

Memorandum

To: Eversource

From: Guidehouse

Date: July 6, 2020

Re: 2019 Electric Vehicle Supply Equipment Direct Load Control Demonstration – Process Evaluation Findings

This memo summarizes the methods and results of the participant survey and literature review conducted for the evaluation of Eversource's 2019 Electric Vehicle Supply Equipment (EVSE) Direct Load Control (DLC) demonstration. The EVSE DLC demonstration evaluated in this study is part of the Massachusetts Program Administrators' (PAs') broader set of active demand reduction initiatives.

Key Findings

Key findings from the participant survey and literature review include:

- Survey respondents were generally very pleased with their program experience in 2019, despite events being called late in the evening (7 or 8 p.m.) when home charging is more common (compared to earlier in the day). In terms of program improvements, participant suggestions focused on modifications to program communications (event notification and program information).
- Based on survey feedback, the most common period during which EVs are connected to chargers on summer weekdays is between 6 p.m. and 6 a.m. A DLC program that calls events in the afternoon (earlier than 6 p.m.) on summer weekdays may see limited impacts.
- 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.
- Early EVSE Demand Response (DR) pilots have shown promising potential, but challenges related to equipment connectivity and asset availability will 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.

Demonstration Summary

The EVSE DLC demonstration aims to reduce peak demand of home electric vehicle (EV) charging load by way of Wi-Fi-enabled Level 2 EVSE.^{1,2} Participating customers were provided incentives for allowing Eversource to restrict their EV charging during demand response (DR) events, as well as for access to their charging data. Eversource is targeting enrollment of 300 chargers by 2021, including residential and commercial and industrial (C&I) customers in Massachusetts and Connecticut. The 2019 demonstration targeted Massachusetts residential customers only. As of October 31, 2019, 74 Massachusetts residential customers were enrolled.

Table 1 summarizes the key attributes of the 2019 demonstration.

Table 1. 2019 EVSE DLC Demonstration Summary

	Program Attributes	2019
Program Participants	State(s)	Massachusetts
	Customer Segment	Residential
	Customer Subsegments*	Customers buying a new Level 2 charger Customers that have an existing Level 2 charger
	Customers Enrolled as of October 31, 2019	74
2019 Event Characteristics	Evaluation Period	August 1-October 31
	Number of Events	4 events ³
	Event Duration	3 hours
	Event Hours	Two events were called from 7 p.m. to 10 p.m. and one event was called from 8 p.m. to 11 p.m. on non-holiday weekdays. ⁴
	Event Dispatch Criteria	Days forecast to be high demand days
	Event Notification Option(s)	In-app; email and SMS text message are additional options
	Event Notification Timing	Day-ahead
	Demand Reduction Approach	Throttling (i.e., Level 2 to Level 1)
	Opting Out	Participants can opt out at any time following event notification via EVSE manufacturer app

*For the 2019 demonstration, only Level 2 chargers from one EVSE manufacturer were eligible to enroll.

Source: Guidehouse

¹ For reference, Level 1 chargers use a 120-volt connection (standard household outlet) and typically have a kilowatt (kW) rating of 1.4. Level 2 chargers use a high-output 220/240-volt power source (what is used for appliances such as clothes dryers and electric ranges and which is often present in garages) and typically have a kW rating between 6.2 and 7.7 kW.

² For the 2019 demonstration, only Level 2 chargers from one EVSE manufacturer were eligible.

³ Charging data suggests the fourth event did not implement throttling as intended—a 3-hour reduction in average power draw starting at the beginning of the event is not visible as it is on the other event days.

⁴ 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.

Eversource designed the demonstration to include two different incentive structures targeting separate customer segments, as Table 2 shows. Of customers enrolled as of October 31, 2019, 37% purchased a new, eligible Level 2 charger in conjunction with or before enrolling in the demonstration.⁵ The remaining 63% of demonstration participants enrolled an existing, eligible Level 2 charger in the program.^{6,7,8}

Table 2. EVSE DLC Demonstration: Enrollment by Customer Incentive Level⁹

Customer Segment	Incentive	Enrolled as of October 31, 2019
Residential customers buying a new* Level 2 charger	Enrollment incentive of \$300 [§]	28
Residential customers that have an existing Level 2 charger	Enrollment incentive of \$150 [§] plus an annual participation incentive of \$50 [‡]	46

* Determined based on first activation date (on or after June 1, 2019).

§ Based on agreement to participate in the program for 3 years.

‡ Contingent on not opting out of more than three events per season.

Source: Guidehouse

Table 3 summarizes the DLC events called in 2019, as well as the number of chargers enrolled when each event occurred.

Table 3. EVSE DLC Demonstration: Enrollment by Event Date¹⁰

	August 19, 2019	October 8, 2019	October 17, 2019
Event Period ¹¹	8 - 11 p.m.	7 - 10 p.m.	7 - 10 p.m.
Chargers Enrolled	31	67	70

Source: Guidehouse

⁵ Activation date on or after June 1, 2019.

⁶ Activation date before June 1, 2019.

⁷ For BEVs, charging times range from 11 to 43 hours (Level 1) and from 3 to 13 hours (Level 2). The following link provides information on charging times for different models of BEVs using a Level 1 v. Level 2 charger: https://www.clippercreek.com/wp-content/uploads/2020/05/Level-1-vs-Level-2_Chart_-20180502_Final_1080.jpg

⁸ For PHEVs, charging times range from 5 to 15 hours (Level 1) and from 1 to 4.5 hours (Level 2). The following link provides information on charging times for different models of PHEVs using a Level 1 v. Level 2 charger: https://www.clippercreek.com/wp-content/uploads/2020/05/Level-1-vs-Level-2_Chart_-20180502_Final2_1080.jpg

⁹ Current costs of purchasing a Wi-Fi -enabled Level 2 charger typically range from \$600-\$1,000 (<https://plugstar.com/chargers>). Costs of installation vary based on existing electrical setup, desired location of charger, and region, but could be in the range of \$400-1,200 (<https://www.chargepoint.com/blog/electric-car-home-charger-rebates/>).

