Guidehouse

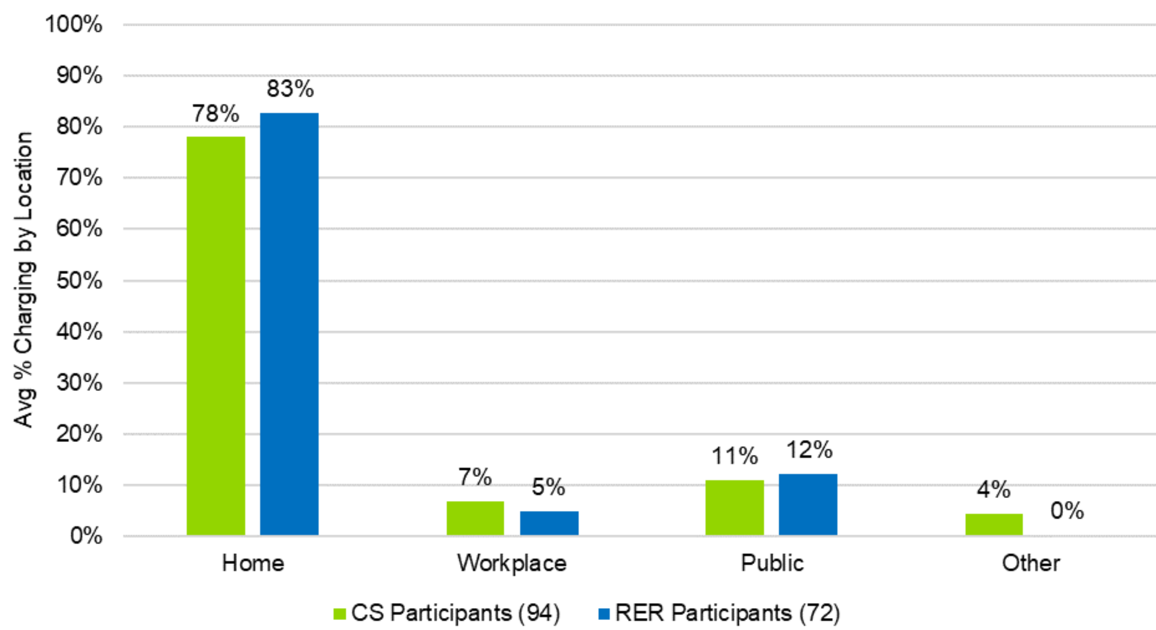
EV19. On a typical summer 2021 weekday (Monday, Tuesday, etc.), on average, how many miles was this electric vehicle driven by you and other members of your household? Don't worry about being exact – just provide your best estimate for the total miles driven on a typical summer weekday for 2021. (n=166)



Source: Guidehouse

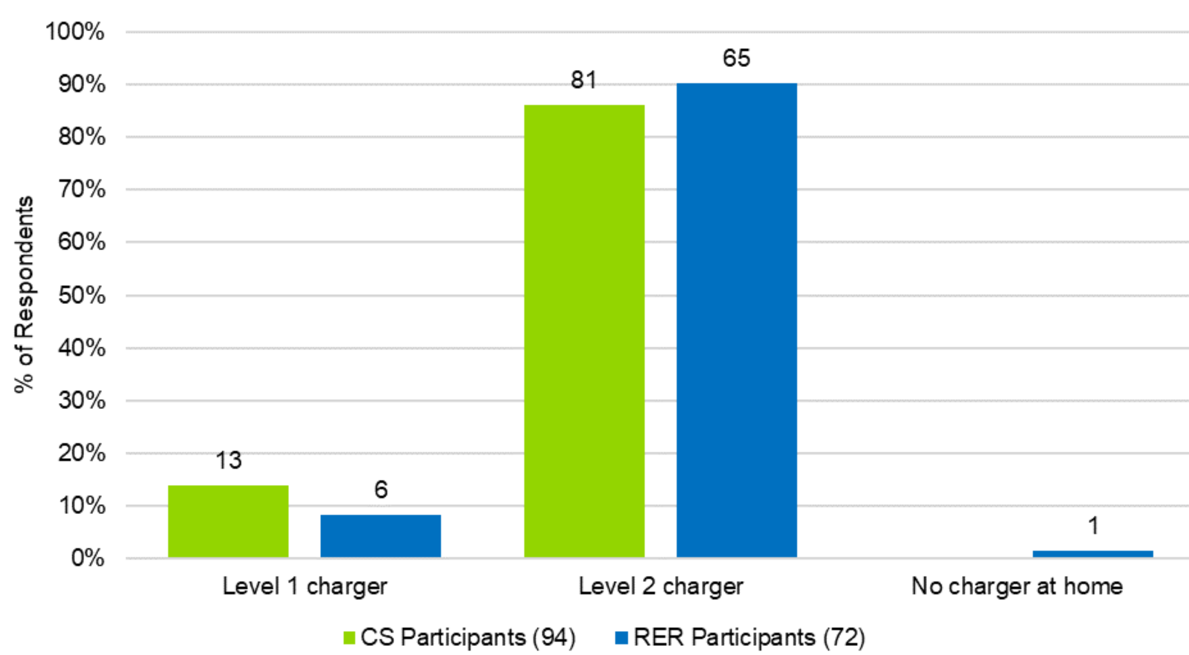
B.1.3 EVSE Characteristics and Charging Behavior

CB1. Approximately what percentage of your EV's charging this past summer took place at your home, work, public, or other charging stations? (n=166)



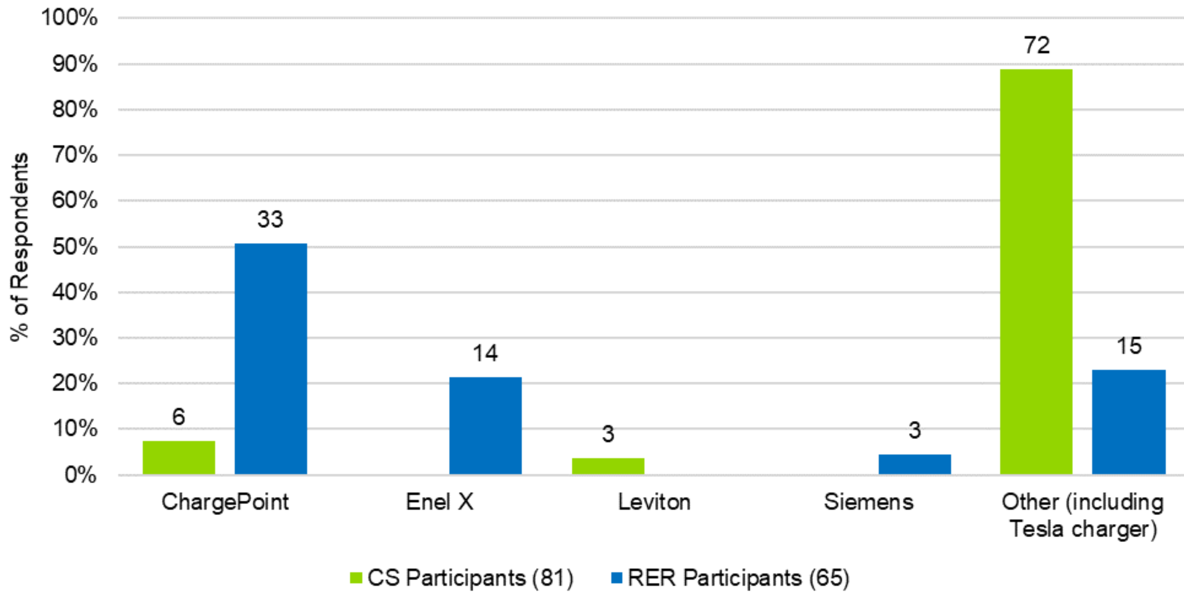
Source: Guidehouse

CB2. Which of the following best describes the electric vehicle charging device that you have at home? (n=166)



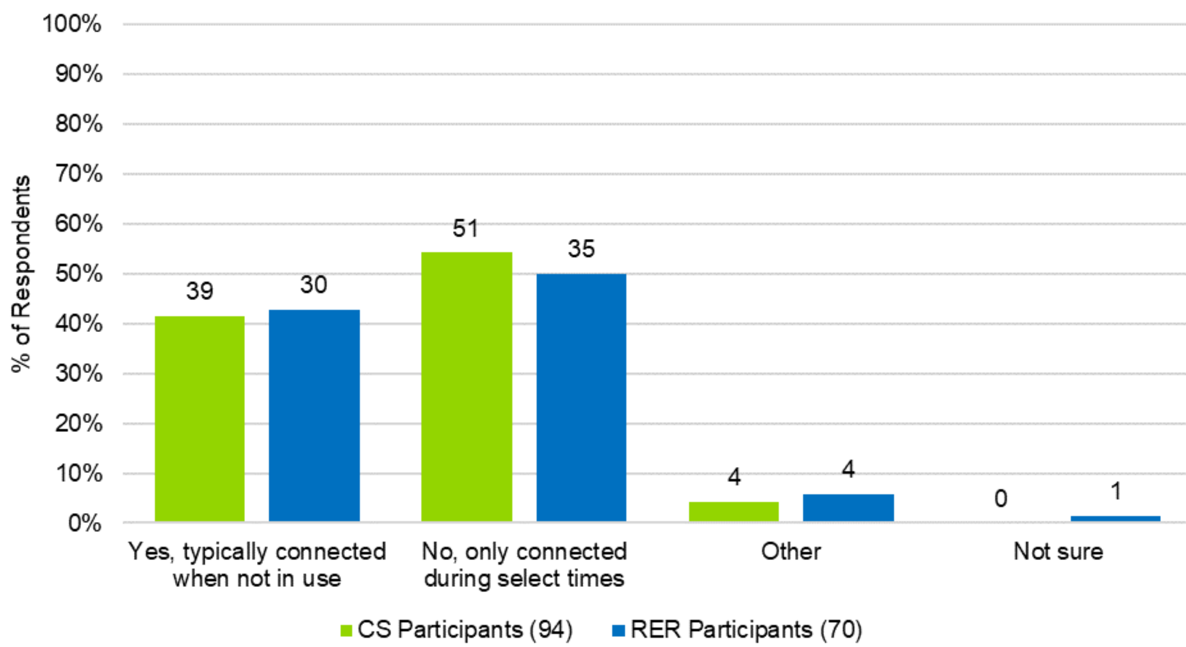
Source: Guidehouse

CB3. Please select the make of your Level 2 charger. (n=146)



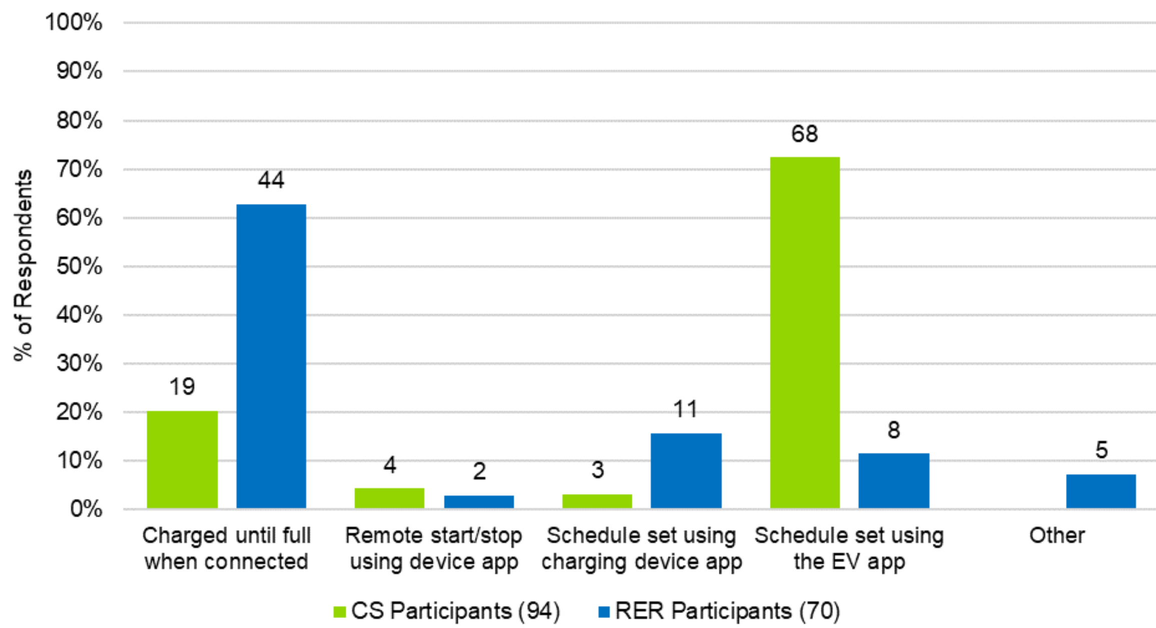
Source: Guidehouse

CB4. During summer 2021, when your electric vehicle was not being used and at home, was it typically connected to your home charging device? (n=164)



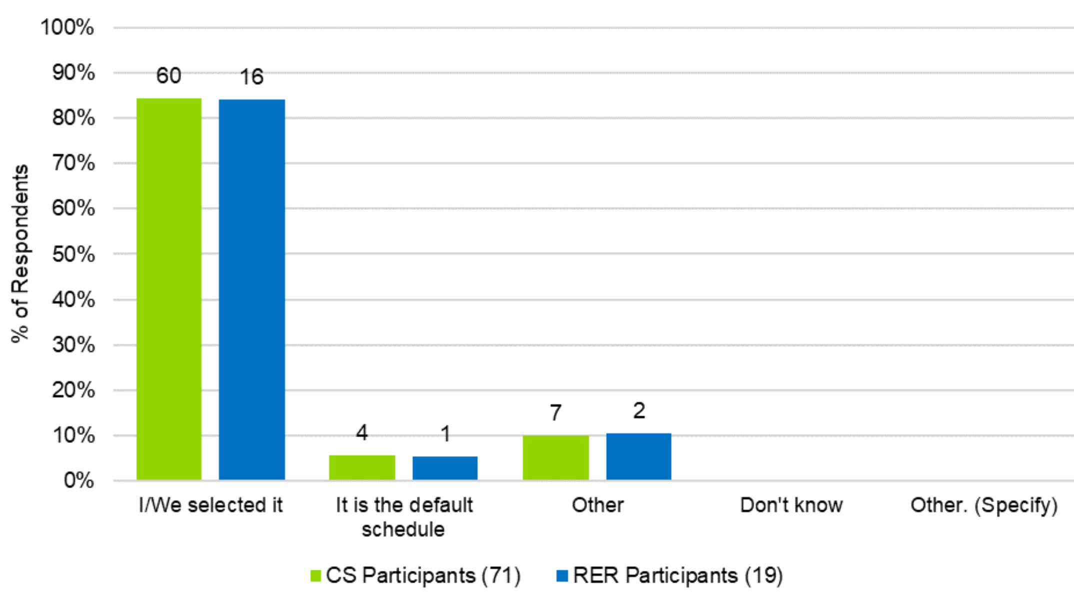
Source: Guidehouse

CB5. During summer 2021, which of the following best describes your household's use of your home charging device for your electric vehicle? (n=164)



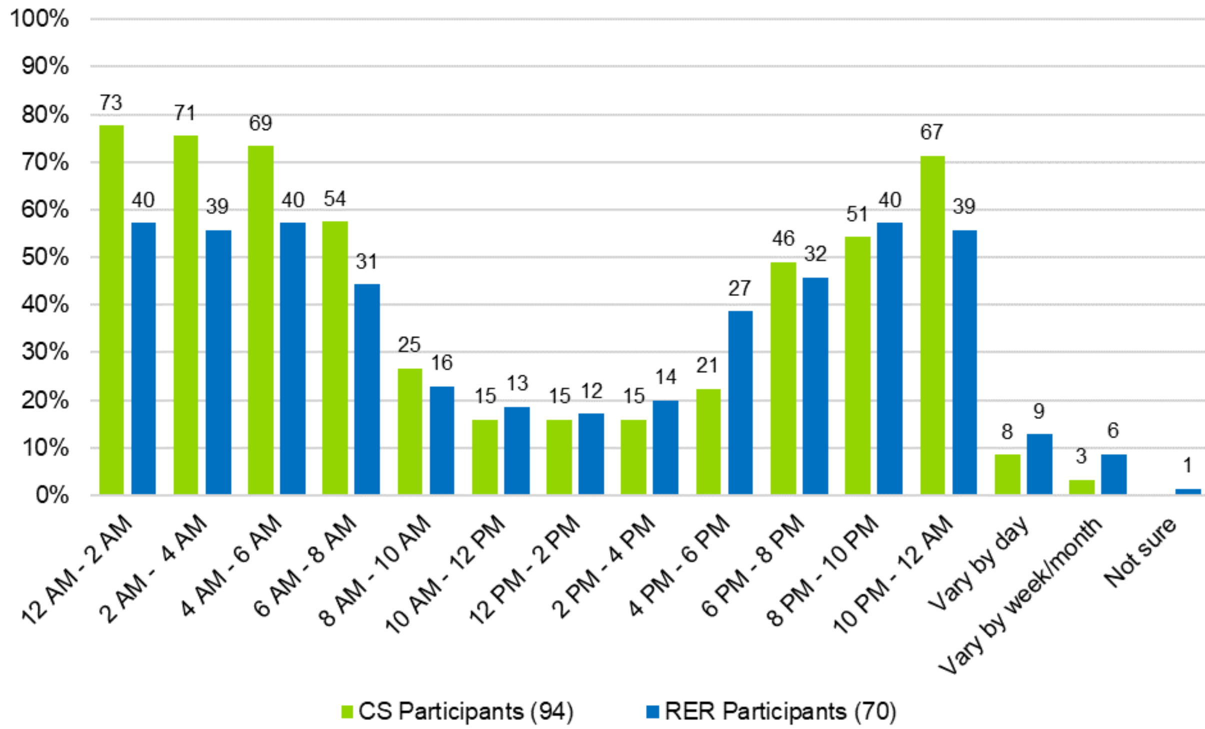
Source: Guidehouse

CB5_b. How was your electric vehicle's home charging schedule determined? (n=90)



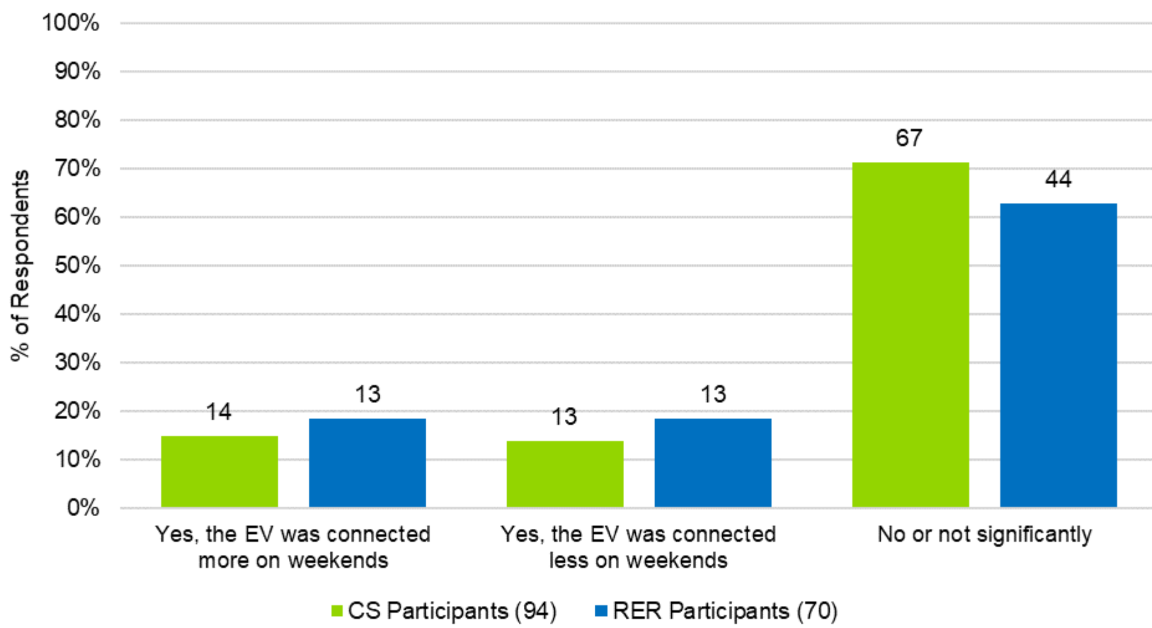
Source: Guidehouse

CB6. Indicate the time ranges during which the electric vehicle was typically connected to your home charging device on weekdays (Monday – Friday) during summer 2021 (June – August). Select all the time ranges that apply. (n=164)