¹⁰ Eversource intended to call a fourth event on October 25, 2019. Charging data suggests event throttling was not implemented as intended on October 25th —a 3-hour reduction in average power draw starting at the beginning of the event is not visible as it is on the other event days.

¹¹ 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.

Evaluation Methods

This section of the memo describes the approaches for conducting the participant survey and the literature review.

Participant Survey

Guidehouse (the evaluation team or the team) administered an online survey with 2019 EVSE DLC demonstration participants enrolled as of October 31, 2019. The survey explored the questions listed in Table 4:

Table 4. Participant Survey Research Objectives

Topic	Research Questions
Motivations and Enrollment	<ul style="list-style-type: none">• What is the primary motivation for customers to enroll?• What program marketing approaches are effective for engaging and enrolling customers in the program?• Did customers experience any challenges during the enrollment process?
Participant EV Types	<ul style="list-style-type: none">• What types of EVs do participants have—e.g., battery EV (BEV) or plug-in hybrid EV (PHEV), power acceptance rate?
Participant Driving and Charging Behavior	<ul style="list-style-type: none">• What are typical driving and charging patterns?• Are certain customer segments more likely to participate?
Experience During Events	<ul style="list-style-type: none">• Are customers opting out? If so, why?• Did events have any impact on participant driving or charging behavior?
Overall Program Experience	<ul style="list-style-type: none">• What suggestions or recommendations do customers have related to program improvement?

Source: Guidehouse

The evaluation team designed the survey instrument and had it reviewed by Eversource and the Energy Efficiency Advisory Council (EEAC) EM&V consultant before fielding the survey. The survey instrument is included in Appendix B. The survey was administered online via the Qualtrics platform from December 16 through December 23, 2019 to the 74 customers enrolled in the demonstration as of October 31, 2019. Ultimately, 53 participants completed the survey.

Table 5. Participant Survey Characteristics

Survey Characteristic	Description
Implementation Method	Online
Incentive	\$25
Frequency/Timing	Conducted from December 16 through December 23, 2019
Sample	All demonstration participants enrolled as of October 31, 2019 (74 participants)
Number of Completes	53 ¹²
Response Rate	72%

Source: Guidehouse

Literature Review

Guidehouse performed a literature review to collect and synthesize information about EV managed charging programs being offered by other utilities around the US. The objective of this review was to provide Eversource with a summary of programs that have similar features as the Eversource program, as well as examples of different managed charging program frameworks that exist in the market. The evaluation team collected information about program design and delivery, technology trends, and the overall experience that other utilities have had when attempting to manage EV charging by means of customer programs. In total, Guidehouse reviewed 14 programs in 12 jurisdictions.

The evaluation team's approach for the literature review included researching publicly available sources and gathering input from Guidehouse staff involved in industry functions related to managed charging. The team reviewed information from various stages of the program life cycle, including some programs that have been previously offered, some that are currently being offered, and some that are planned for future offerings. In this memo, to present findings, Guidehouse grouped the programs into categories based on the delivery model for managed charging (i.e., direct load control via EVSE or vehicle telematics, and pricing-based) and market sectors targeted (i.e., residential, workplace, MUD, municipality, public).

Analysis and Results

This section details the key findings from the participant survey and literature review.

Participant Survey

Guidehouse conducted a participant survey following the evaluation period to obtain feedback from participants on several topics. Key takeaways from the participant survey results include the following:

- **Motivations and Enrollment:**
 - Program incentives were a primary motivation for enrolling in the program and encouraged 15 respondents (28%) to purchase a new charger.
 - The majority of respondents (94%) were satisfied with the enrollment process. Eight respondents indicated that, after completing the enrollment process, they were confused about their enrollment or rebate status.

¹² 55 customers responded to the survey, but two customers were removed because they only made it partway through the survey.

- **Participant EV Types:**
 - Approximately 60% of survey respondents have BEVs and half have PHEVs.^{13,14,15} Those with new chargers tend to have newer vehicles with larger battery capacities, which would require less frequent charging, potentially limiting the DR potential for this program. Relatedly, survey feedback indicates that participants with BEVs are charging less frequently than participants with PHEVs.
- **Charging Behavior:**
 - *Home Charging:* The most common “connected” period during summer weekdays is between 6 p.m. and 6 a.m. A DR program that calls events in the afternoon earlier than 6 p.m. on summer weekdays may see limited impacts.
 - *Workplace Charging:* About half of respondents indicated they have access to charging at their workplace. For those with workplace charging, a weighted average of 25% of charging occurs at the workplace. As access and availability to workplace charging increases, the DR potential associated with home charging will likely decrease.
 - *Public Charging:* Close to two-thirds of respondents indicated they rarely or never use public charging stations on weekdays during the summer.
- **Experience During Events:**
 - Close to all respondents who recalled at least one event recalled receiving advance event notification. Suggestions for improvement to event notification included allowing for receipt of both email and text message notification¹⁶, providing a technical support pathway, and providing information related to the environmental impact of events.
 - Most respondents indicated the event had no effect on their charging and driving behavior. All customers surveyed indicated they did not opt out of any event (not that not all participants were home or connected to charging when events were called).¹⁷ Although customer response to DR events that occur earlier could be different, this finding suggests that participant acceptance of DR events may not be a limiting factor on program potential.
- **Overall Program Experience:**
 - 98% of respondents who recalled at least one event indicated they are likely to continue to participate in the program. Suggestions for improvement included providing explanation of what the program is doing and the environmental impact of the program.

Key results of the survey are summarized in the following sections. Supplemental results are included in Appendix A, including survey results related to participant experience with the enrollment process and participant driving behavior.

Motivations and Enrollment

As Figure 1 shows, customers indicated they primarily enrolled in the program to receive incentives and reduce their environmental impact. Of respondents, 60% (32) were paid a \$200 program

¹³ Percentages sum to more than 100% since 4 participants have both types.

¹⁴ The following are the most common BEV manufacturers and models (with varying model years) reported by survey respondents: Chevrolet Bolt (9), Tesla 3 (5), BMW i3 (4), VW e-Golf (4), and Nissan Leaf (4).