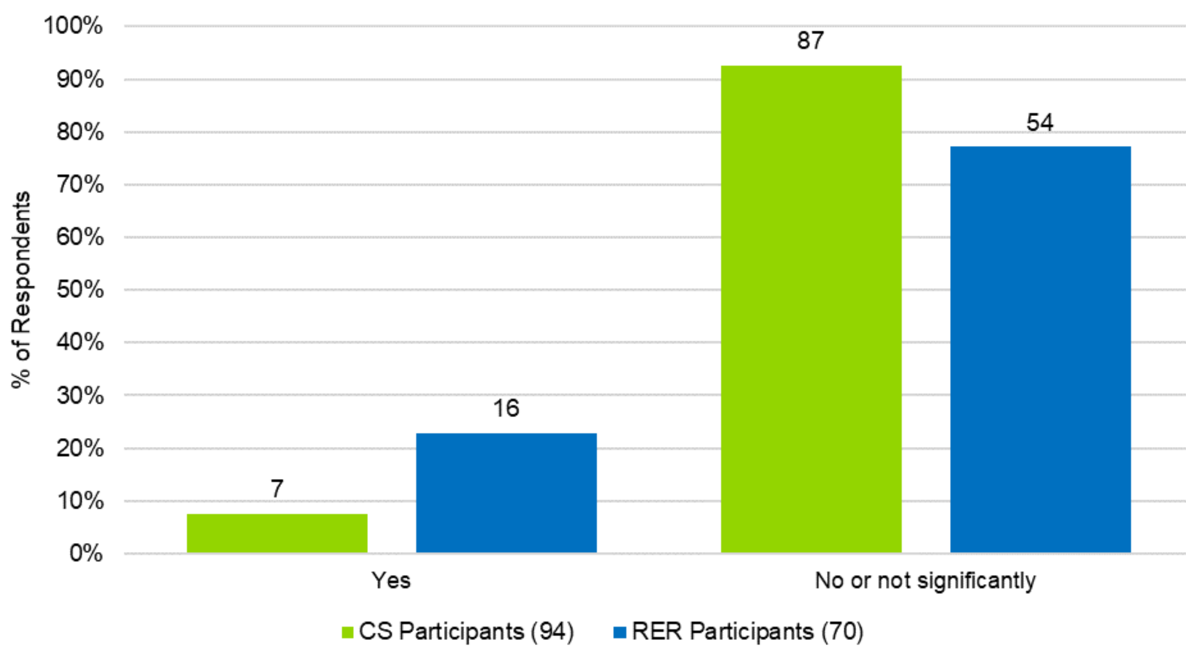
Source: Guidehouse

CB9. Compared to your household's use of your home charging device on weekdays, was the amount of time this electric vehicle was typically connected to your home charging device in summer 2021 different on weekends? (n=164)



Source: Guidehouse

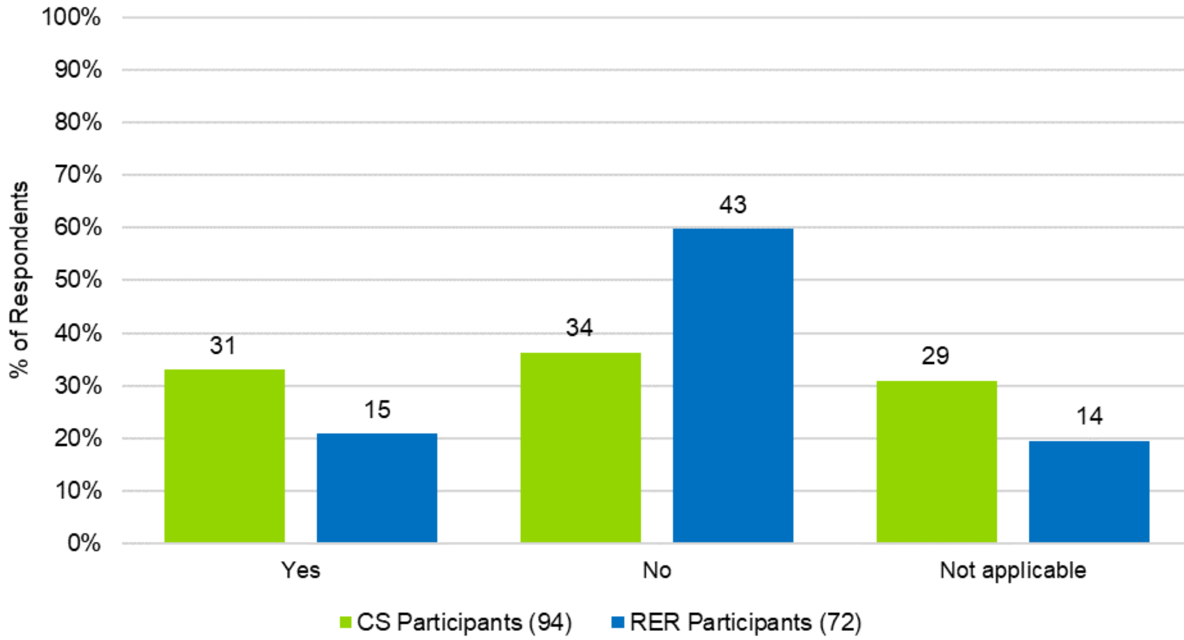
CB10. Compared to your household's use of your home charging device on weekdays, was the timing of when this electric vehicle was typically connected to your home charging device in summer 2021 different on weekends? (n=164)



Source: Guidehouse

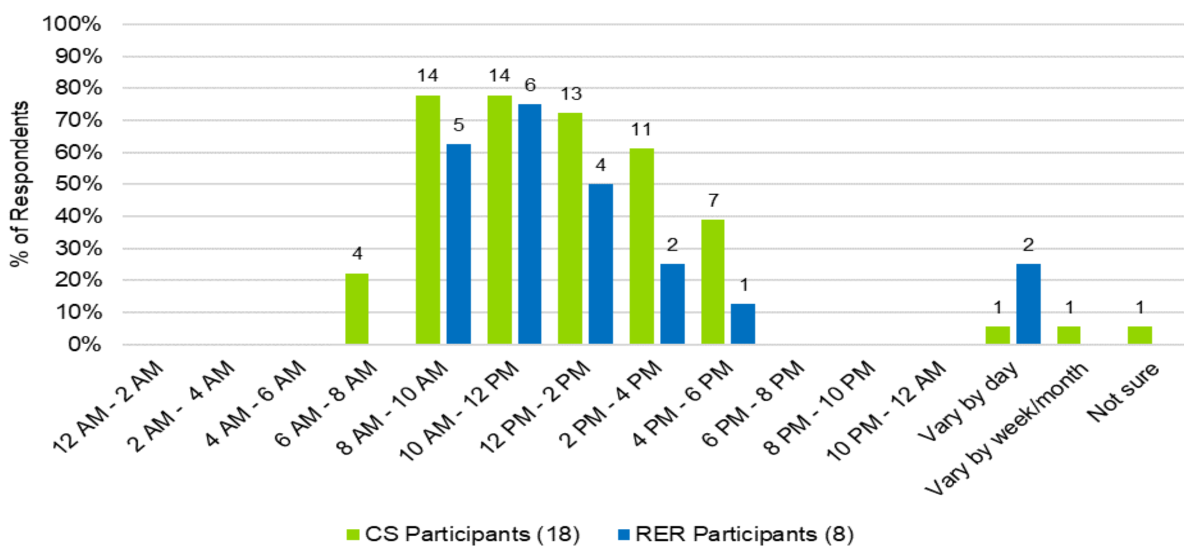
CB11. Is this electric vehicle driven to a workplace that has workplace charging available?

Answer this question based on whether or not charging is available at a workplace, regardless of whether you or other household members go into work regularly and/or use it. (n=166)



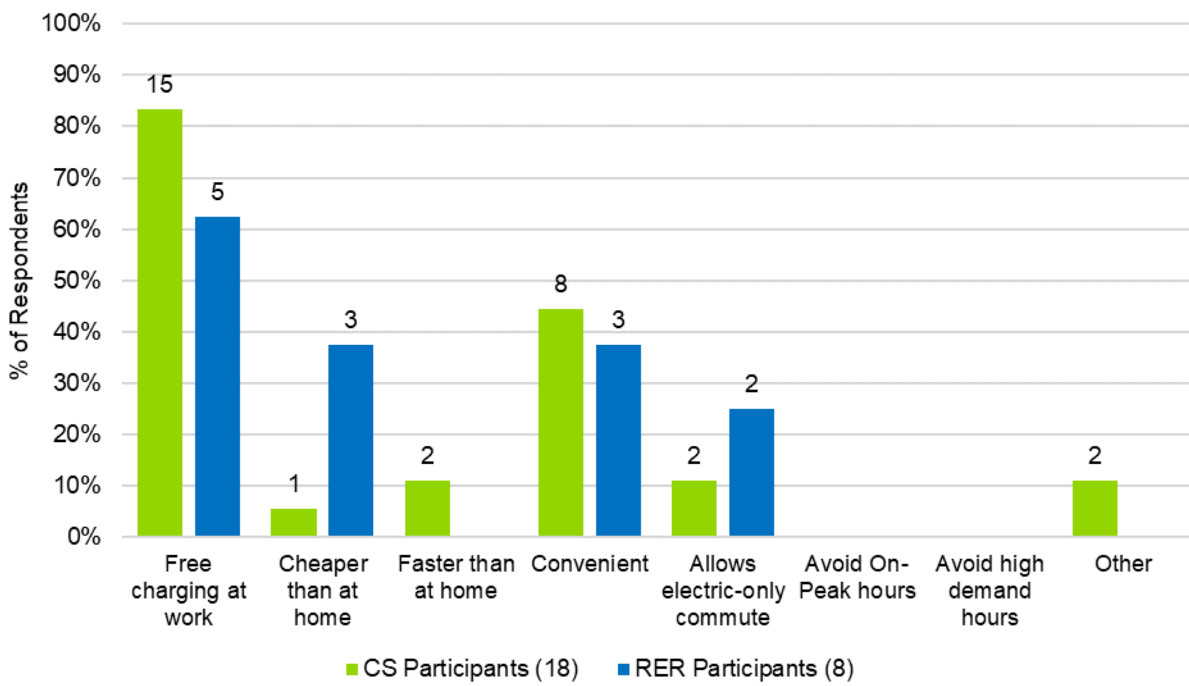
Source: Guidehouse

CB13. Below, please indicate when this electric vehicle was typically connected to a workplace charging station on weekdays (Monday – Friday) during the summer 2021 (June – August). Select all the time ranges that apply. (n=26)



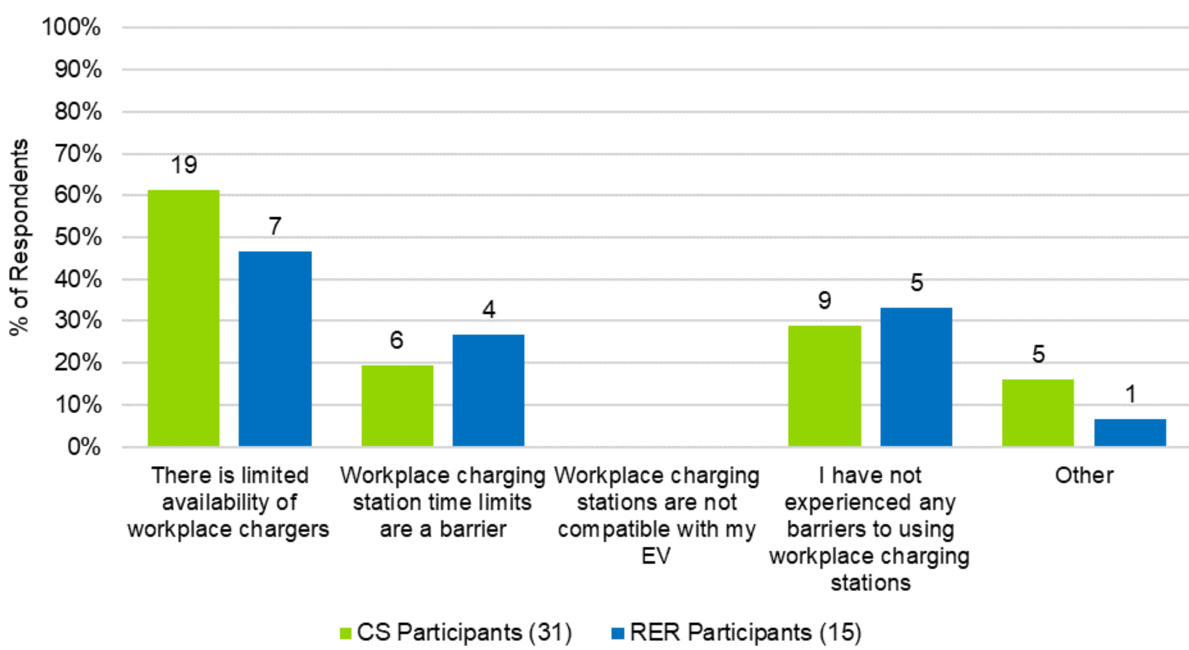
Source: Guidehouse

CB14. What are your main motivations for using workplace charging stations? Select all that apply. (n=26)



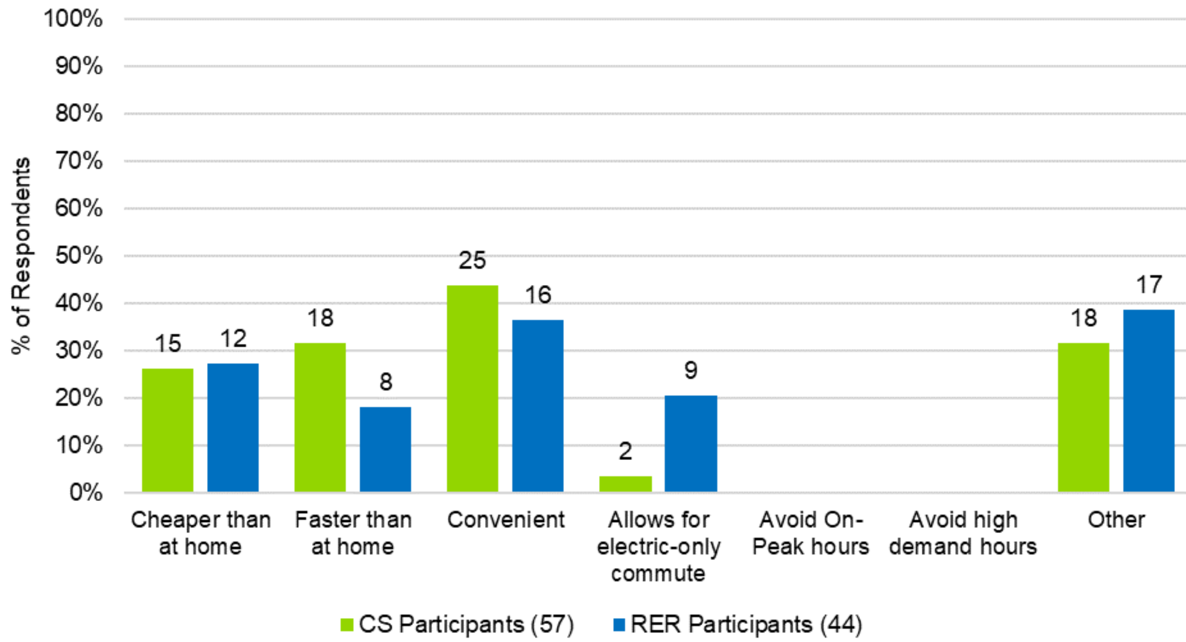
Source: Guidehouse

CB15. Are there are any barriers for you or your household members to use workplace charging stations to charge this electric vehicle? Select all that apply. (n=46)



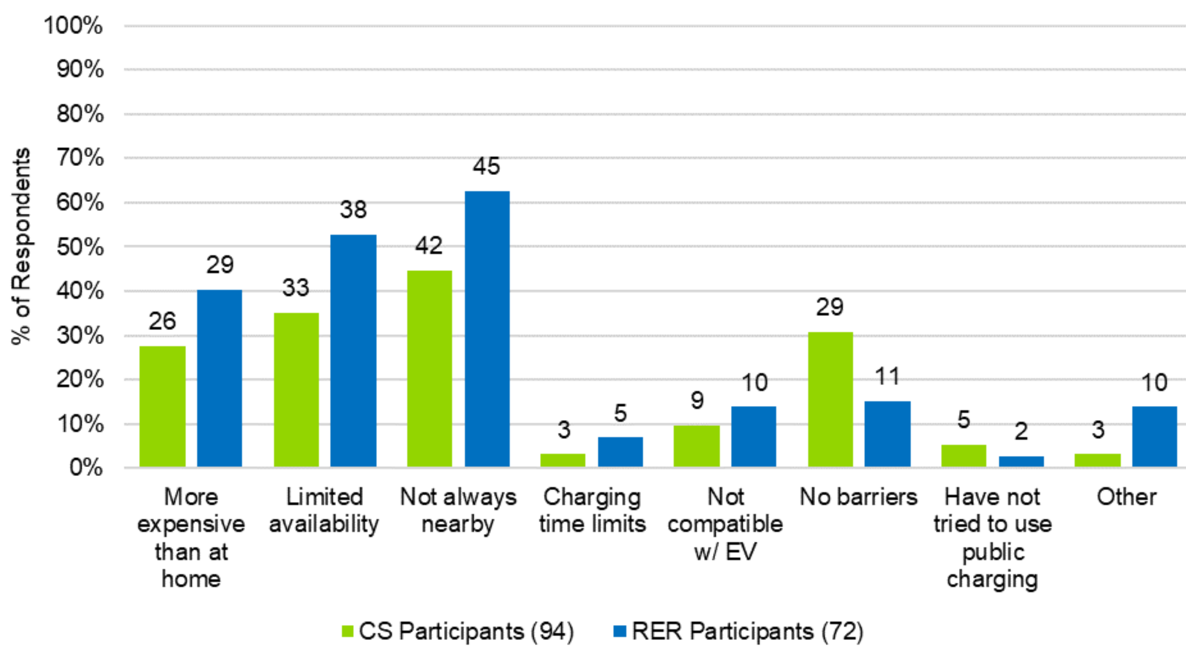
Source: Guidehouse

CB16. What are your main motivations for using ***public charging stations***? Select all that apply. (n=101)



Source: Guidehouse

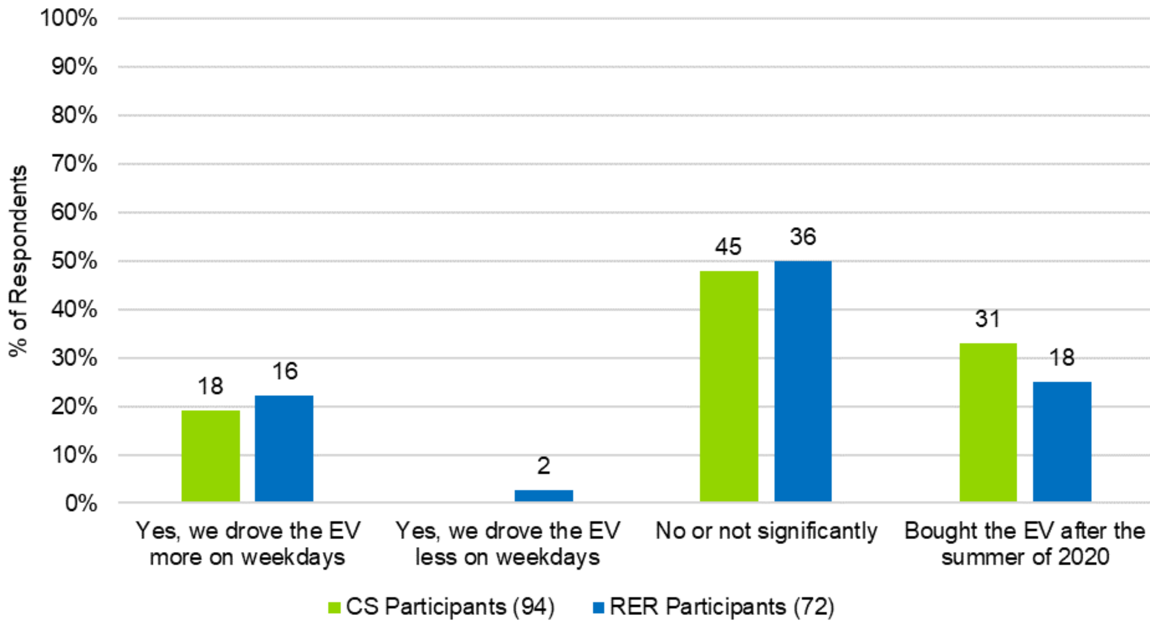
CB17. Are there are any barriers for you or your household members to use **public charging stations** to charge this electric vehicle? Select all that apply. (n=166)



Source: Guidehouse

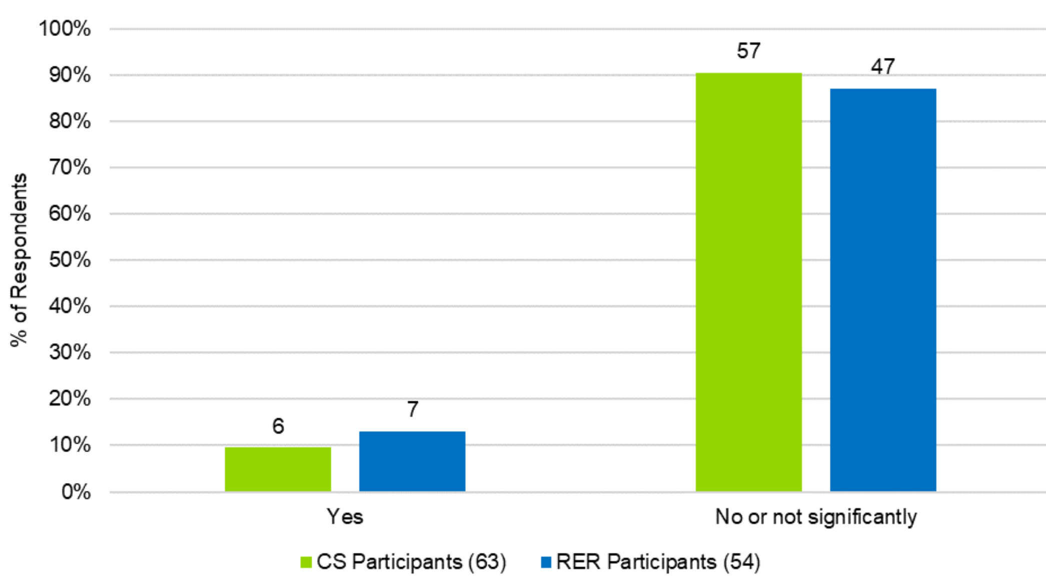
B.1.4 Changes Since Summer 2020

CS1. Compared to your household's use of your electric vehicle in the summer 2020, did the typical ***miles per day*** that this electric vehicle was driven on weekdays change in summer 2021? (n=166)