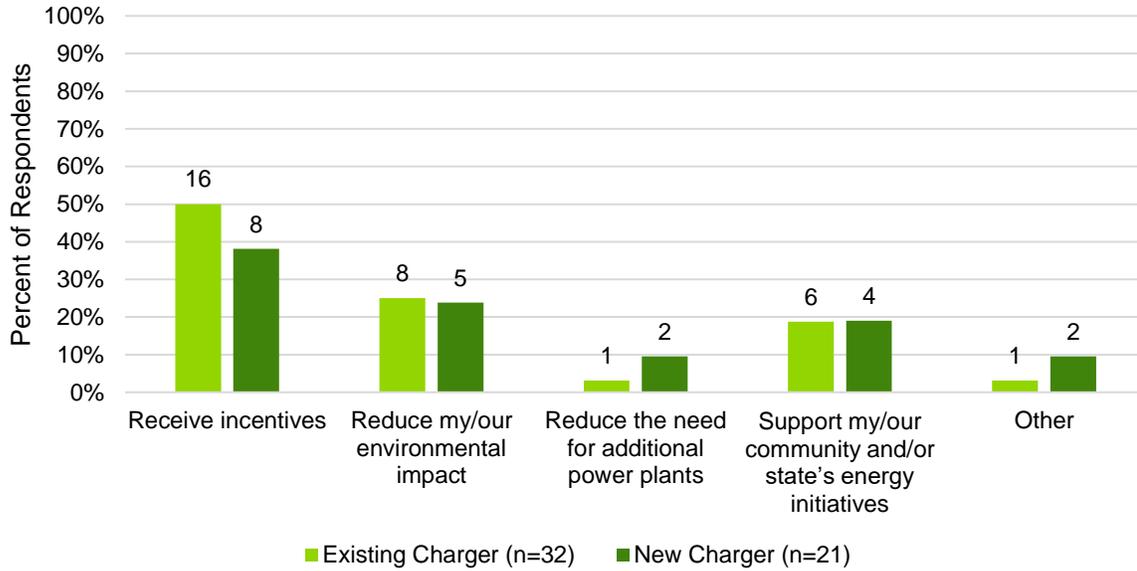
¹⁵ The following are the most common PHEV manufacturers and models (with varying model years) reported by survey respondents: Honda Clarity (6), Chevrolet Volt (5), Chrysler Pacifica (3), Toyota Prius Prime (3).

¹⁶ Indicates some respondents were unaware that they could receive email and text notification.

¹⁷ Guidehouse’s preliminary review of telemetry confirms this.

incentive, indicating they enrolled an existing charger in the program, while 40% (21) were paid a \$300 incentive, indicating they purchased a new charger in conjunction with program enrollment.¹⁸

Figure 1. Top Motivation for Enrolling in the Program



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

Source: Guidehouse

Of respondents with a new charger (21), 71% (15) indicated they purchased a new charger because of the program. When asked about their top motivation for buying their EV(s), 53% of all survey respondents (28) indicated their top motivation for buying an EV was to help the environment. The next most common response was the desire to have the latest technology (13%, seven respondents). Those who cited available rebates as their top reason for purchasing an EV (10%, five respondents) indicated they received both federal and state incentives.

When asked about their experiences enrolling in the program, 94% (50) of respondents indicated they were satisfied with the process of enrolling in the program. Eight respondents indicated that, after completing the enrollment process, they were confused about their enrollment and/or rebate status. Additionally, two respondents indicated they would have liked more information about how the program works and where to go for questions. Two different respondents indicated they wanted to see more information about intended program impact and how the data being collected would be used.

Participant EV Types

Guidehouse collected information about number of licensed drivers and vehicle information (make, model and year of EVs and presence of non-EVs) for each household. Guidehouse used self-reported information on make, model and year of EVs to determine, through additional research, the battery capacity and onboard power draw associated with respondent EVs.

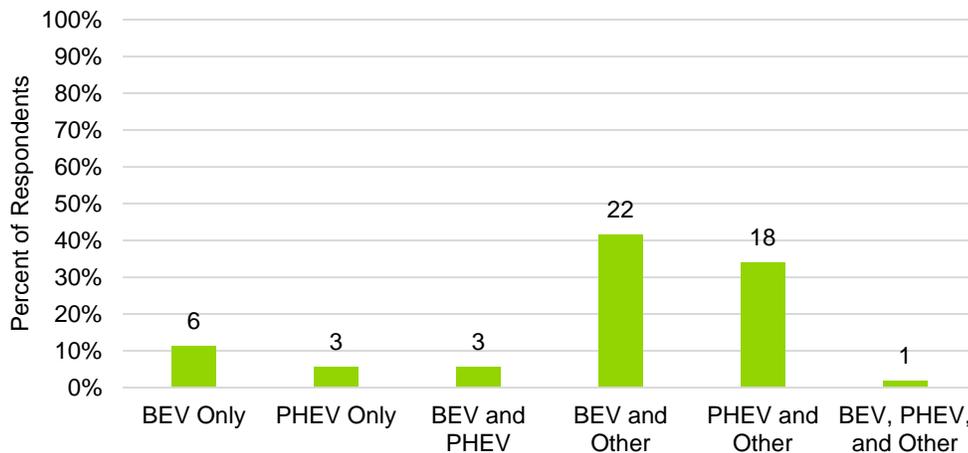
In terms of the number of licensed drivers in participant households:

¹⁸ "Existing" versus "New" counts are based on the incentives tracker provided by Eversource.

- 68% (36) of survey respondents have two licensed drivers in their household.
- 21% (11) of respondents have three or more licensed drivers.
- 11% (6) have only one licensed driver.

As **Error! Reference source not found.** shows, approximately 60% of survey respondents have B EVs and 47% have PHEVs (these percentages sum to more than 100% since 4 participants have both types). Twelve respondents only own EVs.

Figure 2. Vehicle Types by Household (n=53)^{19,20}



Q9. 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). The 53 survey respondents have 61 total EVs—34 BEVs and 27 PHEVs.