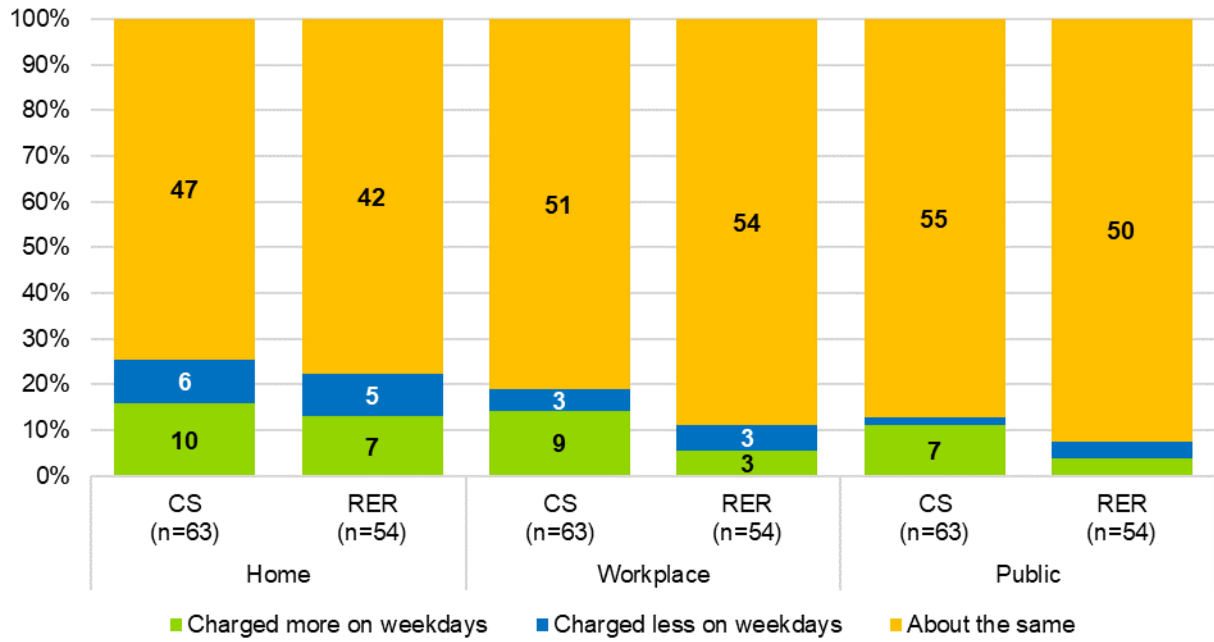
Source: Guidehouse

CS2. Compared to your household's use of this electric vehicle in the summer of 2020, did the ***timing*** of when this electric vehicle was typically driven on weekdays change in summer 2021? (n=117)



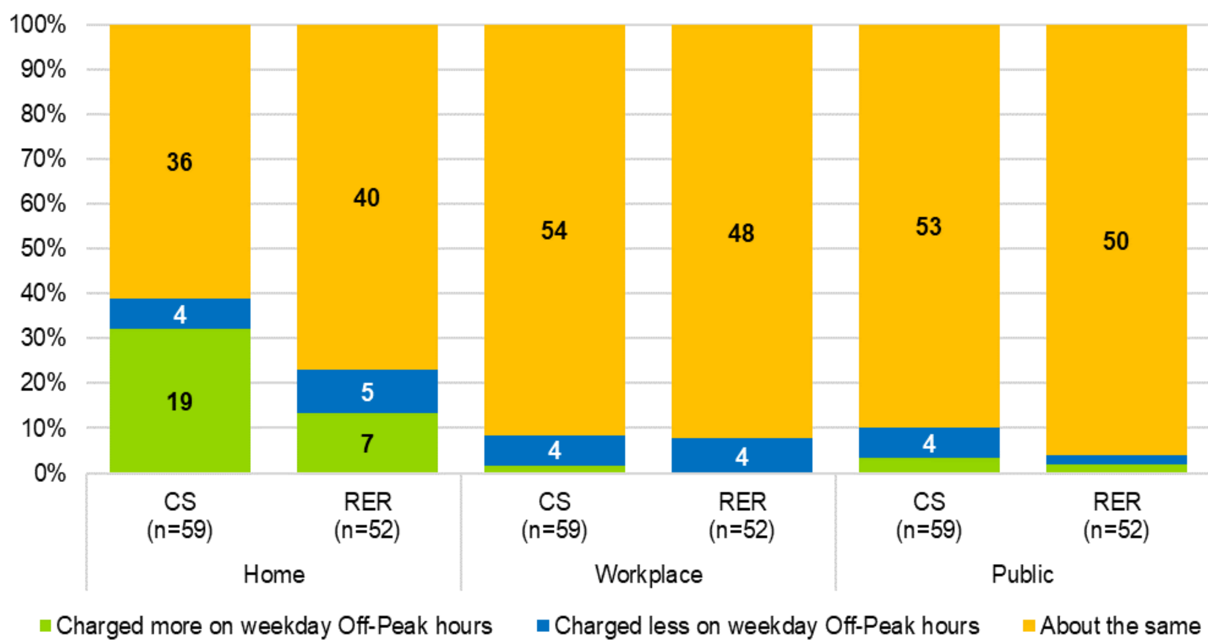
Source: Guidehouse

CS3. Compared to the summer of 2020, was this EV typically charging more, less, or the same amount ***on weekdays*** in summer 2021? Indicate how this varied by charging location. (n=117)



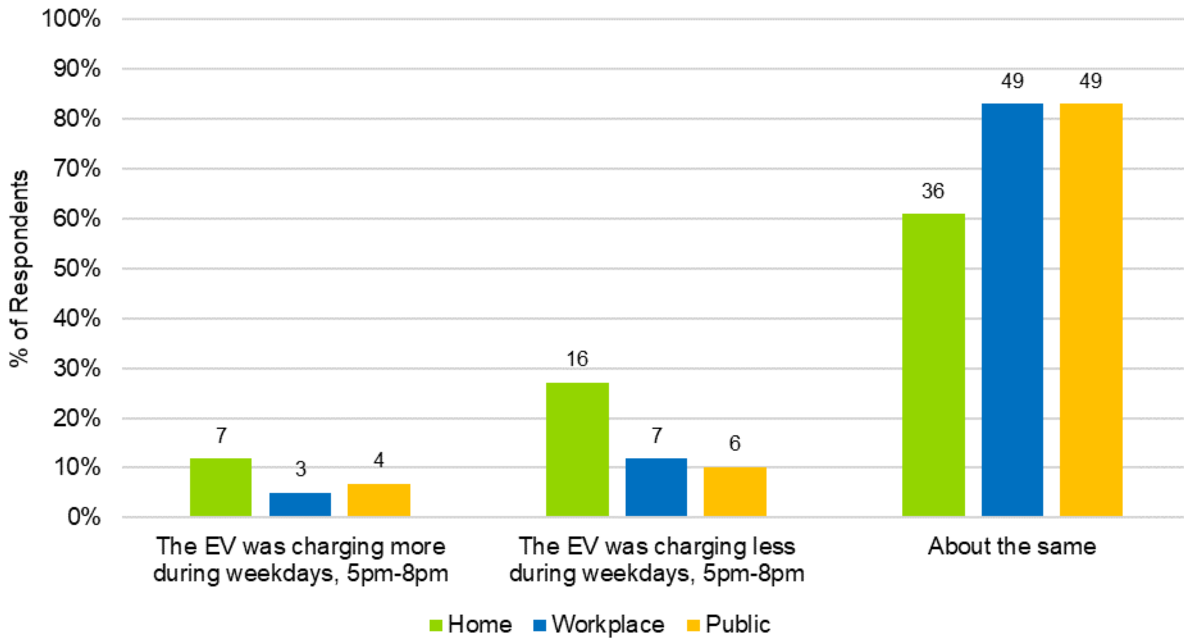
Source: Guidehouse

CS5. Compared to the summer of 2020, was this EV typically charging more, less, or the same amount in summer 2021 during the weekday hours of 11 PM to 7 AM ("Off-Peak" hours) relative to other hours? Please indicate how this varied by charging location. (n=111)



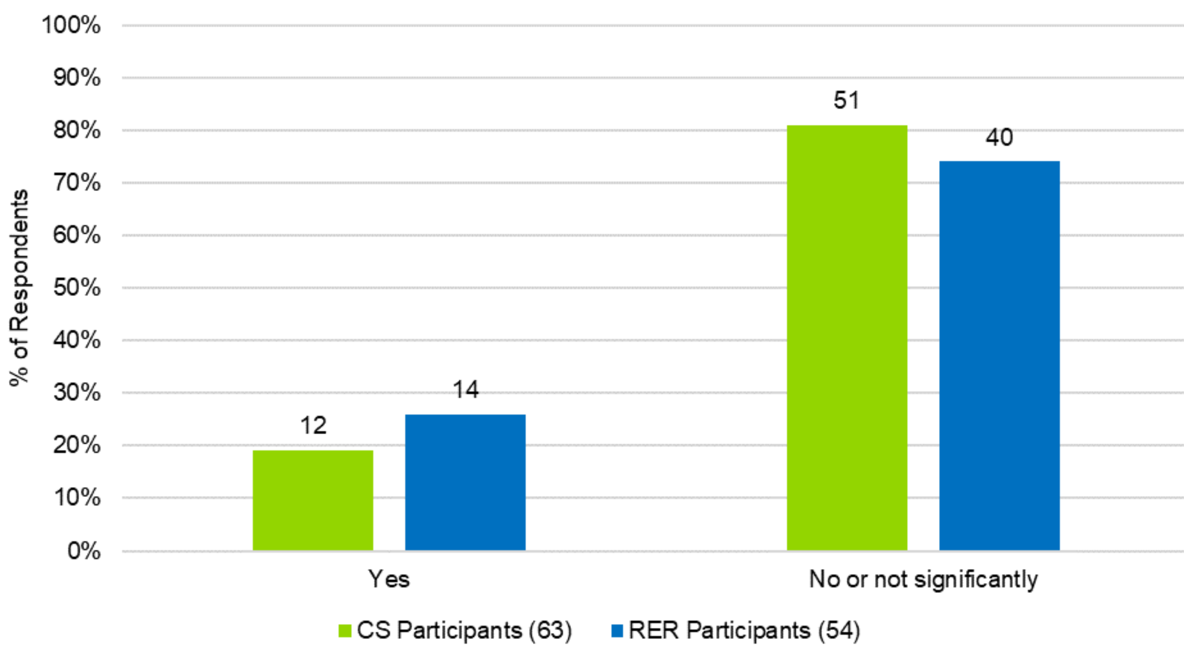
Source: Guidehouse

CS6. Compared to the summer of 2020, was this EV typically charging more, less, or the same amount in summer 2021 ***during the weekday hours of 5 PM – 8 PM*** ("On-Peak" hours) relative to other hours? Please indicate how this varied by charging location. (n=59)



Source: Guidehouse

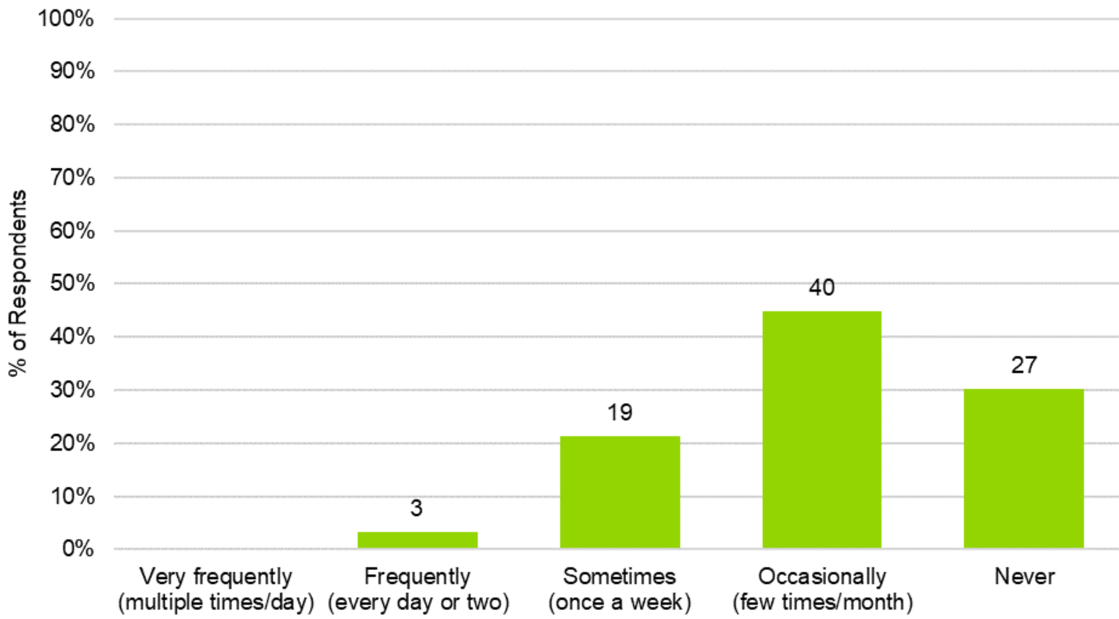
CS7. What, if any, additional observations do you have to share related to how your household's use of this electric vehicle and/or charging stations changed between summer 2020 and summer 2021? (n=117)



Source: Guidehouse

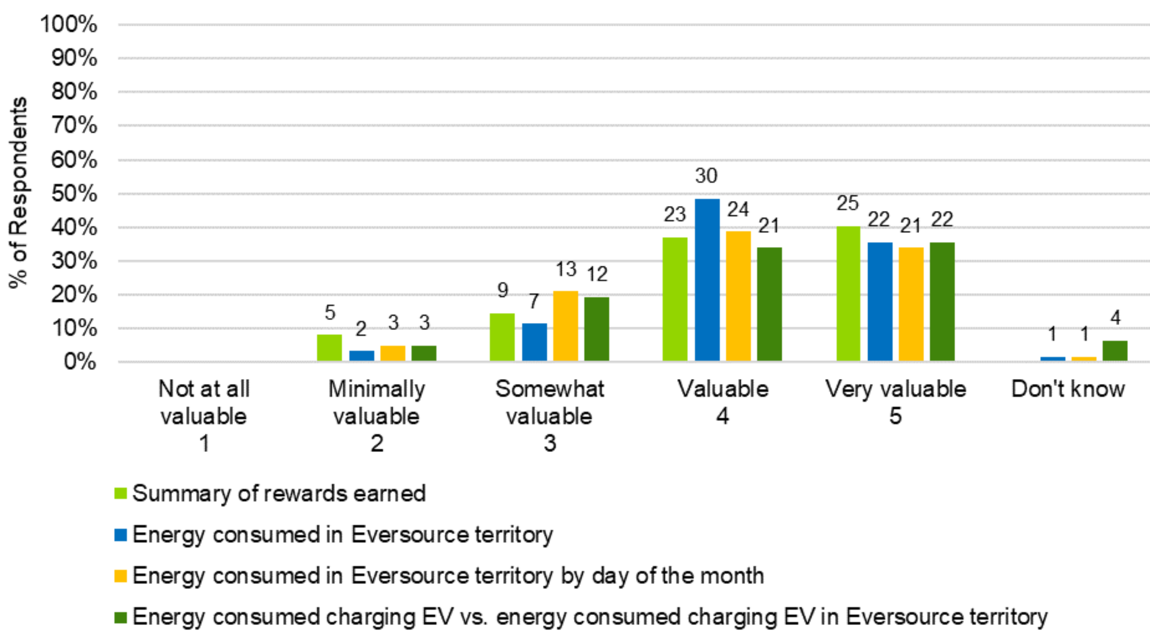
B.1.5 Program Influences

I1. Which of the following best describes how often you view the SmartCharge Rewards Portal provided by Geotab (FleetCarma)? (n=89)



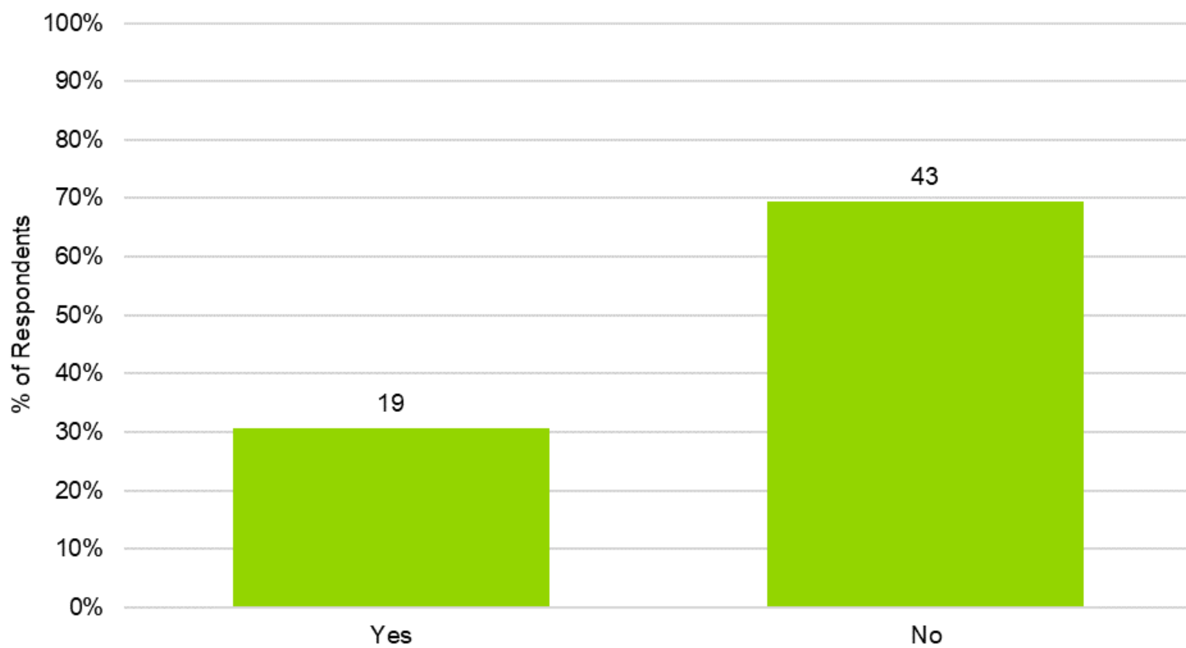
Source: Guidehouse

I2. On a scale of 1 to 5, where 1 is "Not at all valuable" and 5 is "Very valuable", how valuable is the following information provided on the portal? (n=62)



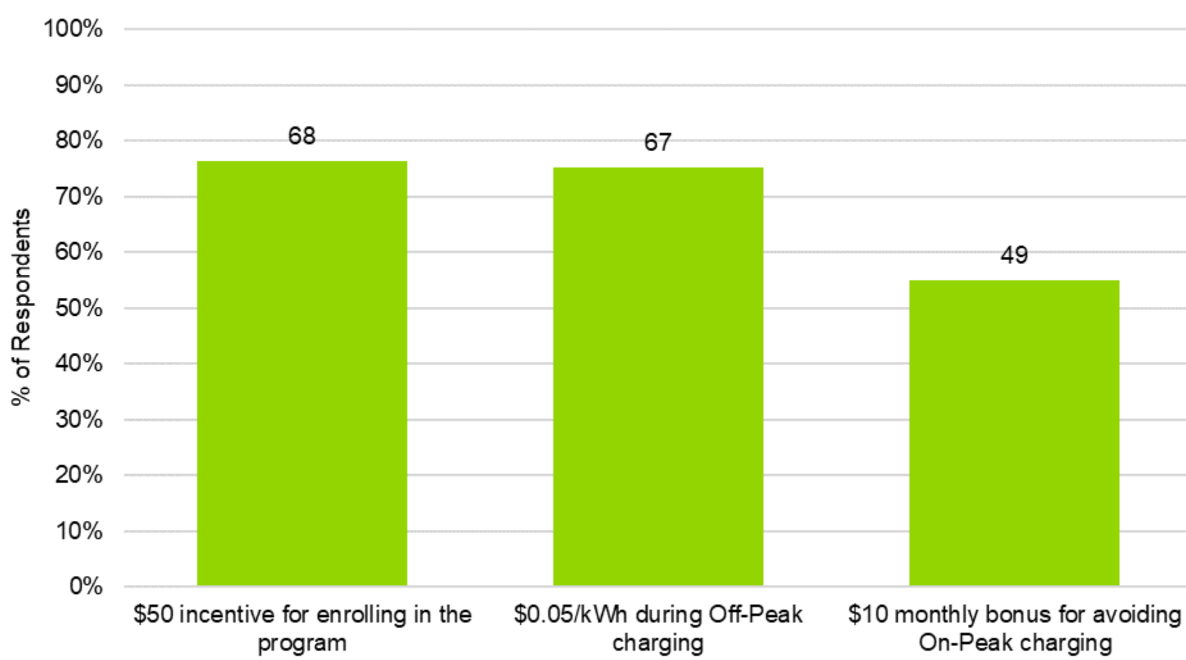
Source: Guidehouse

I4. Are there ways that the information provided on the SmartCharge Rewards portal could be improved? (n=62)



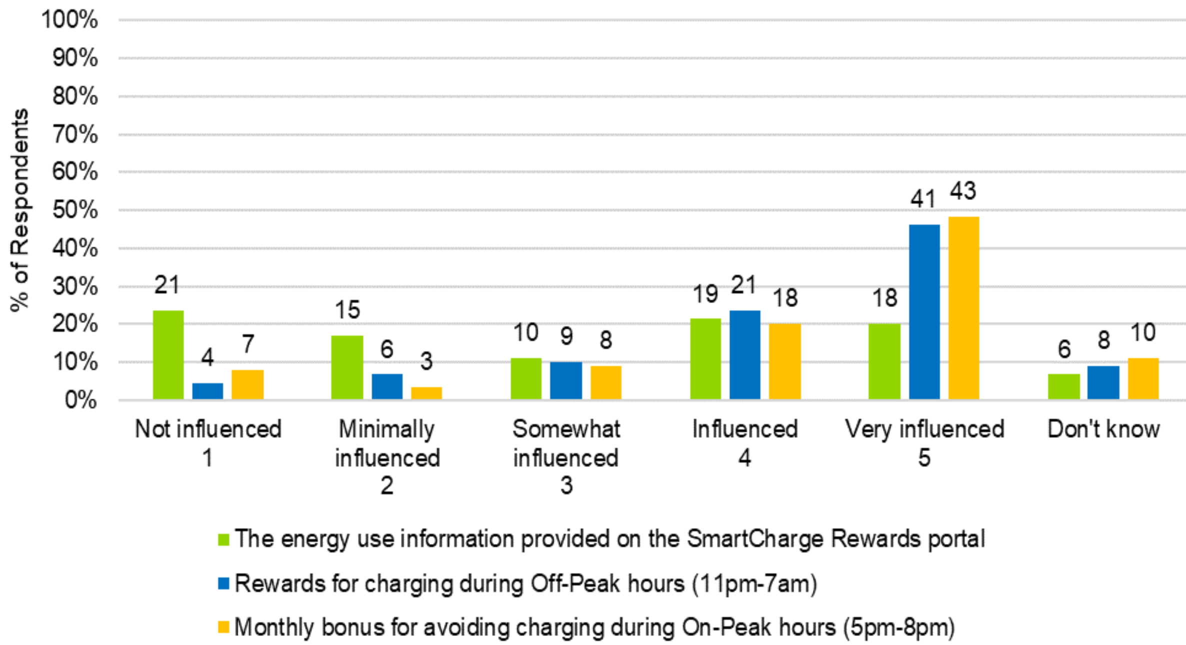
Source: Guidehouse

I5. Which of the following program incentives did you receive in the summer of 2021? Select all that you earned or benefited from at least once. (n=89)



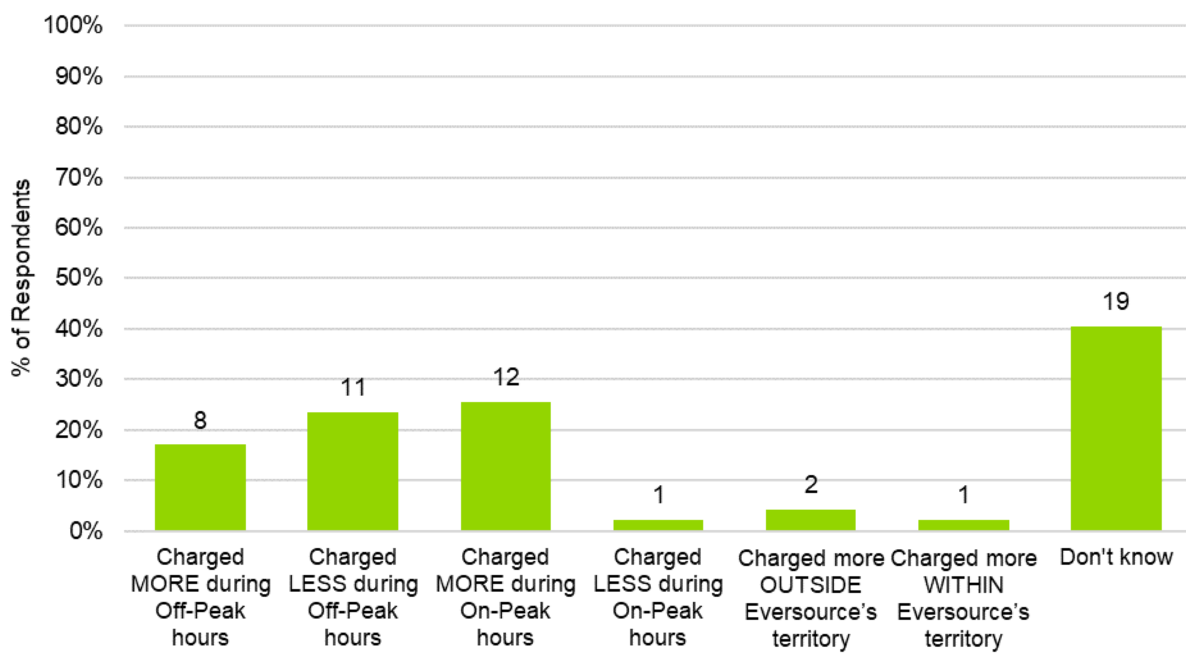
Source: Guidehouse

I6. On a scale of 1 to 5, where 1 is “Not influenced at all” and 5 is “Very influenced”, how influenced was your EV’s charging schedule in summer 2021 by the following aspects of Eversource’s ConnectedSolutions SmartCharge Rewards Program? (n=89)



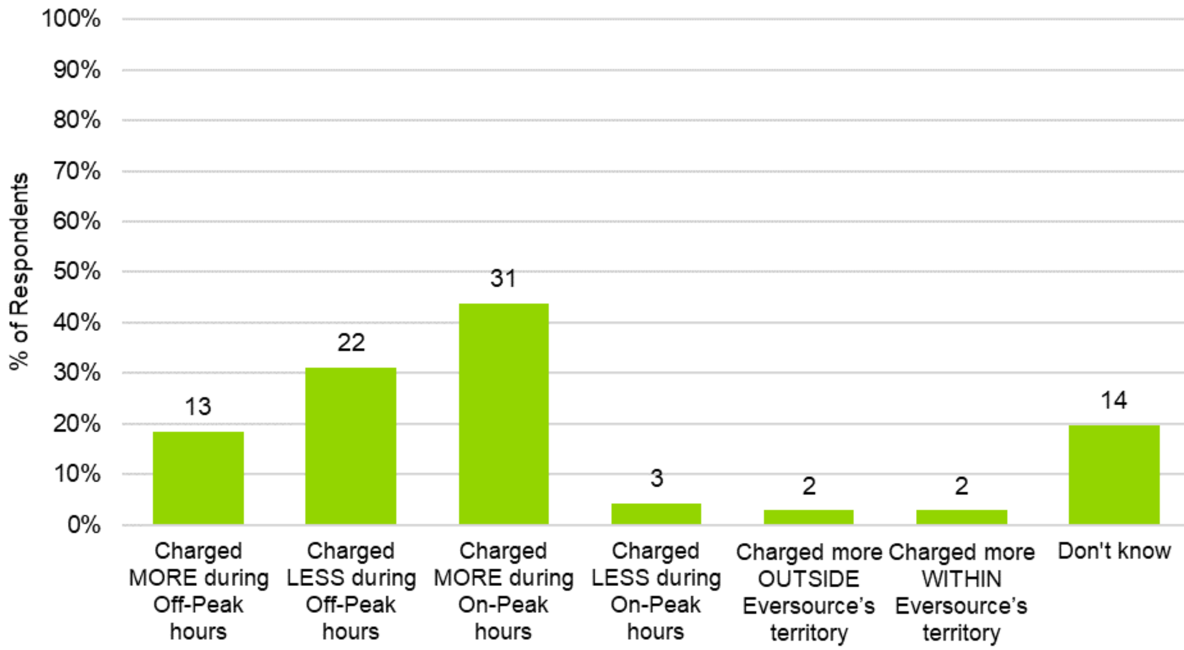
Source: Guidehouse

I7. Please indicate how the ***energy use information provided on the SmartCharge Rewards portal*** affected your charging behavior during summer 2021 relative to what it would have been if the information was not provided. (n=47)



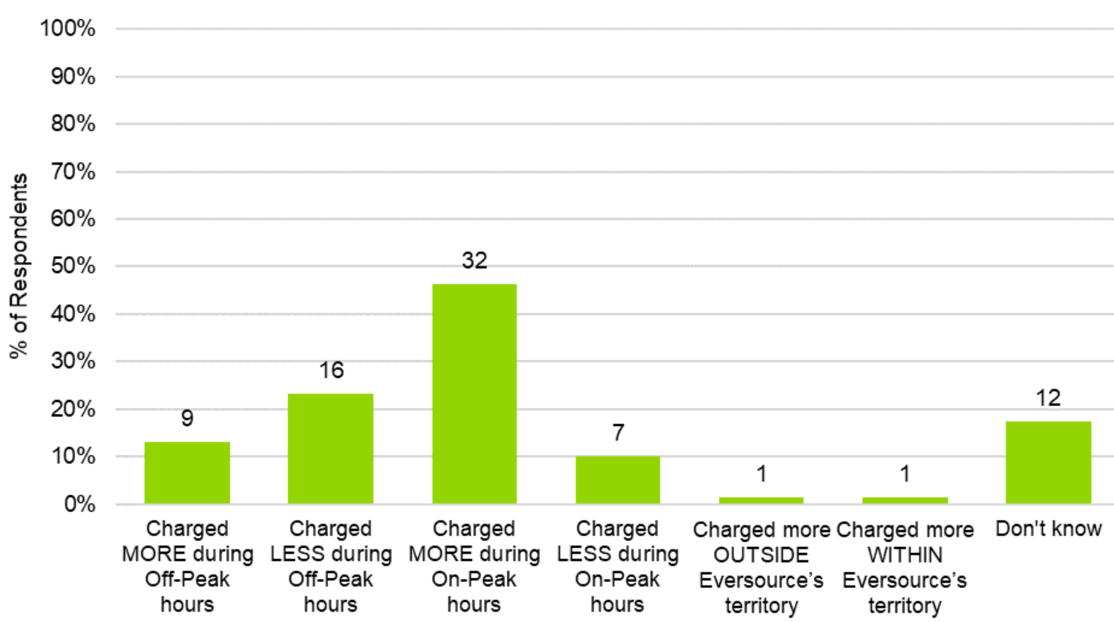
Source: Guidehouse

I8. Please indicate how the ***$0.05/kWh reward for charging during Off-Peak hours*** affected your charging behavior during summer 2021 relative to what it would have been if rewards were not provided. (n=71)



Source: Guidehouse

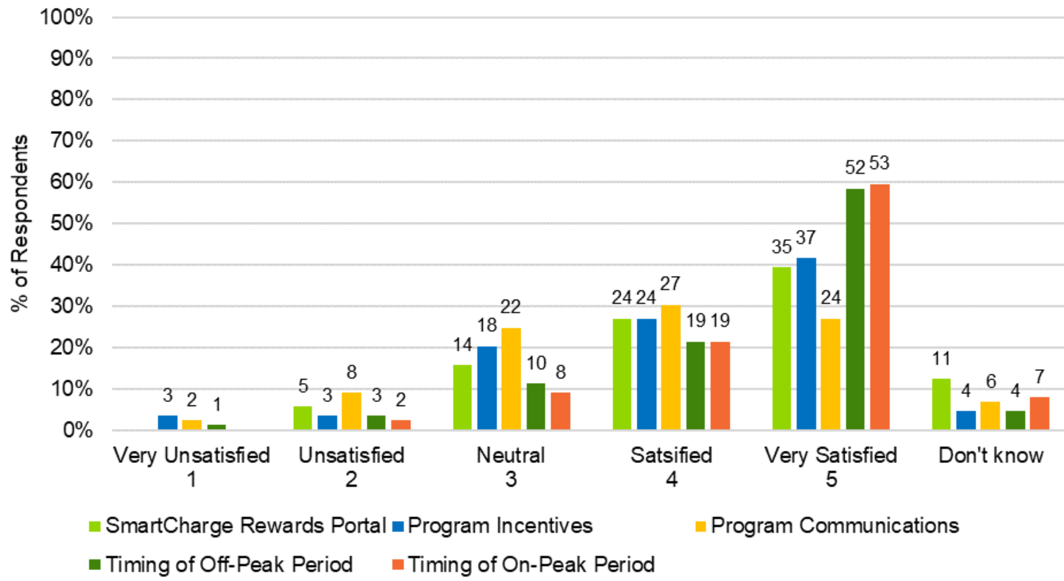
I9. Please indicate how the ***$10 monthly bonus for avoiding charging during On-Peak hours*** affected your charging behavior during summer 2021 relative to what it would have been if the bonus was not provided. (n=69)



Source: Guidehouse

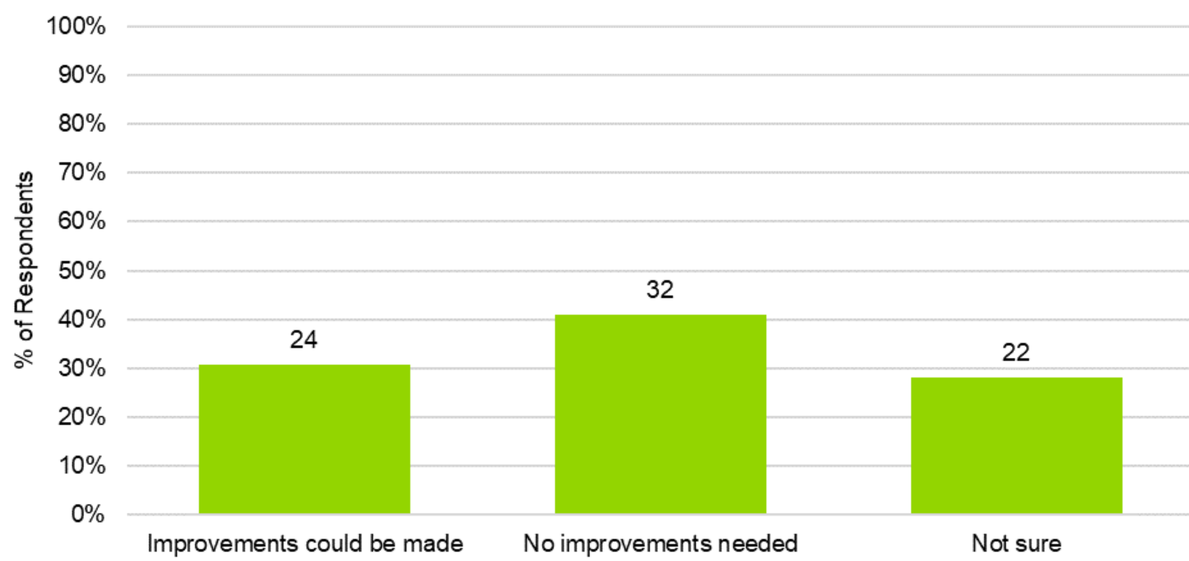
B.1.6 Program Satisfaction

S1. On a scale of 1 to 5, where 1 is “Very unsatisfied” and 5 is “Very satisfied”, how would you rate your satisfaction with the following aspects of Eversource’s ConnectedSolutions SmartCharge Rewards Program to-date? (n=89)



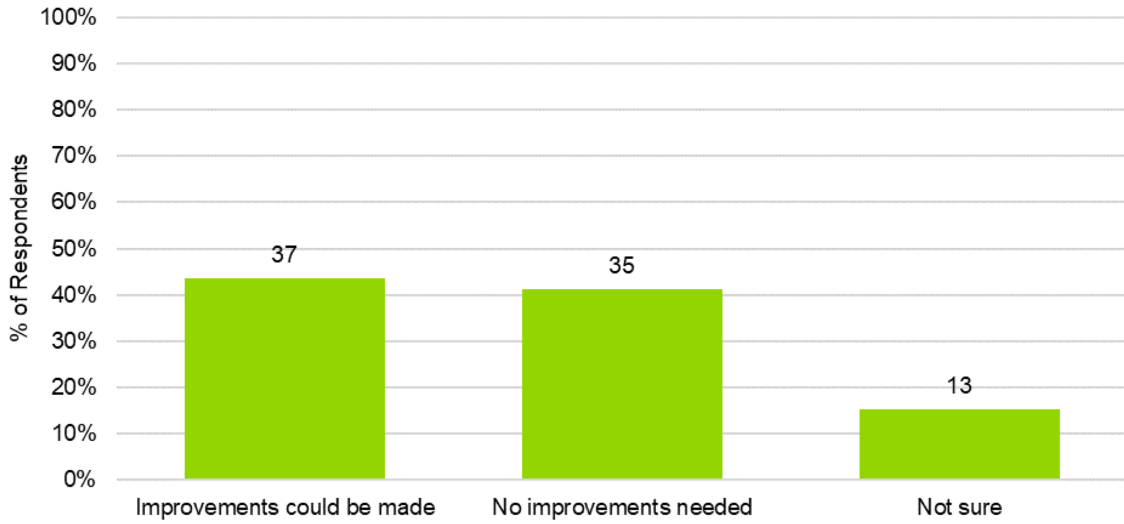
Source: Guidehouse

S2. How could the ***SmartCharge Rewards Portal*** be improved? (n=78)



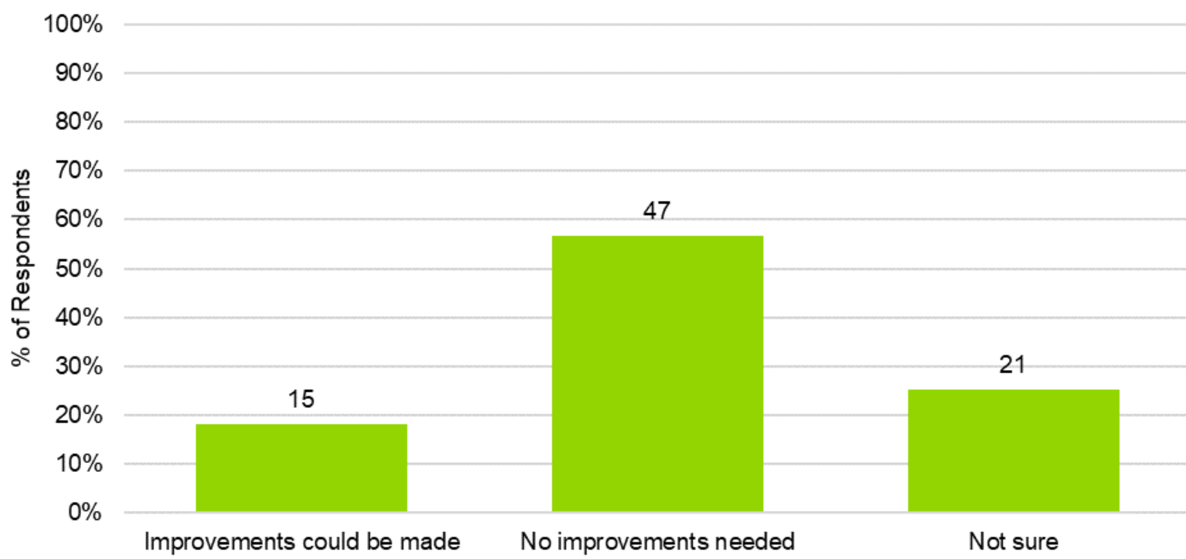
Source: Guidehouse

S3. How could ***program incentives*** be improved? (n=85)