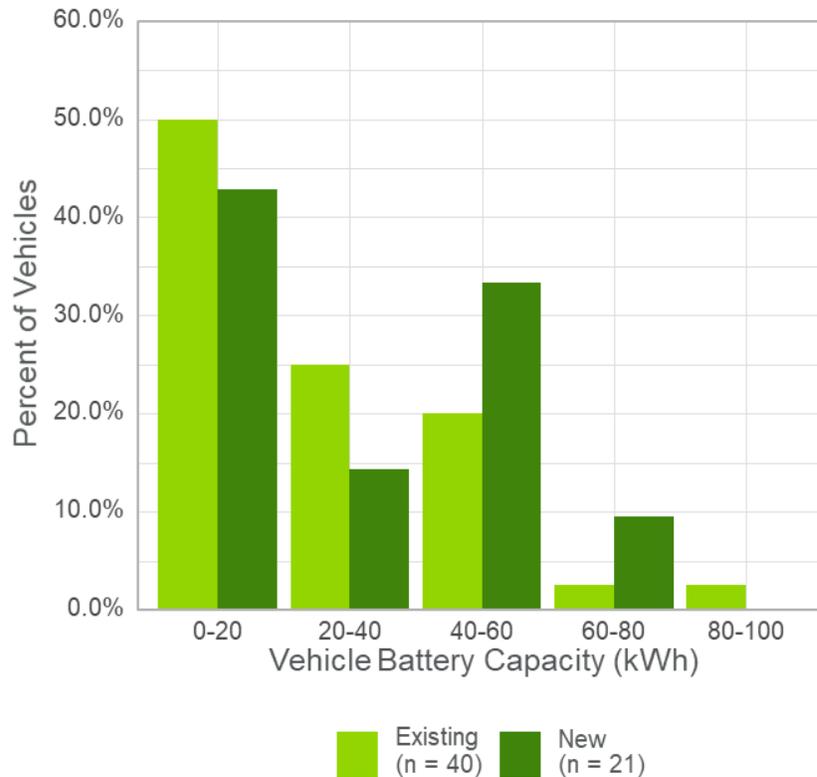
Source: Guidehouse

The 53 survey respondents have 61 EVs among them. Roughly 55% of EVs owned by survey respondents are BEVs and roughly 45% are PHEVs. This breakdown is approximately the same for survey respondents with new versus existing chargers. Survey responses indicate that customers with newly activated chargers tend to have newer vehicles with larger battery capacities (Figure 3), which would require less frequent charging, potentially limiting the DR potential for this program. Additional survey results related to respondent EV types are included in Appendix A.

¹⁹ The following are the most common BEV manufacturers and models (with varying model years) reported by survey respondents: Chevrolet Bolt (9), Tesla 3 (5), BMW i3 (4), VW e-Golf (4), and Nissan Leaf (4).

²⁰ The following are the most common PHEV manufacturers and models (with varying model years) reported by survey respondents: Honda Clarity (6), Chevrolet Volt (5), Chrysler Pacifica (3), Toyota Prius Prime (3).

Figure 3. Respondent Vehicle Battery Capacity by Incentive Type



Note: Vehicle battery capacity was determined based on self-reported vehicle make, model, and year. Devices are considered “New” if their activation date was 6/1/2019 or later.

Source: Guidehouse

Participant Driving and Charging Behavior

The participant survey included questions aimed at understanding participant charging behavior at home, at the workplace, and via public chargers. Respondents with more than one EV were asked to respond to questions related to charging (and driving) behavior for the vehicle whose driving and charging schedule they are most familiar with.

As context for results related to charging behavior:

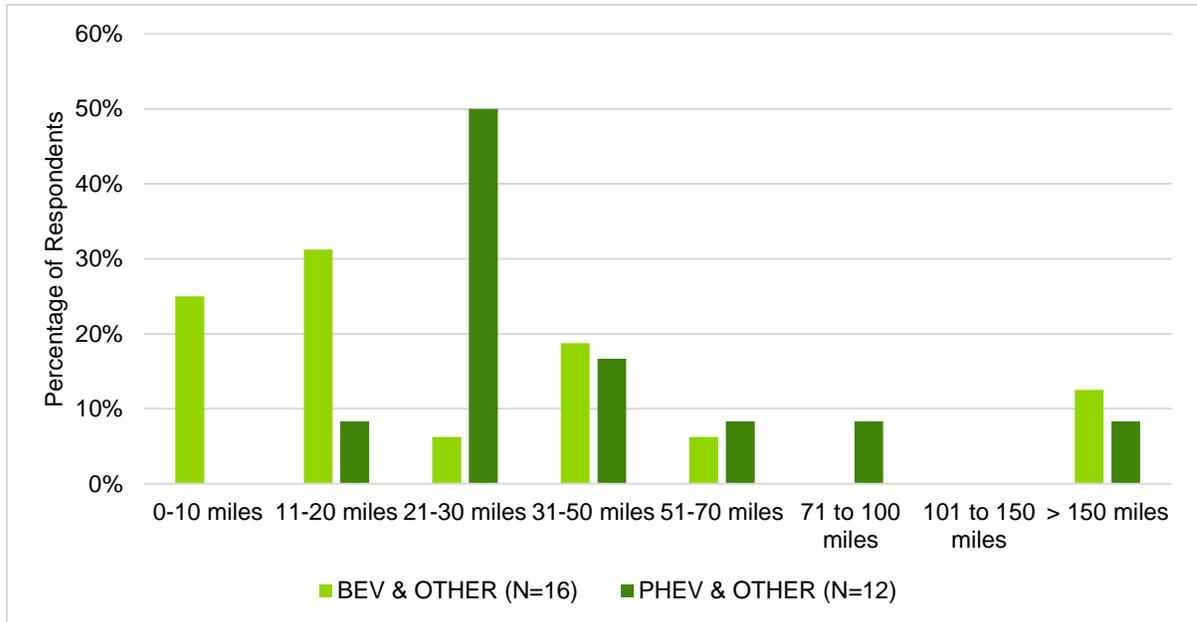
- 79% (42) of respondents indicated they typically use their EV on a regular schedule on weekdays during the summer, while 32% (17) use the EV on an as-needed basis (e.g., to complete errands).
- 64% (34) of respondents indicated the distance their EV is driven is relatively constant from day-to-day across summer weekdays (M-F) while the remaining indicated miles driven depends on day of week or month.