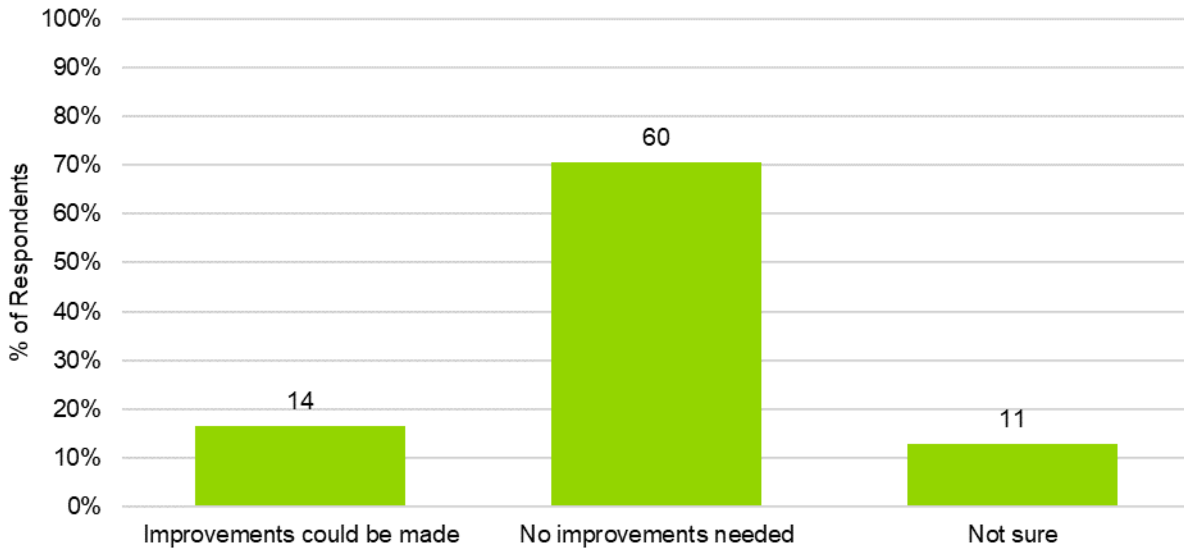
Source: Guidehouse

S4. How could program ***communications*** be improved? (n=83)



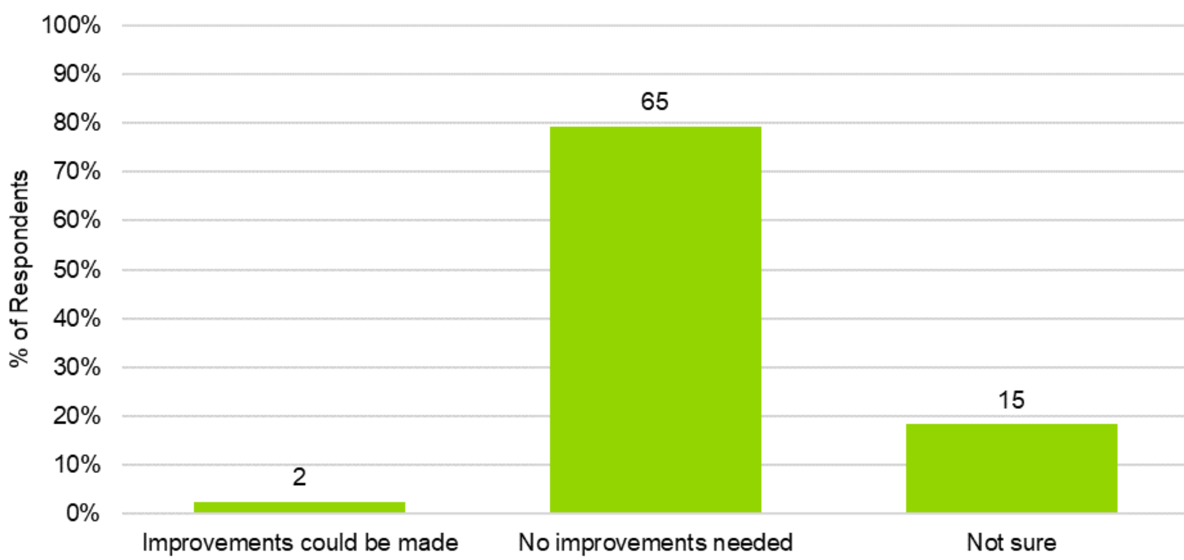
Source: Guidehouse

S5. How could the ***timing of the Off-Peak period*** be improved? (n=85)



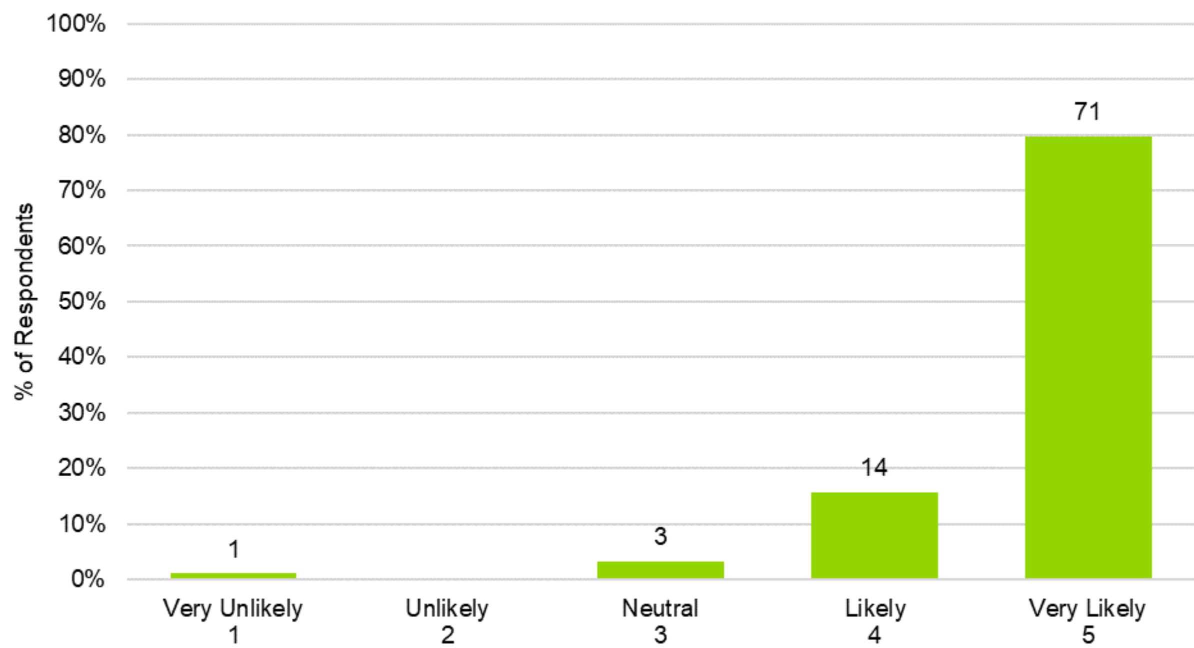
Source: Guidehouse

S6. How could the ***timing of the On-Peak period*** be improved? (n=82)



Source: Guidehouse

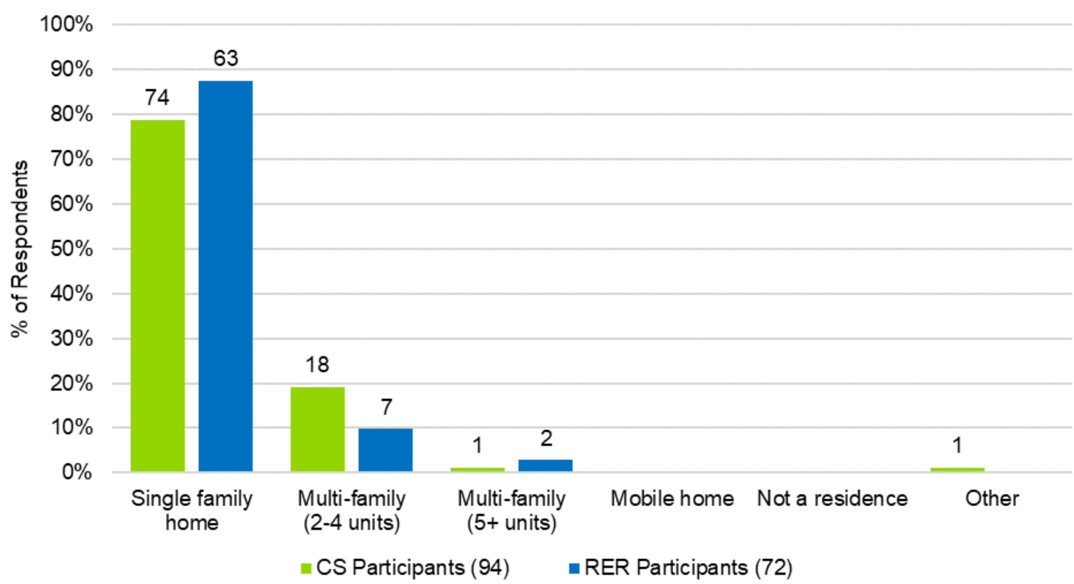
S7. On a scale of 1 to 5, where 1 is "Very Unlikely" and 5 is "Very Likely", how likely are you to continue to participate in Eversource's ConnectedSolutions SmartCharge Rewards Program? (n=89)



Source: Guidehouse

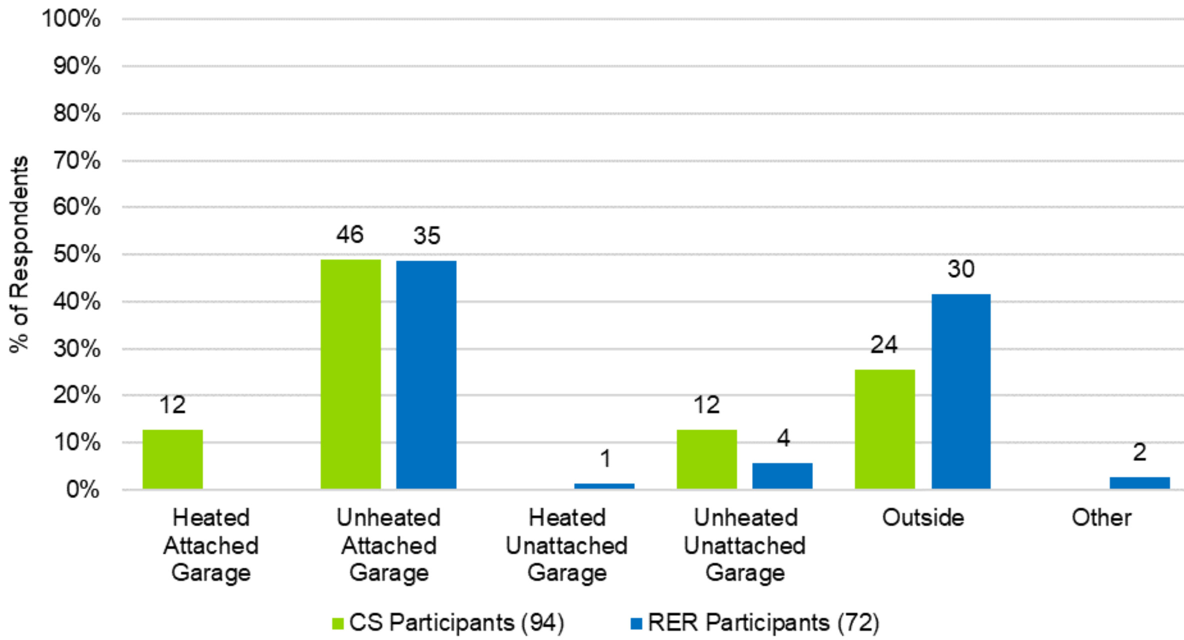
B.1.7 Demographics

D1. Which of the following best describes the property type where your home charging station is located? (n=166)



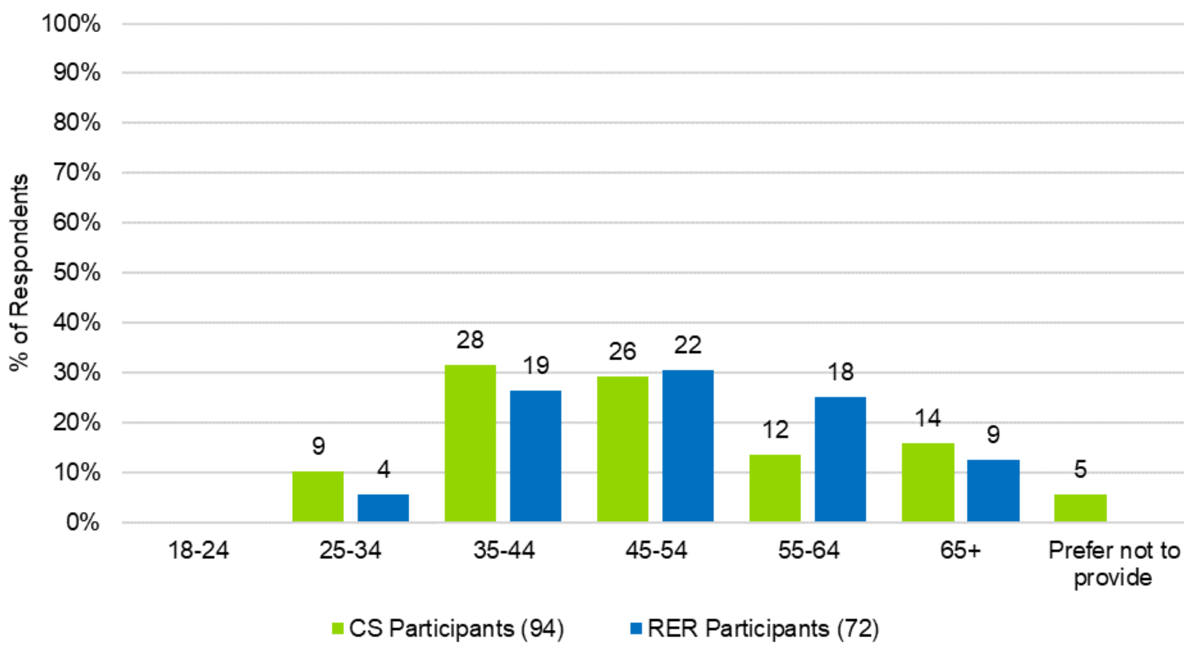
Source: Guidehouse

D2. Which of the following best describes the location of your home charging device? (n=166)



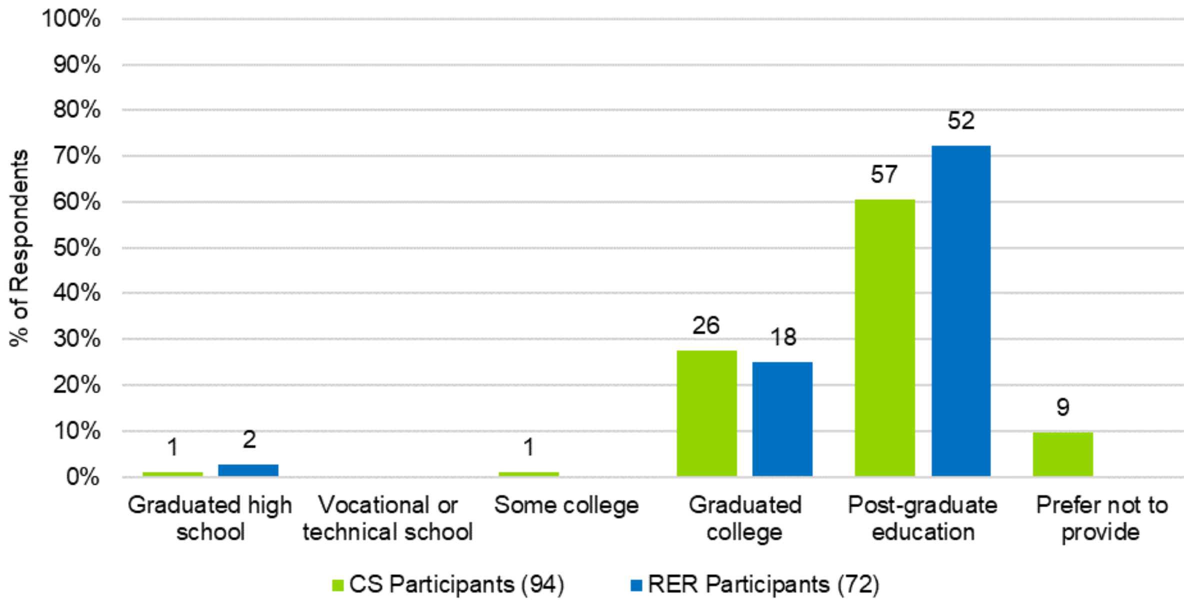
Source: Guidehouse

D3. Which of the following age categories do you fall into? (n=166)



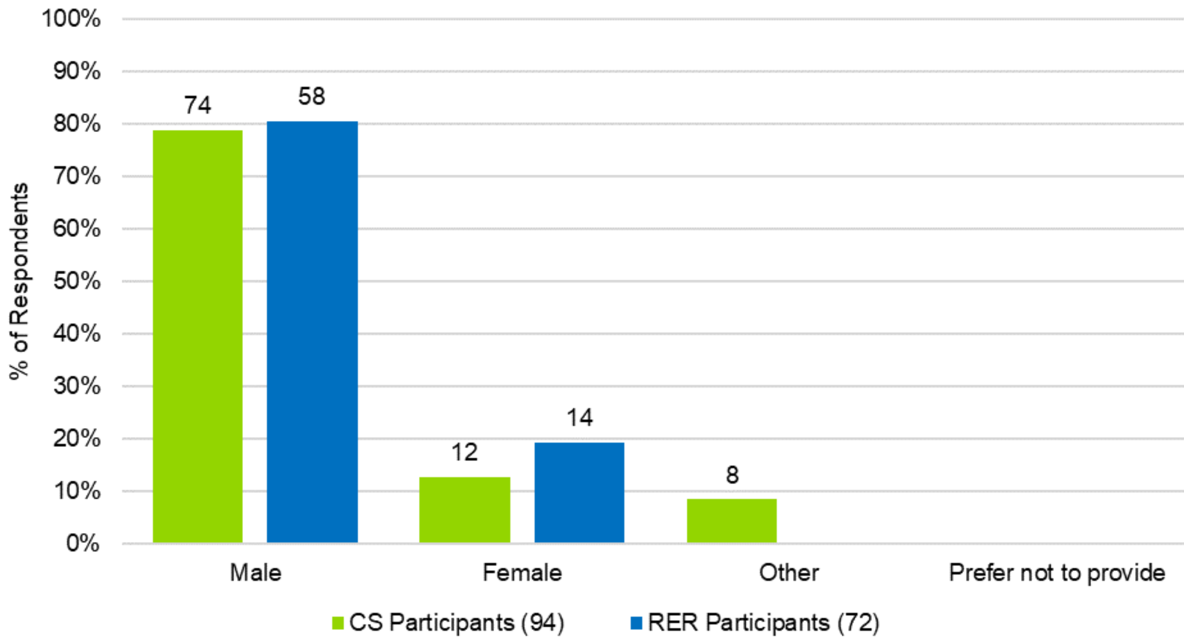
Source: Guidehouse

D4. What is the last grade of school you completed? (n=166)



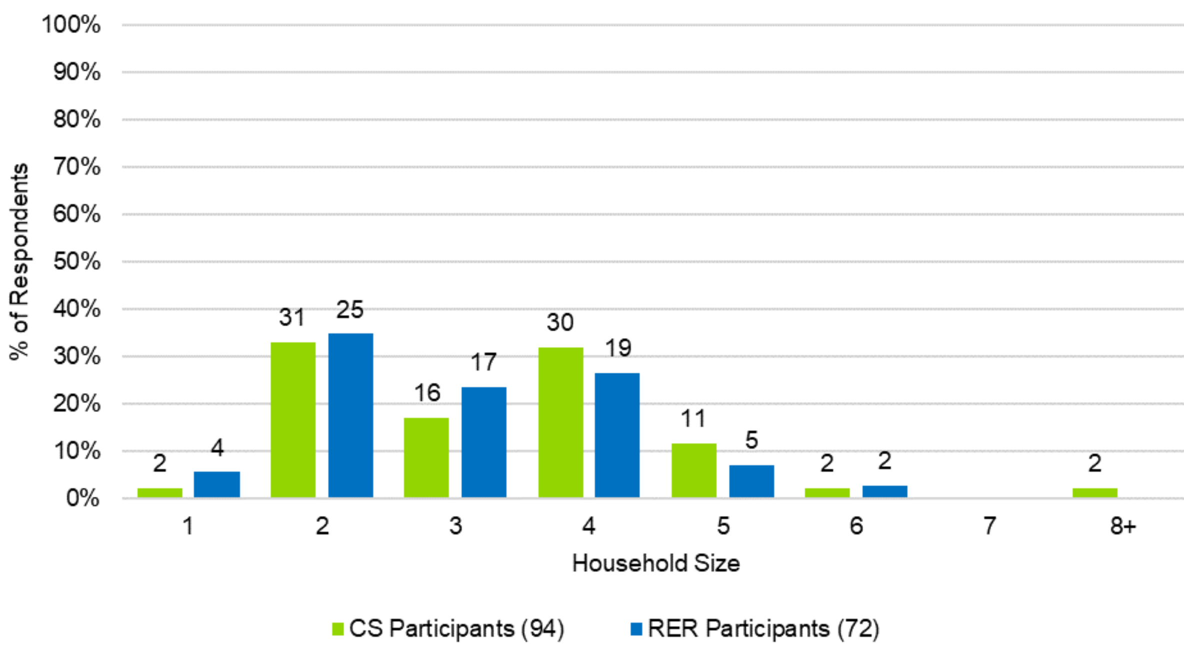
Source: Guidehouse

D5. Which category best describes your gender? (n=166)