Respondents were asked to provide the miles their EV is driven during on a typical summer weekday (M-F). Figure 4 shows daily miles driven on the typical summer weekday broken out by respondents

with BEVs versus PHEVs.²¹ For simplicity, the figure includes only respondents who indicated the distance that their EV is driven is relatively constant from day-to-day across summer weekdays (M-F) and also only includes respondents who indicated their household has a non-electric vehicle(s) in addition to an EV. The figure also excludes respondents with more than one EV (i.e., both a BEV and PHEV or multiple BEVs or PHEVs).

As seen in the figure, there is some indication that participants with BEVs may drive less, on average, than those with PHEVs. However, the sample size is small.

Figure 4. Typical EV Miles Driven on Summer Weekdays



Q15. During a typical summer weekday (M-F), how many miles is your electric vehicle driven by you and other members of your household?

Note: Only reflects respondents who indicated the distance that their EV is driven is relatively constant from day-to-day across summer weekdays (M-F). Counts also exclude respondents with BEV & PHEV, as well as respondents with multiple BEVs or multiple PHEVs.

Source: Guidehouse

Additional survey results related to self-reported driving behavior are included in Appendix A.

Home Charging Behavior

Survey respondents were asked if they typically connect their EV when it is not being used and is at home. Overall,

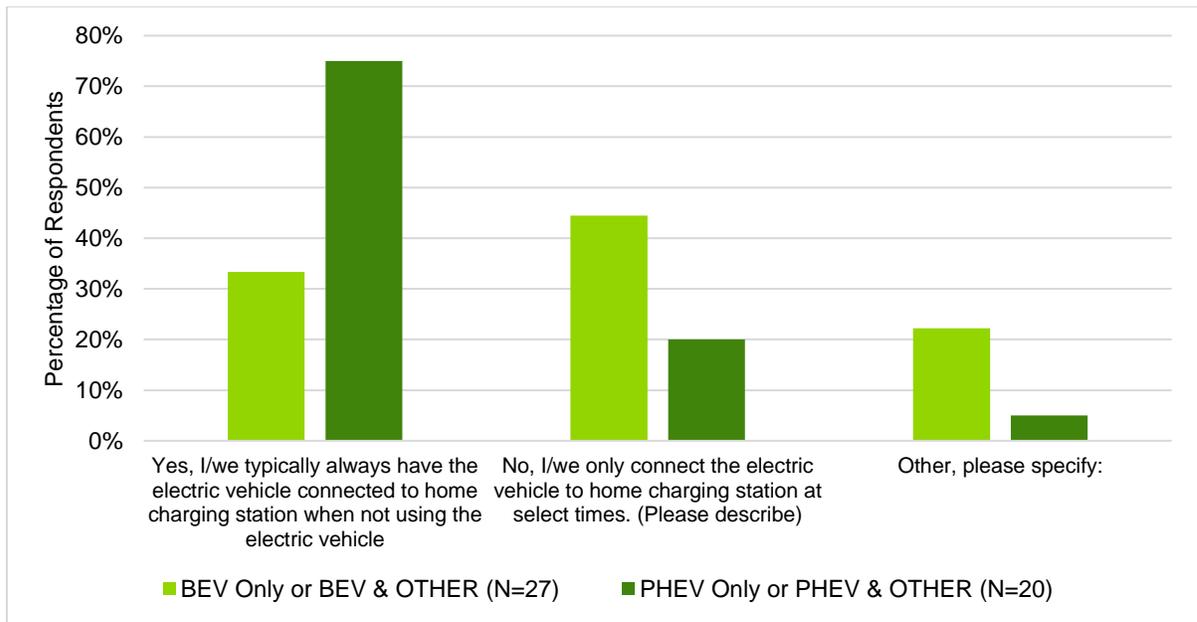
- 51% (27) of respondents indicated their primary EV is typically connected to their home charging station when it is at home.
- 36% (19) of respondents connect to their chargers only during select times. Twelve of these respondents indicated they only connect to charge as needed overnight or if the battery is very low.

²¹ PHEVs may drive for 10 to 50 miles using only electricity before they start using gasoline. The typical mileage range of a BEV is 75 to 250 miles.

- 13% (7) of respondents selected Other; five of these respondents indicated they only charge if the battery is very low.

Figure 5 shows “connected” behavior broken out by respondents with BEVs versus PHEVs. Note again that the figure excludes respondents with more than one EV (i.e., both a BEV and PHEV or multiple BEVs or PHEVs). As indicated in the figure, on average, respondents with BEVs connect and charge less frequently than those with PHEVs. This is likely at least partly explained by the larger battery capacity of BEVs, but is also influenced other factors, such as driving behavior (Figure 4).

Figure 5. “Connected” Behavior by EV Type



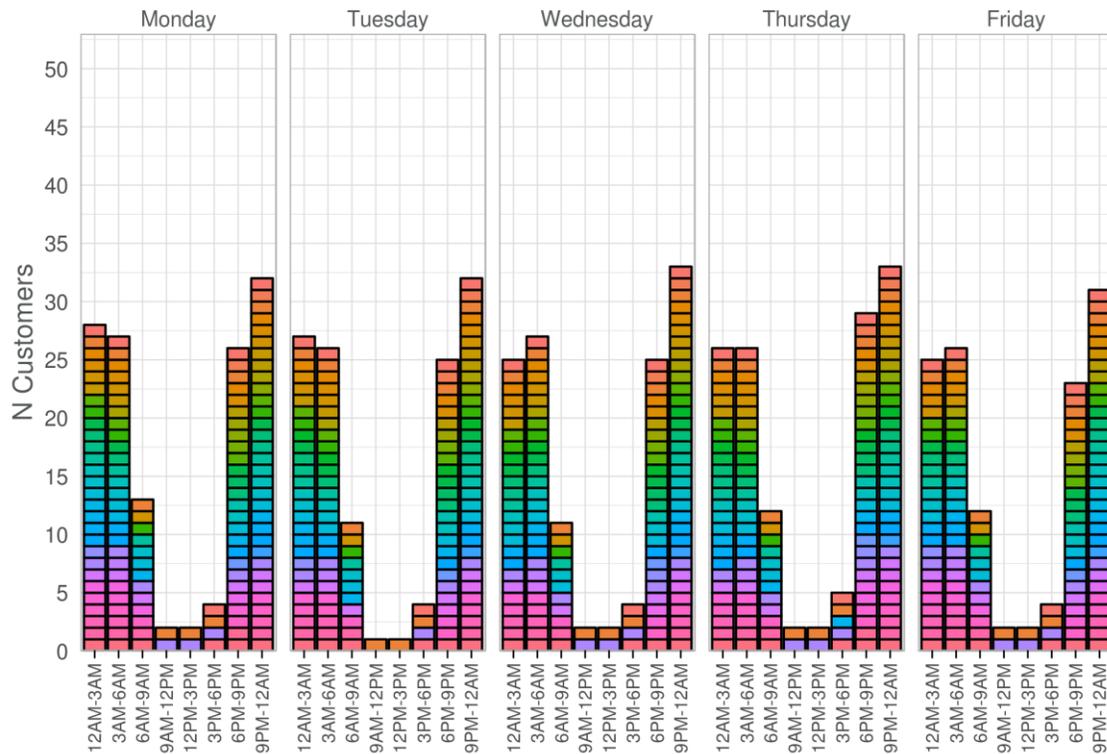
Q19. When your electric vehicle is home and is not being used, is it typically connected to your home charging station?

Note: Counts exclude respondents with BEV & PHEV, as well as respondents with multiple BEVs or multiple PHEVs.

Source: Guidehouse

In terms of the most common times respondents have their EVs connected to home chargers during summer weekdays, the most common “connected” period is overnight between 6 p.m. and 6 a.m. A DR program that calls events in afternoons earlier than 6 p.m. during summer weekdays may be see limited impacts.

Figure 6. Connected Times at Home



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.

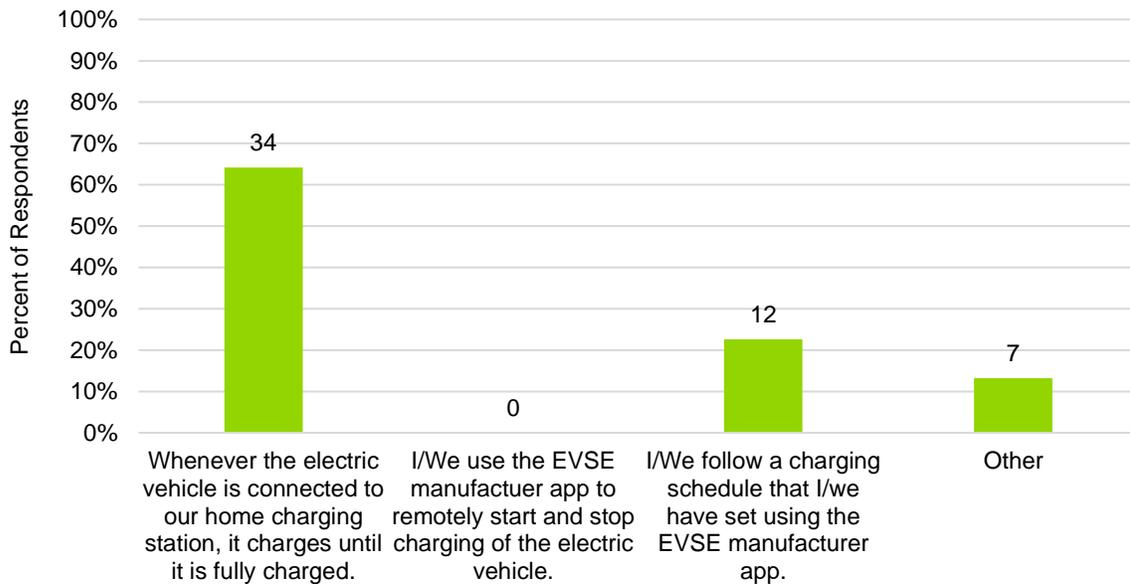
Note: Each color represents an individual respondent. The responses ‘Varies by month’, ‘Do not charge’, and ‘Not sure’ were excluded from the figure due to low response rates to allow for clearer visualization. Depending on the day of the week, 11 to 14 respondents chose responses ‘Varies by month’, ‘Do not charge’, or ‘Not sure’.

Source: Guidehouse

As Figure 7 shows, 64% (34) of respondents indicated that whenever their EV is connected to their EVSE, they charge the EV until it is fully charged. Of respondents, 23% (12) indicated they follow a charging schedule set through the EVSE manufacturer app. Other charging behavior included:

- Setting a schedule through the car/car’s application
- Charging only as necessary
- Charging only as much as needed until they can charge at work

Figure 7. Typical Home Charging Behavior (n=53)