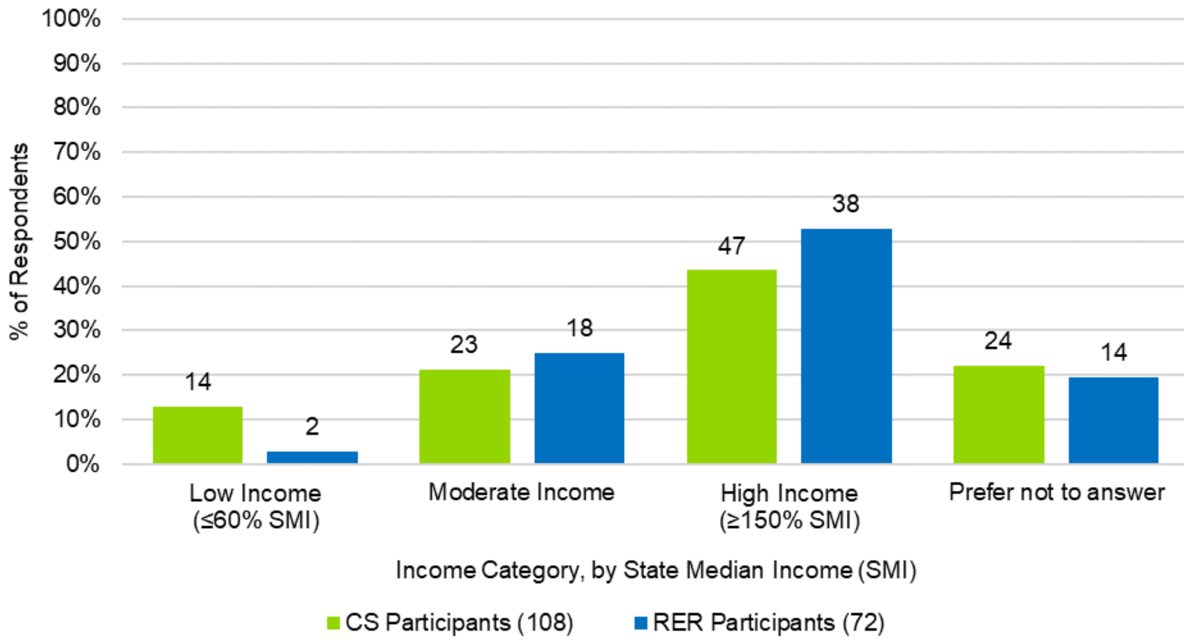
Source: Guidehouse

D6. How many people occupied your home this summer 2021? (n=166)



Source: Guidehouse

D7. What will be your estimated total annual household income in 2021 before taxes (in other words, your gross household income)? (n=166)



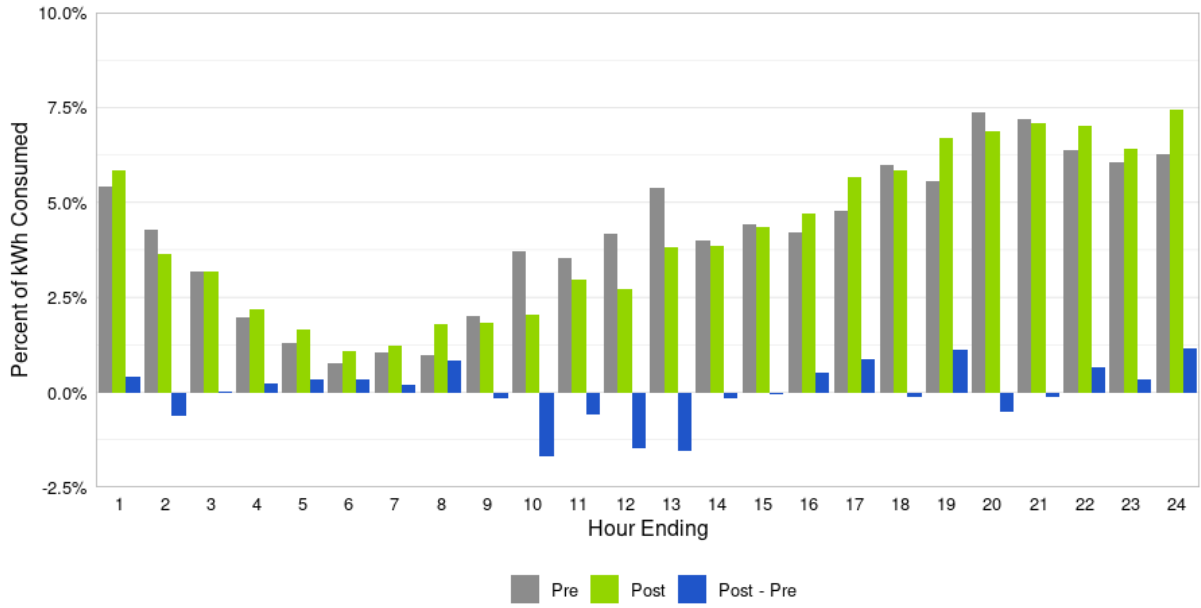
Source: Guidehouse

Appendix C. Assessment of Charging Profiles – Supplemental Results

This section contains a variety of supplementary plots and tables that assess the charging behavior of CS and RER participants.

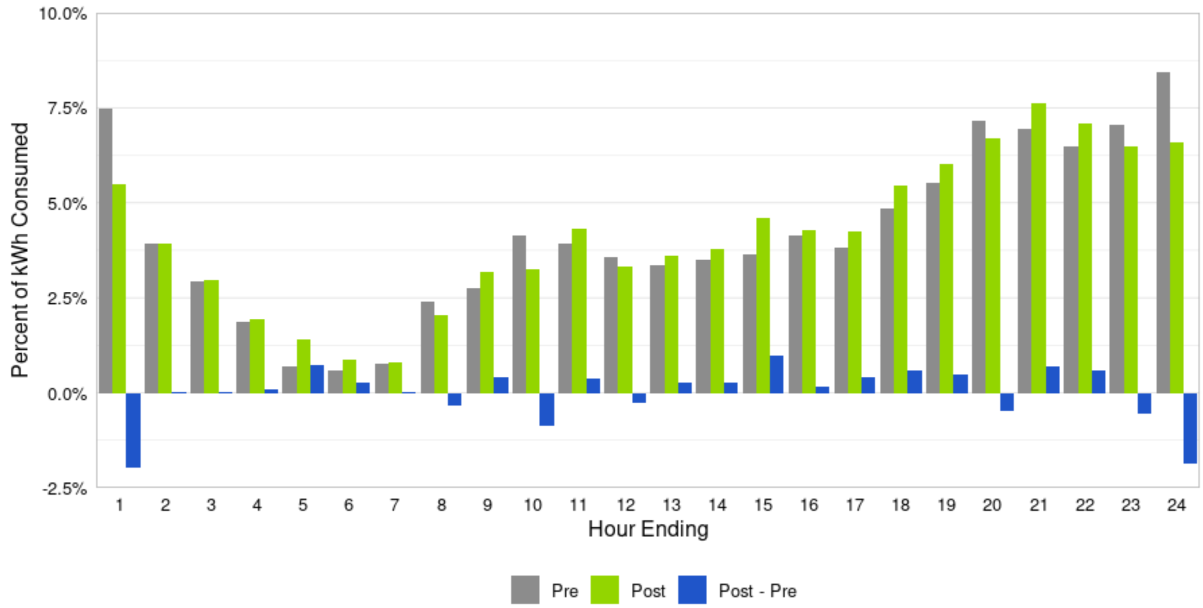
C.1 Energy Consumption

Figure C-1. Percent of Energy Consumed by Hour and Period- RER Participants, Tesla Only



Source: Guidehouse analysis of RER EV telematics data

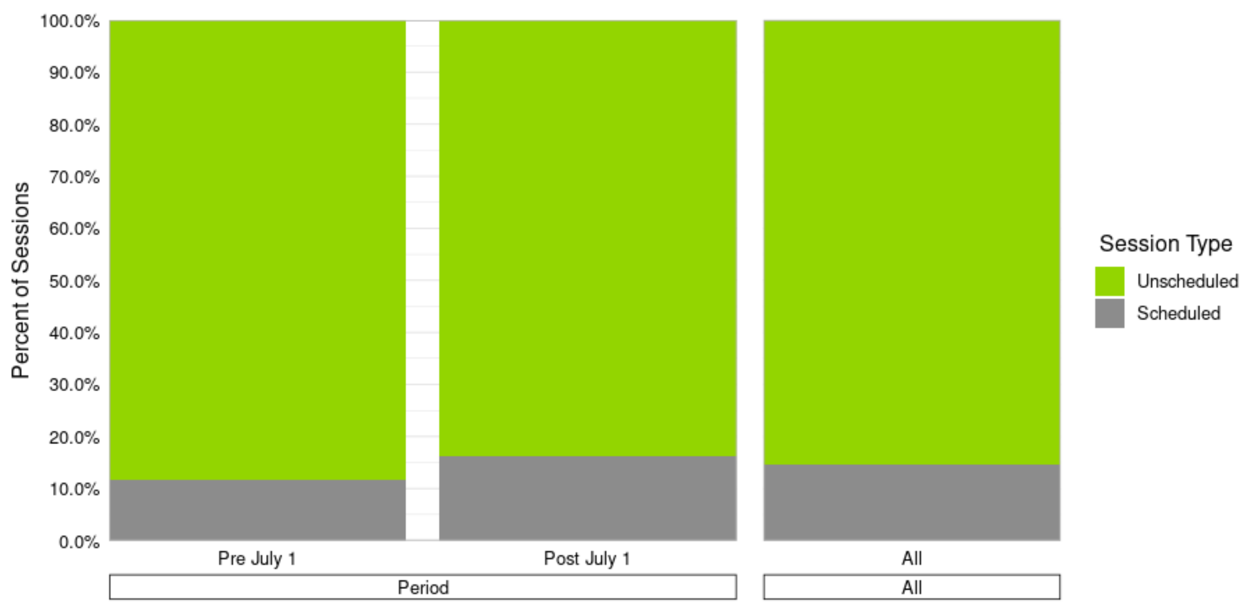
Figure C-2. Percent of Energy Consumed by Hour and Period- RER Participants, No Tesla



Source: Guidehouse analysis of RER EV telematics data

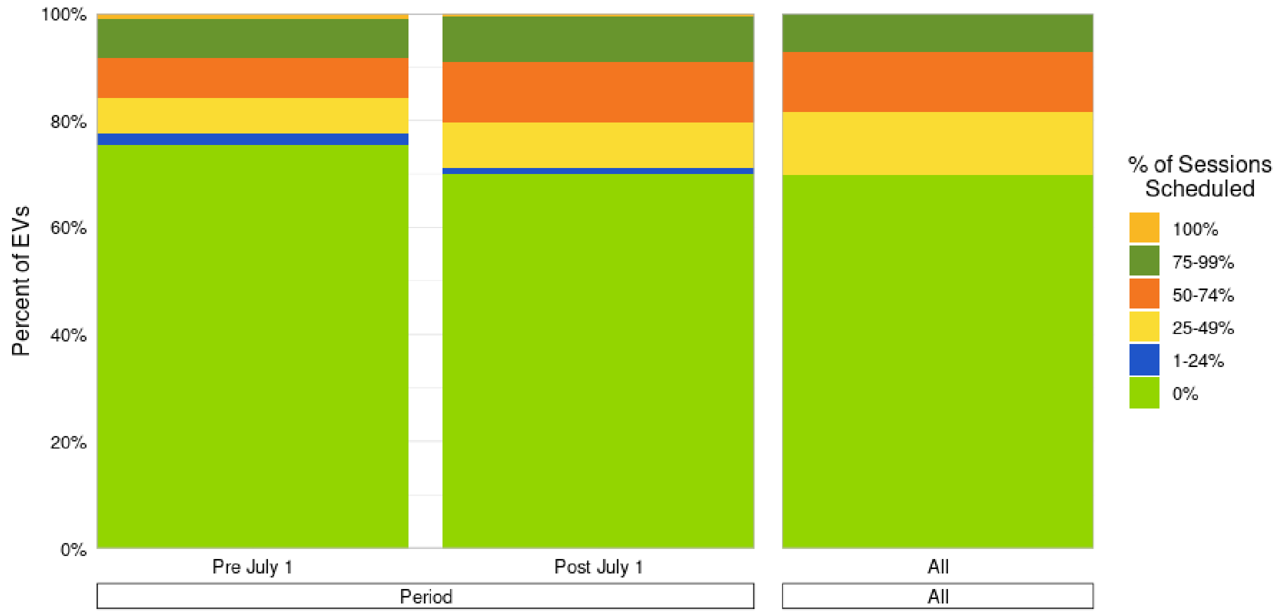
C.2 Scheduled Charging

Figure C-3. Percent of Sessions by Type and Period, CS Participants



Source: Guidehouse analysis of CS EV telematics data

Figure C-4. Percent of EVs by Scheduled Session Frequency, CS Participants



Source: Guidehouse analysis of CS EV telematics data

Table C-1. Comparison of Scheduled Charging and EVSE Level, CS Participants

Scheduling	EVSE Level					
	Level 1	%	Level 2	%	Unknown	%
Use Scheduled Charging	6	18%	54	34%	0	0
Do Not Use Scheduled Charging	28	82%	104	66%	1	100%
Total	**34**	**100%**	**158**	**100%**	**1**	**100%**

Source: Guidehouse analysis of CS EV telematics data

Table C-2. Comparison of Scheduled Charging

Scheduling	CS		RER	
	n	%	n	%
Use Scheduled Charging	59	30.0%	18	22.8%
Do Not Use Scheduled Charging	134	70.0%	61	77.2%
Total	**193**	**100%**	**79**	**100%**

Source: Guidehouse analysis of CS and RER EV telematics data

Appendix D. Impact Analysis – Supplemental Results

For the calculation of impacts, Guidehouse considered two core regression specifications. The first and primary regression specification used for the impact analysis was the difference-in-differences regression using CS participant and RER participant charging data during the periods prior to and following the beginning of the program. The second regression specification considered for the impact analysis was a participant-only (CS-only) regression, using charging data of only participants during the periods prior to and following the beginning of the program.

Table D-1 summarizes the two models considered for impact analysis. Guidehouse ultimately opted to use the difference-in-differences specification to quantify impacts associated with program participation. The model can difference away underlying differences between CS and RER participants.[10] In addition, the model can difference away changes in charging associated with seasonality, which reduces the risk of seasonality contaminating the assessed kW and kWh treatment effects.

Table D-1. Models Considered for Impact Analysis

Model	Difference-in-Differences	Participant-Only
Description	• Regression model that quantifies changes in charge energy and demand between pre-period and program treatment period, CS and RER participants. • Develops a counterfactual using CS EVs and RER EVs, pre-period and program treatment period kW and kWh. • Differences between groups over time are controlled for via a series of dummy variables.	• Regression model that quantifies changes in charge energy and demand between pre-period and program treatment period for CS participants only. • Counterfactual is pre-period kW and kWh.
Sample	• CS and RER participants	• CS participants only
Pros	• Differences away seasonal changes in charging behavior, reducing risk of seasonality contaminating in savings estimates	• Omitting RER EVs reduces risk of differences between CS and RER contaminating savings estimates
Cons	• Savings estimates of kW and kWh may be contaminated by CS and RER's underlying differences	• Savings estimates will include kW and kWh changes attributed to seasonality and program treatment

[10] This requires a parallel trends assumption for the modeled dependent variable to be met during the pre-treatment period. Guidehouse has verified that pre-treatment period differences in measured kW and kWh are comparable during the pre-treatment period.

Source: Guidehouse

Guidehouse estimated a participant-only model to serve as a sensitivity check. Results of the difference-in-differences and participant-only models are compared in Table D-2. The impact of program participation during off-peak hours was statistically insignificant in both model specifications. However, the impact of program participation during peak hours was a 0.13 kW reduction in demand and a 1.85 kWh daily energy savings per EV in the difference-in-differences model. The impact of program participation during peak hours was a 0.09 kW reduction in demand and a 1.18 kWh daily energy savings per EV in the participant-only model.

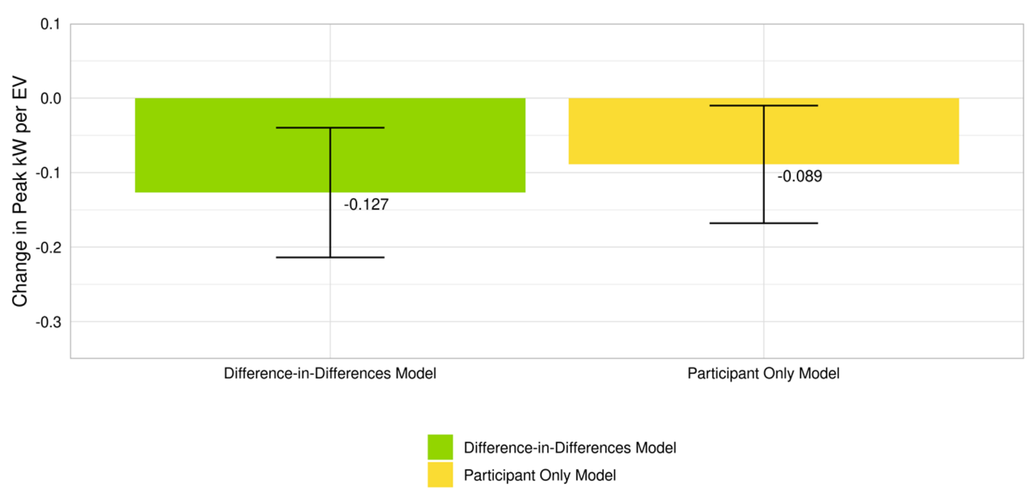
Table D-2. Difference-in-Differences and Participant-Only Impacts per EV by Period

Impact Analysis Metric	Time Period	Difference-in-Differences Impact Estimate	Participant-Only Impact Estimate
Average Half-Hourly kW Reduction per EV	7 a.m.–11 p.m.	-0.127 kW**	-0.089 kW*
	11 p.m.–7 a.m.	0.015 kW	0.040 kW
Average Daily kWh Savings per EV	7 a.m.–11 p.m.	-1.852 kWh**	-1.18 kWh**
	11 p.m.–7 a.m.	0.130 kWh	0.363 kWh

* Indicates significance at 90% confidence
** Indicates significance at 95% confidence
*** Indicates significance at 99% confidence
Source: Guidehouse analysis of EV interval data

Figure D-1 compares the kW impact per EV during peak hours during the period spanning July 1 through September 30 with 90% confidence bounds overlaid.

Figure D-1. Difference-in-Differences and Participant-Only Impacts on kW in Peak Hours



Source: Guidehouse analysis of EV interval data

In the charging profile analysis, Guidehouse identified that CS participants underwent an overall reduction in charge kW and kWh from May through September. Without a group upon which to compare charge kW and kWh between May and September, kW and kWh reduction estimates will include kW and kWh changes attributed to program treatment as well as unobservable factors unrelated to the program that led to reductions in charge kW and kWh between May and September. Therefore, Guidehouse recommends the use of the difference-in-differences impact estimate.

Connecticut Electric Vehicle (EV) Charging Program

2023 Participant Guide for Residential EV Drivers

January 25, 2023

Table of Contents

Section 1:
Introduction

Welcome to the Connecticut Electric Vehicle Charging Program

New technology like electric vehicles ("EVs") raise many questions and your utilities know informed consumers drive great partnerships. In this guide, United Illuminating and Eversource explain a unique new EV charging program and help you understand just how easy EV charging can be, how you will save money through EV charging programs, pay less for your usage during designated charging times, get faster charging options to simplify your life, and understand how smart choices can protect the future of our environment. EVs produce less lifetime pollution than gas-powered vehicles, and, as sources of electricity become cleaner, these emissions will continue to decline. The EV community and public charging network are quickly growing around you. Let's find out just how you can become part of this new technology revolution!

The Connecticut EV Charging Program ("the Program") offers eligible residential EV drivers the opportunity to earn rebates and incentives to charge their EV smarter, avoid costly peak time energy use, and help your utility, either United Illuminating ("UI") or Eversource, collectively ("utilities"), manage the additional electricity demand from EV's now and into the future. Charging an EV at your home can offer many benefits, from convenience to cost savings and vehicle emission reductions. Whatever your motivation, we welcome your participation and look forward to supporting you.

So, how does it work? This guide will provide all the information you need to participate successfully and receive the Program incentives that are applicable to you. Overall, customers interested in the Program will follow these general steps to be explained in more detail below.

STEP 1: DECIDE HOW TO PARTICIPATE

STEP 2: INSTALL & SETUP YOUR SOLUTION

STEP 3: APPLY FOR YOUR REBATES*

STEP 4: ENROLL IN THE PROGRAM

STEP 5: PARTICIPATE & RECEIVE INCENTIVES

*__Eligibility requirements apply__

Section 2:
Definitions

The definitions in this section will help new and existing EV drivers understand some of the terms used throughout this guide.

Advanced Metering Infrastructure ("AMI") Disaggregation: AMI Disaggregation is available to UI customers only and refers to the ability of UI's technology partners to perform sophisticated analysis of electricity usage to determine how and when EV charging is occurring. AMI Disaggregation provides customers with an opportunity to participate in the Program even if they don't have a Smart Charger or a Connect Vehicle (Telematics).

Direct Load Control: The capability of the utility has to manage the participant's electrical load through the utility's Technology Partner. There are two forms of Direct Load Control that the utilities have the ability to use within the program:

> **Emergency Demand Response:** refers to actions taken by utilities if the utility determines action is required to maintain the safety and reliability of the grid. Critical system events that impact system voltage levels, system stability and safety, or distribution system events that are considered emergencies by utilities may require override of a customer's EV charger. While such conditions are rare, utilities will attempt to provide advance notification whenever possible, dependent on the nature of the event. Customers will still have the ability to opt out during an Emergency Demand Response event.

Demand Response: refers to actions taken by utilities during times when the electric system is strained. This system strain typically occurs on the hottest days of the summer but can also happen any time of the year such as in emergency situations or when electricity supply is limited. By initiating Demand Response "Events," utilities act with their customers and through their Technology Partners to reduce electric usage for short periods of time. When customers respond to an Event it helps maintain a stable electric system. In most cases advanced notification up to 24 hours can be provided.

Electric Vehicle Supply Equipment ("EVSE"): refers to devices used to supply EVs with electricity. These devices generally fall into two categories – we'll cover those that are commonly used in your home:

> **Level 1 ("L1"):** The lowest speed charger, these chargers plug into the average 3-prong, 120 volt ("V") plug in most homes. These plugs charge a vehicle very slowly, and the time required varies greatly depending on the size of your vehicle battery. An L1 charging plug may have been included in your EV purchase. ***These chargers are not eligible to participate in the Program.***
>
> **Level 2 ("L2"):** Generally, the most powerful chargers for the home. These chargers connect to a 240V outlet and usually require an electrician to install a new outlet where you charge your EV. L2 chargers are most often purchased separately from your EV, although more EV's are beginning to come with an L2 charger as standard equipment as an option when you purchase your EV. An

L2 charger can have “smart” features that can be accessed through a mobile app and are available in several power levels. L2 chargers can fully charge a vehicle from empty between 3 and 7 hours, depending on the size of your EV’s battery and power rating of the charger.

Networked L2 or “Smart Charger”: These chargers can connect to the internet (via Wi-Fi or cellular connection) and can be controlled, generally, through a mobile app.

Non-Networked L2: These chargers don’t connect to the internet (via Wi-Fi or cellular connection) but do charge a vehicle as quickly as a Networked L2.

Managed Charging: this is also known as “smart charging” where utilities or other third-parties are able to coordinate with Participants in a Managed Charging Program to start, stop, or slow down charging during times of high stress on the utility system. This can be done either by sending signals to Participants to remind them to control their charging themselves, or it can be done by the utility sending direct load control signals to the EV or EV charger during those times of stress. This Program uses both approaches. Managed Charging allows the utilities to adequately integrate the growing, new demand on their systems from EVs, and allows utilities to use the flexibility of EVs to reduce costs.

Managed Charging Platform: this is the behind-the-scenes software platform that allows your utility to coordinate charging among all Program Participants and supports implementation of this Managed Charging Program. Depending on if you are an Eversource or UI customer, you will have different approaches to interacting with this platform, but there will be customer-facing elements that allow you to set your preferences and control your charging to participate in the requirements of the tier of participation you opt for.

Off-Peak: For the purpose of this program off-peak charging is charging your vehicle outside of the hours of 3pm to 9pm on weekdays and is one of the requirements for achieving participation incentives. **Off-Peak in this document is not related to the off-peak Time of Use (TOU) rates that UI offers which pertains to the hours of noon to 8pm.**

Technology Partners: utilities have many technology partners that assist in delivering programs like this one to customers. In this program guide we often refer to our “Technology Partner”, which is a third-party contractor that provides analytics, communication, and reporting to assist utilities in delivering value-added programs and a great customer experience.

Telematics: Like many of the appliances, communications, and entertainment systems we use today, vehicles have also become “connected devices”. Telematics is the capability of a vehicle to wirelessly communicate with other systems like those used to administer the Program. This communication allows important vehicle and charging data to be shared with our technology partners and can be used to enable control signals that can slow the rate of charge or turn the EV charging station on or off as needed by the grid during Demand Response Events.

Section 3:
Program Description

The Program offers rebates to eligible customers to reduce the cost of installing new, qualified Smart Chargers and wiring upgrades. The Program also provides ongoing incentives to promote consistent participation in Managed Charging over time. Participants are rewarded for charging their vehicles during off-peak periods throughout the year and for participating in load control events from June through September. Participants use their EV and/or EV charging station to respond to signals from their utility as the utility continually monitors the electric grid. Utilities will occasionally initiate a reduction in power, or in some cases completely stop power, to the participant's EV under times of high energy cost or electric grid stress. Customers can set their own charging schedules or have the utilities set their charging schedules for them to avoid charging during those times. Participants always have the option to opt out of any charging curtailment if it is necessary for them to charge during that time. To receive rebates and incentives, customers must agree to participate in one of the two tiers of participation and adhere to the requirements of that tier.

These incentive dollars are available to EV owners who agree to participate in one of two tiers of participation which correspond to different levels of incentives and customer responsibilities. There is the Baseline Tier and the Advanced Tier.

The **Baseline Tier** is the fundamental managed charging tier where participants are rewarded for shifting a large majority of their charging to off-peak periods. There are also optional Demand Response Events ("Events"), which help the utility grid respond to changing conditions like electricity cost and congestion by curtailing EV charging at very specific times of the year and times of day. Participation in these Events is optional, but if participants do adhere to these charging curtailments, they will be rewarded for their participation.

The **Advanced Tier** is a more sophisticated managed charging tier where participants are rewarded for partnering with the utility to coordinate charging such that EV charging is optimized on the utility system. This optimization helps the utilities operate a more cost-efficient and flexible grid. This tier requires more coordination between the participant and the utility than the Baseline Tier and therefore the utilities offer more incentives for customers participating at this level. In this tier, participants will create a charging schedule for themselves, and the utilities will coordinate and optimize the charging schedules of all EVs in the Advanced Tier to drive better outcomes for their grid systems. Participants are required to keep a schedule and do their best to not override this schedule.

In both tiers, participants are rewarded monthly for meeting the relevant requirements of each tier. Please see **Section 7** for more details regarding these tiers, their differences, and requirements for full participation in the Program.

Section 4:
Rebates & Incentives

Incentives in this Program fall into a few categories that we will explain in more detail below. There are upfront incentives, like rebates for equipment and electrical work, and Enrollment Incentives to encourage customers to sign up for the Program. Then, there are ongoing incentives for continued, consistent participation in either the Baseline or Advanced Tiers, awarded twice per year for Eversource participants and quarterly for UI participants after verification that participants have achieved the minimum level of participation.

Participants must apply for upfront incentives as part of their application and enrollment process, and these will be distributed after the application is approved. Participants will be required to show documentation of installation and receipts of purchase. Below is more detail on what you can expect from these incentives and how to qualify.

❖ **Upfront Rebates & Incentives:**

- **Wiring Upgrade Rebate:** For participants needing electrical upgrades for their home to participate in the Program, up to $500 will be available for qualifying work (for example, adding a sub panel, increasing main panel amperage, installing conduit runs, wiring a 240V plug). This incentive is only available for those purchasing a new Networked L2 charger (“Smart Charger”) or those participating with qualifying EV with Telematics.
- **Smart Charger Rebate:** For participants purchasing and installing a Qualifying Networked L2 charger for use in this program, there is up to $500 available to participants who provide proof of purchase and installation. Only new Smart Chargers purchased on or after January 1, 2022 and listed in the Qualified Products List (“QPL”) are eligible (see **Section 6**) for this incentive.
- **Enrollment Incentive:** For those customers who participate through Telematics, existing Networked L2 chargers, or AMI Disaggregation, a one-time $100 Enrollment Incentive is available. Participants must enroll using eligible devices and/or methods of connection (see **Section 6** for the list of eligible technologies) and successfully set up their technology. Enrolling through an existing Networked L2 charger means that it was purchased and installed prior to 01/01/23. Rebates for devices installed in 2022 are eligible to apply to the program until January 31, 2023.
- *Above incentives to be paid via mailed check after the application is approved.*

Table 1: Upfront Incentives for Equipment & Enrollment

Customer Scenario		Smart Charger Rebate *(up to)*	Wiring Upgrade Rebate *(up to)*	One-Time Enrollment Incentive
New Networked L2 Charger	*Needs 240v Outlet †*	$500	$500	$0
	Has 240v Outlet †	$500	$0	$0
Existing Networked L2 Charger **(purchased & installed prior to 01/01/23)**	*Already Installed*	$0	$0	$100
Telematics with Non-Networked L2 Charger	*Needs 240v Outlet †*	$0	$500	$100
	Has 240v Outlet †	$0	$0	$100
All Other L2 Chargers *(UI only)*	*No Wiring Rebate*	$0	$0	$100

† 240v Outlet refers to the electrical circuit and receptacle needed for level 2 charging.

❖ **Ongoing Incentives:**

Both participation tiers have ongoing incentives for meeting the performance requirements of the given tier on a monthly basis. The Baseline Tier requires less of the participant than the Advanced Tier. The Advanced Tier participants allow the utility more potential for optimization and cost-efficiency on the system, so participants in this tier are entitled to more incentives; their actions improve the performance of the utility system to a higher degree than Baseline Tier participants.

Baseline Tier Ongoing Incentives:

There are ongoing monthly incentives capped at $200 per year for full participation in the Baseline Tier. If a participant, in a given month, times their charging such that 80% or more of the charging happens during the off-peak period (3pm to 9pm on non-holiday weekdays, the customer will earn a $10 incentive for that month which is a potential earning of $120 annually.

Also, there are incentives available for participating in optional Demand Response Events. These events can happen between June and September and only occur on non-holiday weekdays. The participant must participate in all optional events in order to receive the $20 incentive for a given month in the Demand Response Season. For full participation in all four months of the Demand Response Season, the participant could earn up to $80.

Finally, in order to receive any incentives in this tier, the participating EV or EV charger must also be used at least once in the month.

Participants achieving 80% or greater off-peak charging and responding to each Demand Response Event could, therefore, earn $200 annually for their participation.

Advanced Tier Ongoing Incentives:

There are ongoing monthly incentives capped at $300 per year for full participation in the Advanced Tier. The participant and utility coordinate charging by having the participant set a daily charging schedule and adhere to this schedule as closely as they can on a monthly basis. The participant is responsible for not overriding this schedule and, if successful, will earn a $25 incentive for a given month. Participants must also agree to participate in occasional EV charging curtailments during times of high stress on the utility system. These are rare and generally occur during the periods where charging will be curtailed anyway, but the utilities reserve the ability to curtail EV charging when it is most critical to the utility system.

Finally, in order to receive any incentives in this tier, the participating EV or EV charger must also be used at least twice in the month.

Utilities and their Technology Partners will inform customers monthly about their accumulated credit or any lost incentives due to too many opt-outs. Ongoing Incentives are paid via e-gift card or check and sent directly to the participant.

More specific details on how to successfully participate in both the Baseline and Advanced Tiers can be found in **Section 7** below.

Section 5:
Eligibility & Enrollment

The Program is open to all residential UI and Eversource customers in Connecticut with an active account. Residential customers are defined as existing UI or Eversource customers, in Connecticut, living in a single-family home or a multi-unit dwelling (“MUD”), with four or fewer units on the property. To be eligible, each unit of an MUD must be separately metered with its own utility account.

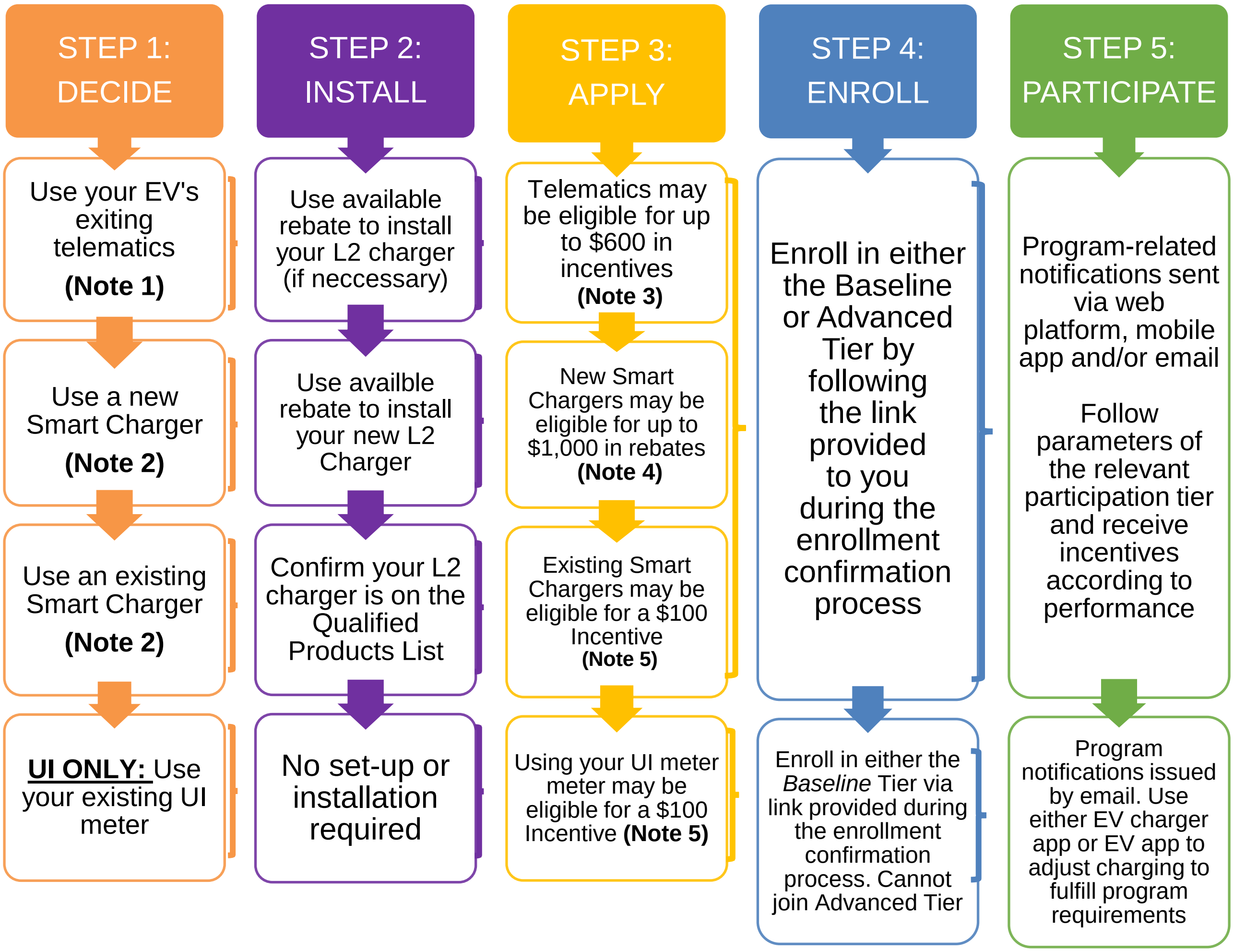
Participation in the Program requires that a participant’s EV charger, EV, and/or combination of technologies meet certain criteria. Below is an outline of setups that can qualify and how each setup must enroll. **Section 6** contains a list of eligible devices called the Qualified Products List (“QPL”).

Connecting via Telematics can be a convenient option for many participants. Telematics provides a one-time “set it and forget it” experience and, if participants prefer connecting with a non-Networked L2 charger or a Smart Charger not on the QPL, it’s possible to connect using the vehicle’s Telematics built into their vehicle. See **Section 6** for the QPL to understand which vehicles and EVSEs can participate. *Note: this list is constantly growing as our Technology Partners integrate with more vehicle and EV charger manufacturers, so check back regularly.*

A Note for UI Customers: Participating Through Your AMI Meter

Due to the AMI metering infrastructure built in UI territory, UI offers another option to participate in the Program for those who don’t have access to other options. If you cannot purchase and/or install a Networked L2 charger on the QPL and your vehicle doesn’t allow Telematics, you can choose to participate using any L2 charger and UI will verify participation in Events using AMI Disaggregation.

The following figure provides an overview of the Program process and the different methods of participation:



Note 1: *Not all vehicle makes are eligible for the Program. See* ***Section 6*** *for a list of compatible vehicle makes. If your EV is not compatible you can participate via another method.*

Note 2: *Not all Smart Chargers are eligible for the Program. See* ***Section 6*** *for a QPL of eligible Smart Chargers. If your Smart Charger is not compatible, you can participate via another method.*

Note 3: *Compatible Telematics are eligible for up to a $500 Wiring Upgrade rebate and a $100 Enrollment Incentive. See* ***Section 4*** *for more information on Rebates and Incentives.*

Note 4: *New, eligible Smart Chargers can receive up to a $500 Smart Charger rebate and up to a $500 wiring upgrade rebate. See* ***Section 4*** *for more information on rebates and incentives.*

Note 5: *Existing Smart Chargers purchased & installed before 1/1/23 (**for UI customers:** participation through your existing UI meter is eligible for a $100 Enrollment Incentive.) See* ***Section 4*** *for more information on rebates and incentives.*

After you choose the technology that makes sense for you, it's time to enroll your system! Customer eligibility will be confirmed during the application process.

Program Application
The Program offers an easy online process to provide secure and reliable processing of applications.

Eversource: Please visit the Residential Section of the Eversource website to access the application portal.

UI: For more Program information visit our EV Programs for Your Home site to access the application portal. For those who prefer a paper application, this site also has a fillable PDF application for you to download, fill out, and collect relevant documents listed below. You can then submit the application and relevant documents to UIEVApplications@clearesult.com.

In the application, there are clear steps to follow, terms and conditions for the Program that you must accept, and guidance on how to activate your device. Along the way you will need a few items:

1. *Receipts and invoices related to the purchase and/or installation of a Networked L2 charger, labeled as paid*
    a. *Installation information must include date of installation, installer/ contractor name, equipment cost, total installation cost, and town/ city building permit*
2. *Customer's utility account number, service address, and billing address*
3. *EV and EVSE information: make, model, year, serial number, EV Charger Unit Number/ MAC ID*

If you are having trouble with your application, please contact your utility by emailing HomeEV@uinet.com for UI or EversourceEVSupport@clearesult.com for ES, or by using the contact information provided in **Section 8** of this guide. A Program associate will support you and/or may provide an alternate application method.

Errors in your application may lead to delay or cancellation of your application. Upon identifying any such issues, the Program team will attempt to contact you using the information supplied in the application. If we are unable to reach you or you do not respond with the information needed to correct the application, your application will be cancelled.

Device Activation
All devices must be activated in the Program and any delay in activating your device may lead to delay or cancellation of your incentive payment. The activation process varies by device type and vendor. You will receive activation instructions that are specific to your chosen device in the confirmation email that you receive when you submit your Program application. Follow instructions carefully and use the contact information in the email for support if you experience any difficulties.

Enrollment Incentive
Customers will receive their Enrollment Incentive in the form of a check mailed to the address listed on the application. These incentives are paid to the utility account holder associated with the application unless the customer designates an alternate payee

when submitting the application. Payments that are sent via US Postal Service require several more days for delivery.

❖ **Additional Eligibility Requirements:**

The following requirements apply to all participants regardless of method of participation they chosen:

- Participants must remain in the Program for a period of not less than 24 months from the date of incentive payment.
- Participants who leave the Program before the 24-month period ends will be required to pay back a prorated portion of the upfront incentives they received as part of this Program.
- Incentives are limited to the stated incentive amount listed above or the documented project cost, whichever is less. For the Smart Charger rebate, any other applicable grants, rebates, incentives or credits the customer may receive from another source will be deducted from the total documented device cost.
- Only new Smart Chargers listed in the Program's QPL are eligible for incentives.
- Electrical work must be completed by a qualified professional, in full compliance with laws and regulations.
- Participants are required to share the EV charging data with their utility. Please refer to the Terms and Conditions included with the Program application.

❖ **Data Sharing and Privacy:**
Utilities will collect information on your EV charging behavior, such as when and how often you charge and how much energy you use each time you charge. Your utility may share this information with third parties for the purposes of evaluating the Program. **All EV charging data will be aggregated, anonymized, or otherwise encrypted if/when disclosed publicly.**

Section 6:
Qualified Product List (EVSE) & Eligible EVs (Telematics)

To participate, users must follow requirements for enrollment that may include Networked L2 Smart Chargers, non-Networked L2 chargers, or vehicle Telematics. Only applications including eligible devices that are listed on the Program's QPL will be accepted by the Program. For the QPL, please visit UI's EV Programs for Your Home landing page found here or Eversource's Program landing page found here. Please note that this list will regularly be updated as new manufacturers will be added on an ongoing basis.

Eligible Devices
It is the customer's responsibility to select an eligible device. The Program attempts to include a range of eligible device options to meet different customer needs. General information about the different device types is provided on the Program website, with additional product-specific information listed in the QPL. The vendors will differ on charger models, software, costs, and manufacturer details. Utilities do not offer preferences or recommendations for any approved Program vendors, and Program participants are responsible for determining suitability of products and services.

New Smart Charger
If you decide to install an eligible Smart Charger, you may purchase a new charger from any source you prefer. Please save the receipt to include in the Program application. The charger must be installed and operational before submitting your Program application and **the application must be submitted within 90 days of purchase**. Please ensure you schedule your installation when you purchase your Smart Charger so you can complete your application within that timeframe.

Smart Chargers incentivized by the Program must connect to the vendor's online network. Often this connection is enabled locally by connecting the Smart Charger to your Wi-Fi network. Depending on where your router is located relative to the Smart Charger, you may need to install a Wi-Fi signal booster to achieve a reliable connection. Please ensure that your Smart Charger is connected to the network before submitting your Program application. If you do not have access to a reliable internet connection, we recommend enrolling using your existing AMI meter (UI customers only).