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

Source: Guidehouse

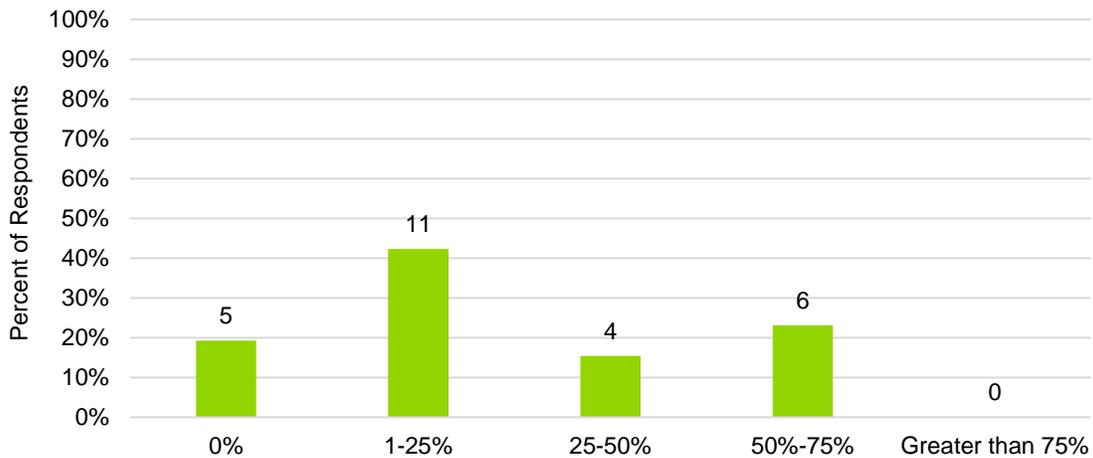
Workplace Charging Behavior

Of respondents, 49% (26) indicated they have access to charging at their workplace. For those with access to workplace charging, a weighted average of 25% of charging occurs at the workplace (using range mid-points and shown in Figure 8). Only 23% (6) of respondents with workplace charging available indicated that over half of their EV charging occurs at work. Customers who use workplace charging said they primarily do so because it is free and convenient.

One-fifth of respondents (20%, 5) with access to workplace charging do not use it. The top barrier to workplace charging was the availability of charging stations.

As access and availability to workplace charging increases, the DR potential associated home charging will likely decrease.

Figure 8. Percentage of EV Charging Occurring at Work (n=26)



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

Source: Guidehouse

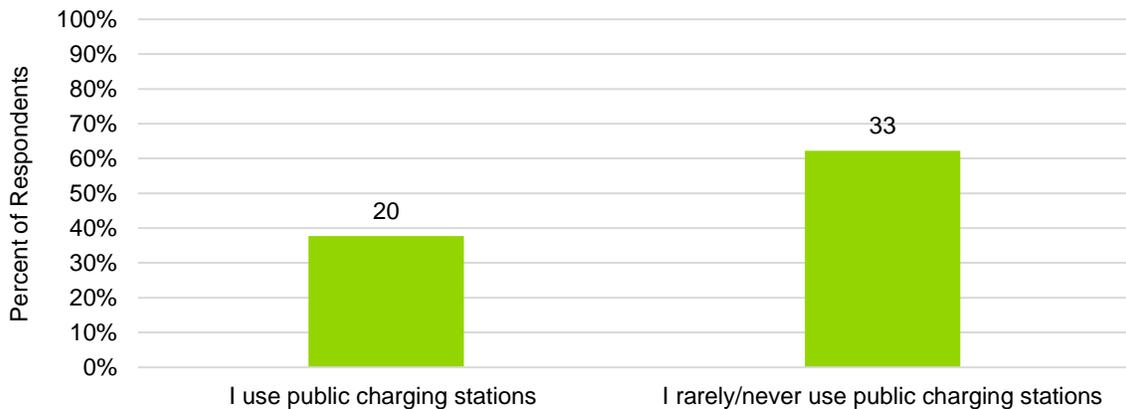
Public Charging Behavior

Survey respondents were asked to describe their use of public charging stations during a typical summer weekday.

- 62% (33) of respondents indicated they rarely or never use public charging stations on weekdays during the summer (Figure 9).
- 38% (20) of respondents reported using public charging during summer weekdays.

The frequency and duration of public charging sessions varied across respondents. The maximum and minimum reported time spent charging with public chargers during summer weekdays was 16 hours and less than 1 hour per week, respectively. Across the 20 respondents who use public charging during summer weekdays, the weighted average of reported weekly public charging use was approximately 5 hours per week.

Figure 9. Use of Public Charging During Summer Weekdays (n=53)



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

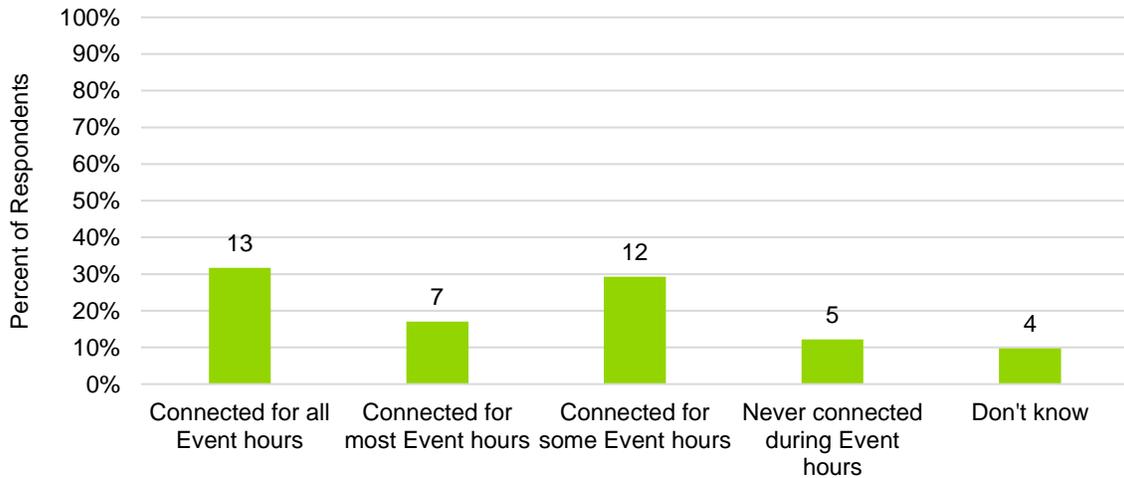
Source: Guidehouse

Experience During Events

Guidehouse asked survey respondents about event recollection and charging behavior. Forty-nine respondents enrolled prior to the last event on October 17.²² Forty-one respondents recalled at least one event occurring since they enrolled.²³

Of respondents who recalled at least one event, 78% (32) indicated their EV was connected to its charger for at least some of the event hours (Figure 10).

Figure 10. 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)



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

Source: Guidehouse

Almost all (93%, 38) respondents who recalled at least one event recalled receiving advance event notification. Two-thirds recalled notification by email, and a little over half recalled notification through the EVSE manufacturer app.²⁴ Customers suggested several ways that event notification could be improved:

- Including information about who to reach for technical support
- Sending both an email and text notification
- Provide more advanced notice (1 day) before events through email and text (two respondents)
- Sending information about the benefits/environmental impact after the event is complete

As shown in Figure 11, 95% (39) of respondents indicated that the event had no effect on their charging and driving behavior. Of respondents, 88% (23) indicated they made no changes after an event notification, while 12% (3) of respondents indicated they became more conscious of other electricity usage in their household.