Wiring Upgrade
L2 chargers require a 240V outlet. If you need to install a new, dedicated electrical circuit and outlet to support your EV charger, you may use any licensed electrical contractor. The Program offers up to $500 in a Wiring Upgrade rebate to cover eligible costs necessary to support your L2 charger. Please be sure to obtain an itemized invoice that clearly shows the cost of the EV charging circuit separate from any other electrical work with invoices showing they were paid. The work must be completed before submitting an application and **the application must be submitted within 90-days of the invoice date**.

Vehicle Connections (Telematics)
Telematics is a system embedded in many EVs that enables more control by users over their EV by making smart decisions about energy use, connect to nationwide charger networks, and other innovative actions. If your EV has Telematics, you likely have access to additional insights and functionality that can give you more control of your EV that might save energy. To receive an upfront Enrollment Incentive for participating with Telematics, you must activate a qualified vehicle model with Telematics in the Program for a period of not less than two years. You will receive activation instructions that are specific to your chosen vehicle in the confirmation email that you receive when you submit your Program application.

Please note that you cannot receive both a Smart Charger Rebate and an Enrollment Incentive. You can, however, combine a Wiring Upgrade rebate with a Smart Charger rebate or Enrollment Incentive.

❖ **A Note to EVSE Vendors Interested in Being Added to the QPL:**
Eligible devices are selected via a request for qualifications ("RFQ") that is hosted periodically by the utilities. Vendors who wish to qualify devices for the Program should register their interest by sending an email to HomeEV@uinet.com for UI or CTEVcharging@eversource.com for Eversource with the subject line "EV Charging Vendor Qualification" and your firm will be notified of the next qualification cycle.

The RFQ includes evaluation of vendor and device capabilities, including but not limited to product safety, environmental suitability, network communications, and data collection and reporting. Vendors with qualifying devices must accept the Program vendor agreement prior to devices being added to the QPL.

Section 7:
Participation in Baseline & Advanced Tiers

The Connecticut EV Charging Program is designed to help customers outfit their homes with the necessary equipment to charge their EVs and to help the utilities reduce the stress on their systems. This Program is intended to be mutually beneficial between the utility customer and the utility such that the customer is aided in their EV journey and the utility is able to orchestrate the charging of large numbers of EVs on the system which ensures system reliability and lower costs for all utility customers. The utilities provide ***two tiers*** of participation which correspond to different levels of participant responsibility, incentives, and of benefit to the utility system. The **Baseline** and **Advanced Tiers** both require the participant to adjust their charging to benefit the utility system, but differ in their approach. This Section defines and explains the two tiers, specifically how the customer must participate in each tier in order to earn incentives.

Baseline Tier

The Baseline Tier aims to be simple and easy to understand such that the participant can “set and forget” an EV charging schedule and shift their charging from times that cause more stress to the utility system to times that cause less stress. The participant always retains control over their charging, scheduling when they would like to charge or not, and receives incentives based on their performance. The fundamental structure of the Baseline Tier is as a **Passive Managed Charging** program where the customer sets a simple schedule, and the utility simply observes performance. There is also the potential for participants to earn more incentives by participating in **Demand Response Events** during the summer months where the utility grid is most stressed.

- **Passive Managed Charging** *(Required)*:

The Baseline Tier is designed as a Passive Managed Charging tier where customers simply set a schedule around a given window of time and avoid charging during that time for the majority of each month. In this way, participants are able to simply set a default schedule and let the Managed Charging Platform stop charging as necessary while preserving the participant’s ability to charge when needed.

Participants must use their relevant utility Managed Charging Platform to charge their EV outside of a specific window of time during the week and coordinate their charging such that 80% or more of their charging time occurs outside of this window. The window is 3pm to 9pm on non-holiday weekdays.

In a given month, if a participant avoids charging between 3pm to 9pm on non-holiday weekdays, then they will earn $10 for that month's performance. For a full year of successful performance, a participant could earn up to $120.

The utilities will observe each participant's charging patterns on an ongoing basis and provide updates on their performance and incentive earnings within their relevant utility Managed Charging Platform so that the participant can keep track of their progress each month and adjust their habits accordingly.

Participants must also charge at least one time for 15 minutes per month. This is to ensure that the participant is actually using the charger and that charging is theoretically being avoided, as the value to the utility system is in avoiding charging during stressful times on the system.

- **Demand Response Events** *(Optional)*:

The Program is managed with consideration of the operating conditions of the electric power system. Demand Response Events are called to assist in controlling the system at key times, as these Events are a way for the utilities to harness the collective electric load of EVs on the utility system and to stop charging for very specific hours when the system's stress is at its maximum. The utilities will call an event and the EVs participating in the Program will have their charging halted for the specific hours of high stress on the grid. Events most commonly occur on hot summer afternoons or early evenings and will last a few hours or less. These periods of high energy demand are called "on-peak" periods. For this Program, Events will be set during the peak season which is June through September during the times of 3pm-9pm.

Participants will, in most cases, be notified well in advance of an Event so there is plenty of time to plan ahead. For most EV drivers, charging occurs during periods of low energy demand, or "off-peak" periods, for example in the evening while they sleep. During these times, there is usually no need for Events, so participants experience very little impact if any on their vehicle's availability and owners of L2 chargers will generally have adequate charge in the morning when participating in Events.

During Events, participants have the option to participate or opt-out if it is necessary for them to charge during that time. This way, participants always retain control over the use of their vehicle but can earn incentives for being flexible when they charge their vehicle.

As mentioned in **Section 4**, participants in the Baseline Tier are able to earn an additional $20 per month during the Demand Response Season which is four months. Therefore, participants could earn up to $80 in additional incentives by participating in optional Demand Response Events.

To receive these optional Event incentives, customers must participate in all Events scheduled in a given month. Participants may opt-out of any event during the four-month Demand Response season, but will forfeit their eligibility for any Event-related incentive in that month. Forfeiting the incentive in one month does not impact the potential incentive in any other month, so participants are able to participate when they can and be rewarded accordingly.

The Demand Response Cycle

Demand Response follows a regular pattern of **Notification**, **Event & Opting Out**, and **Results**:

- ***Notification***
  Participants will, in most cases, be notified well in advance of an Event so there is plenty of time to plan ahead. There may be rare occasions where the utility will call an Emergency Event with less than 24 hours of advance notice. Please refer to the Events & Opting Out section below for more information.

  Notifications providing a schedule for an upcoming Event are issued to participants through the participant's preferred means of contact, determined during the application process (e.g. email and/or via the Program's mobile app and/or web platform provided by utility's respective Technology Partner.)

  After an Event ends, the participant will receive a notification alerting them that the Event has ended.

- ***Events & Opting Out***
  Demand Response Events may occur in June, July, August, and/or September, on weekdays and/or weekends (not including holidays). A typical Event may be up to 3 hours in duration and occur between the hours of 3pm—9pm. During Events, EV charging will be curtailed.

  Once a notification has been received, participants have the option of:

  1. Participating in the Event (Default), or
  2. Opting out of the Event, meaning their charging device will be unaffected by the Event.

  During the Event, the power delivered to any device that has not opted out will be reduced or suspended. Opting out can be completed on the Program application portal or, if applicable, via the Program's mobile app and/or web platform, and customers may opt out of any Event at any time.

  At the end of the Event, power delivery should resume at its normal level. In some cases, devices fail to return to their normal operating mode at the end of an Event. We therefore recommend that participants check the status of their device after receiving the end of Event notification.

  Customers are considered as participating in the Event if they do not opt out through the platform or are not charging during the Event. For example, if a customer is not home during the Event or not plugged in, but did not opt out, they will be considered as participating in the Event.

- **Emergency Demand Response Events**
  If required to maintain the safety and reliability of the grid, utilities may issue Emergency Demand Response Events without prior notice. Critical system events that impact system voltage levels, system stability and safety, or distribution system events that are considered emergencies by utilities may require override of a

customer's EV charger. While such conditions are rare, utilities will attempt to provide advance notification whenever possible, dependent on the nature of the event. Participants do retain the right to opt out of these types of Events, but the above rules on opting out of no more than two Events per month still apply.

As a summary of the Baseline Tier, Participants are able to earn $10 per month for simply setting a charging schedule that avoids charging during the highest stress periods on a daily basis and sticking to that schedule at least 80% of the time. Participants are also able to earn $20 per month between June and September if they do not opt out of occasional Demand Response Events. These events generally occur during the same window that the charging schedule set by the participant avoids. Using a passive "set and forget" schedule, a participant could earn up to $200 annually for participating in the Baseline Tier.

Advanced Tier

The Advanced Tier is a step up from the Baseline Tier in a number of ways, particularly in the benefits to the participant and the utility system, as well as in the role that the participant plays in shifting their EV charging. While there still is a lot of automation that can allow a participant to "set and forget" their charging, the participant may find that they need to keep a more active eye on their charging compared to the Baseline Tier.

In this participation tier, participants are required to set a schedule of charging using two inputs: the **State of Charge** (SOC) they need in a given day, and their **Time the Charge is Needed** (TCIN). The participant must always have these two inputs selected, but can change them at any time. In this way, it is possible to "set and forget" these two inputs, but the participant may find that differences in daily routine might require different inputs.

These inputs are then aggregated with all other participants in the Advanced Tier by the utility's Technology Partner who then uses their advanced managed charging algorithms to coordinate charging to lessen the load on the utility system while delivering the participant's required charging by the time they need it.

As an illustrative example, Participant A generally starts work at 9am, but leaves home at 8:30am. He sets the default inputs to make sure he always has a full battery in time for his commute. Therefore, he sets the default SOC to 100% and the TCIN to 8:30am. These default inputs will resume every day until he needs to adjust them. For example, the same Participant A now has an appointment at 9am on Wednesday morning an hour and a half away from his home. He knows he needs almost a full battery for the round trip, and he needs it ready by the time he leaves at 7:00am to give himself a bit of extra time so he's not rushing. On Tuesday night when he's planning for the next day, he sets the SOC to 100% and the TCIN to 7:00am in order to be sure there is a full charge by the time he needs to leave for his appointment. After the appointment, he then resets his inputs back to the default and resumes as normal until he must adjust his SOC and/or TCIN to accommodate variations in his routine.

The utilities will observe each participant's charging patterns on an ongoing basis and provide updates within their relevant utility Managed Charging Platform so that the participant can keep track of their progress each month and adjust their habits accordingly.

Participants must also charge at least twice for 15 minutes per month. This is to ensure that the participant is actually using the charger and that charging is theoretically being avoided, as the value to the utility system is in avoiding charging during stressful times on the system.

Participation Results & Distribution of Incentives

The utilities are able to observe the performance of all participants in order to evaluate each participant's adherence to the requirements of the relevant tier and to determine the amount of incentives to which each participant is entitled. Participants will be provided their individual results on their dashboard in the online application portal or through their respective utility's Managed Charging Platform throughout their participation in the Program, so they may track their progress each month. Participants are distributed incentives based on their performance in this Program. If you have questions about your participation results, please reach out to HomeEv@uinet.com for UI and EversourceEVSupport@clearesult.com for Eversource.

All incentives earned by a participant in either the Baseline or Advanced Tier are paid on either a semi-annual basis (Eversource participants) or a quarterly basis (UI participants), based on that participant's performance during each month of the preceding time period. The payment will be distributed via prepaid e-gift card.

Moving or Ending Participation

All enrolled participants are required to remain in the Program for a period of not less than two years from the date the participant's application is approved. After two years, participation continues until the participant submits a request to disenroll or until the Program is discontinued.

In the event a participant moves within the utility's territory, they are required to continue their participation at the new service address. Customers can move the location of their participation by logging into the application portal, opening a Request Support form, and submitting the required information.

Customers can request to disenroll by logging into the application portal, opening a Request Support form, and submitting with the required information. A participant moving outside of the utility's territory shall be an approved reason for ending participation before completing two years.

Participants that leave the Program before the 24-month period ends will be required to pay back a prorated portion of the upfront incentives they received as part of this Program.

Section 8:
Program Support

For application or rebate support, customers can contact Program staff for questions using the contact information below. Please allow two businesses days for a response to your email or voicemail.

Phone: (888) 978-1440
Hours of availability: 8:30am–5:00pm, Monday–Friday excluding holidays
Emails:
Eversource: EversourceEVSupport@clearesult.com
UI: UIEVSupport@clearesult.com

For UI customers seeking device setup and/or Program support, please email UI at HomeEV@uinet.com. An Energy Specialist will contact you within two business days.

Section 9: Frequently Asked Questions (FAQs)

The following are a list of Frequently Asked Questions for this Residential Managed Charging Program provided by United Illuminating (UI) and Eversource.

What are the benefits of this program?
By participating, you can earn upfront rebates and enrollment incentives, as well as ongoing participation incentives. These rebates and incentives help offset the cost of EV charging, including the cost of outfitting your home with a Smart Charger. There are also ongoing incentives available for Managed Charging participation over time. Participation in Managed Charging helps reduce your carbon footprint.

Who is eligible to participate in this program?
Residential UI and Eversource customers living in single-family dwellings (four units or fewer) who meet the technical requirements, specified in this Program Participant Guide, may enroll in the Managed Charging Program. Participation in Managed Charging is required to take advantage of utility rebates for the purchase and installation of a new Smart Charger or enrollment incentives for participation using an EV’s onboard telematics system. In addition, residential customers with an existing Level 2 Smart Charger can participate in the program.

What is Managed Charging?
Managed charging programs provide incentives to customers who adjust or permit their utility to adjust the timing of their EV charging. Managed charging helps minimize energy consumption during times of peak demand, or stress, on the utility grid. In doing so, the utilities avoid using more expensive and carbon-intensive electricity, which reduces our region’s electricity cost and carbon footprint. Presently, managed charging functions in two ways: through demand response events and off-peak charging.

Demand Response for EVs is a type of Managed Charging where signals are sent from the utility to the EV owner and their EV or Smart Charger. These are called “Events,” and during these Events, the participant allows the utility to curtail, or turn off, charging for the duration of an event, usually 2-3 hours.

Off-peak charging allows participants to manage their own charging schedule and be incentivized for charging at times that are beneficial for their utility. The goal of off-peak charging is to have a high portion of charging take place during off-peak times when there is less demand on the electric grid. Off-peak charging times include any time outside of 3:00 p.m. to 9:00 p.m. on non-holiday weekdays.

What are my responsibilities for participation in this program?
To receive incentives within this program, customers must participate in Managed Charging, which provides rewards for helping UI and Eversource reduce strain on their electric systems. Depending on which level of participation to which you apply, your participation will require different actions from you:

Baseline Tier of Participation:

1.) You control your energy usage by scheduling your charging during off-peak hours at least 80% of the time. Off-Peak hours are non-holiday weekdays anytime outside of 3:00 p.m. to 9:00 p.m. This simple action can earn you incentives of up to $120 per year when you’re enrolled in the Baseline Tier of Managed Charging.

2.) During specific times of peak energy demand and stress on the system, the utilities adjust the time and speed of charging using what are known as “Demand Response Events.” These Events only happen during the summer months between June and September and will only occur at times of high stress on the utility grid. Participating in these Events can help minimize more expensive and more polluting power generation. You can participate either through a vehicle with eligible telematics or a qualified Level 2 Smart Charger. Participating in these Events is optional, but you can earn incentives of $20 per summer month ($80 per year) for participating in all events in each summer month when enrolled in the Baseline Tier.

Advanced Tier of Participation:

3.) Finally, there is an Advanced Tier of Managed Charging which steps up the responsibilities of the participant, but, in turn, rewards the participant significantly more. Whereas it is possible to earn $200 annually in the Baseline Tier ($120 for off-peak charging plus $80 for participating in all Demand Response Events), participants in the Advanced Tier can earn up to $300. In this tier, the participant is required to maintain a charging schedule on a daily basis by coordinating with the utility. The participant, using a web portal and/or mobile app, must input the level of charging they need the next day and at what time they need it. The utility does the rest, coordinating charging of all participants at once and ensuring that each participant has the amount of charging they need, when they need it. This does require participants in the Advanced Tier to keep a closer eye on their charging, but this extra effort is rewarded!

Please take some time to learn about the difference between, and the requirements of each participant within, the two tiers of participation. There are more details on participation that are not explained above and the utilities have developed helpful guides and documentation which can be found on either the **UI Managed Charging page** or the **Eversource Managed Charging page**.

Are there incentives available for participation in Managed Charging?
Yes. UI and Eversource offer monthly incentives to customers for their Managed Charging participation. The specific rewards vary depending on which participation level to which you apply. The Baseline Tier enables participants to earn up to $200 per year, while the Advanced Tier enables participants to earn up to $300 per year. The higher incentive levels in the Advanced Tier correspond with higher levels of responsibility.

For more details, visit the **UI Managed Charging page** or the **Eversource Managed Charging page**.

If I already have a home charger, can I still receive incentives through this program?
Yes, if you've already taken the step to install an eligible charger at your home you can still be eligible for $100 to enroll that device in the program and also be eligible for ongoing participation incentives, as long as you are willing and able to fully participate in the responsibilities of your chosen participation tier.

Why are utilities like Eversource and UI administering this program?
Managed Charging programs encourage users to charge off-peak, which helps the utilities handle times of stress on the grid which, if unmanaged, can lead to higher costs for all utility customers. It also helps the utilities avoid using more carbon-intensive electricity, which reduces our region's carbon footprint. These programs can also enable utilities to integrate more renewable energy and utilize the flexibility of EV charging to provide additional services to their territory. Utilities pass on these benefits to all customers in the form of cheaper electricity and other programs such as this.

Will participating in managed charging require me to change my charging habits?
The short answer is "yes" – the utilities provide incentives and tools to make these habit changes painless and may make charging easier and more efficient for you. The Program is intended to assist drivers in meeting their needs for charging while helping the utilities coordinate EV charging such that their systems are not impacted by the growing number of EVs in their service areas. You will always retain control of your charging while participating in the program and you will be able to set your preferences to match your needs.

The Program and associated platform provide tools that help with scheduling your charging in such a way that your charging is beneficial to you and to the utility. There are two tiers of participation which correspond to different level of responsibilities and incentives for shifting your charging. If you are currently charging during stressful times on the utility system, this will require a habit change, but the utilities have made this as effortless and as rewarding as possible.

What are the incentives and rebates available through this program?
Below is a table outlining incentives available for different technological setups for this program.

Note: *the amount of incentive dollars available per solution does not imply one setup is inherently better than another. Depending on the particulars of your EV and technology setup, the cheapest and best option might receive the fewest incentive dollars. Please review the remainder of this Program Participant Guide to understand which of the possible eligible technologies is best for you.*

Customer Scenario		**Networked Level 2 Charger Rebate** *(up to)*	**Wiring Upgrade to 240v Rebate** *(up to)*	**One-Time Enrollment Incentive**	**Baseline Managed Charging Program (up to)***	**Advanced Managed Charging Program (up to)***
New Networked L2 Charger	*Needs 240v Outlet*	$500	$500	$0	$200/year	$300/year
	Has 240v Outlet	$500	$0	$0	$200/year	$300/year
Telematics with Non-Networked L2 Charger	*Needs 240v Outlet*	$0	$500	$100	$200/year	$300/year
	Has 240v Outlet	$0	$0	$100	$200/year	$300/year
All Other L2 Chargers *(UI ONLY)*	*No Wiring Rebate*	$0	$0	$100	$200/year	Not Available

**These incentives accrue over the first year of participation in either the Baseline or Advanced Managed Charging Tiers. Participating customers are eligible for up to $200 or $300 respectively per year.*

When will I receive my incentives?
Upfront rebates and incentives will be distributed via check 10 business days after meeting all eligibility requirements, including proof of purchase and installation, and connecting your charger or vehicle to the utility’s Managed Charging Platform. Participants in Managed Charging will receive ongoing incentives throughout the year. Participation incentive payments will be distributed bi-annually in April and October by Eversource and quarterly by UI. Participants will be notified of their progress and performance throughout the year.

What charging technologies qualify?
There are many technologies that can participate in this program and this list is always expanding as EV manufacturers expand their capabilities and more Smart Chargers enter the market. The Program is designed to allow almost all EV owners with any level 2 charger (Networked or non-Networked) to participate, however, specific combinations of EV and EV chargers might not be eligible. Please refer to **Section 6** of this Program Participant Guide for information on eligibility and information on the types of devices and vehicles that can participate. You can find the Qualified Products List ("QPL") on Eversource's website here and on the UI website here.

What does it typically cost to install a Level 2 EV charging station at my home?
Costs to install a Level 2 charging station vary depending on which charger you choose and how much electrical work must be done to put the station where you need it. Typically, a Networked Level 2 charger will cost $600-700. Depending on your situation, the typical installation can cost between $500-1200.

Are there additional incentives available if I have more than one EV in my household?
Yes, if you have more than one EV, you can apply for a second set of incentives for a smart charger and participation in Managed Charging, however this is the limit for incentives per electric account.

If I already applied and received EV charging incentives, can I apply for incentives again?
Yes, but only if you are applying for a second EV in the house. If you have a second residence that is on a separate electric meter, you can apply for this separately from your current electric account.

Is there a limit to how many incentives will be provided?
Yes, the utilities have been approved for a certain level of funding for incentives. At this time, the funds have not reached their limit and encourage you to apply.