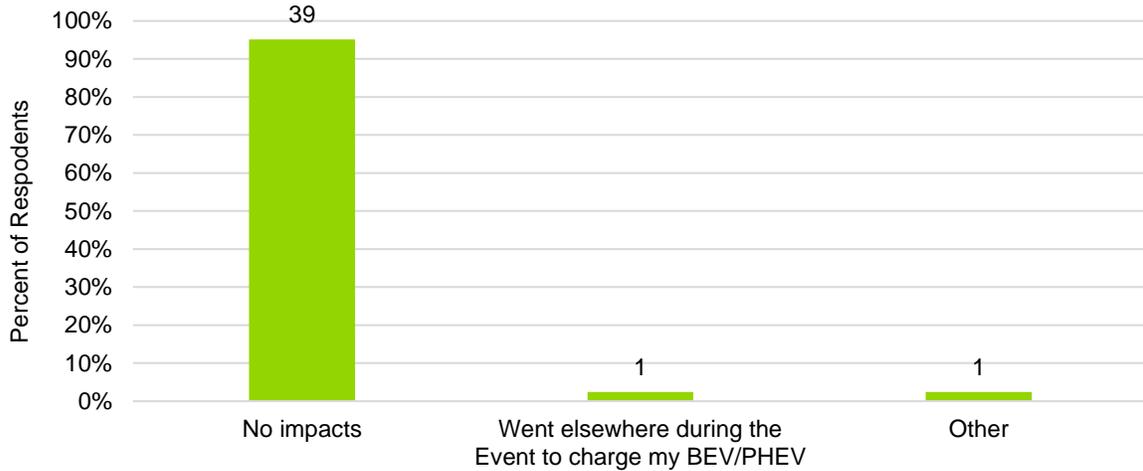
²² Event recollection questions were asked of the 51 respondents that enrolled prior to October 25th.

²³ The 41 respondents includes one respondent who enrolled after the last event (October 17th) and recalled at least one event.

²⁴ Respondents who recalled receiving event notifications through more than one mode were able to select more than one answer choice. In addition to email and the EVSE manufacturer app, five respondents noted advance notification via SMS text message and two respondents could not recall the mode of notification.

Importantly, all customers surveyed indicated they did not opt out of any event. Although customer response to DR events that occur earlier could be different, this finding suggests that participant acceptance of DR events may not be a limiting factor on program potential.

Figure 11. Impact of Events on Charging or Driving Behavior (n=41)



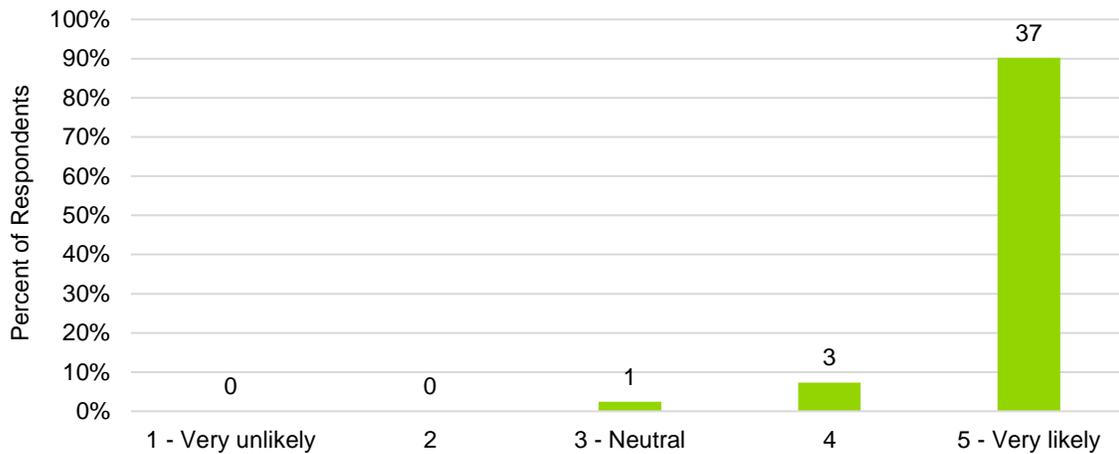
Q26. Please indicate how the events affected your normal charging and/or driving behavior (select all that apply).
Source: Guidehouse

Overall Program Experience

Of respondents who recalled at least one event, 98% indicated they are likely to continue to participate in the program (Figure 12). Suggestions for program improvements from customers included:

- Explanation of the program and what is happening and the impact (three respondents)
- Information on how to access support for this program (one respondent)
- Reduce cost or offer incentives to charge during off-peak hours (five respondents)
- Providing more public charging stations (one respondent)

Figure 12. Likelihood of Continued Participation (n=41)



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?

Source: Guidehouse

Literature Review

There is growing interest in understanding the potential capability and barriers that must be overcome to effectively manage the way EVs are charged. Utilities and a range of transportation industry participants are developing and testing different solutions for managing the contribution of EVs to peak demand; these stakeholders are simultaneously evaluating the risks involved with allowing EV charging to occur in an unmanaged way. The managed charging landscape is quickly evolving as technology solutions emerge, such as the expanding availability of managed charging capable EVSE products, smart circuit breakers, distributed energy resource management (DERMS) platforms, and telematics-based solutions. Lessons are being learned from early demonstration projects that can be leveraged by utilities to design or expand programs. During the team's literature review process, Guidehouse identified several key points for Eversource to consider:

- 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.
- Early EVSE DR pilots have shown promising potential, but challenges related to equipment connectivity and asset availability²⁵ will 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.

Guidehouse collected information from 9 utility programs (Table 6), past and current, around the U.S. to inform this literature review. Additionally, Guidehouse has included available information related to 5 future utility programs (Table 16) that are worth monitoring.

For the purposes of presenting these findings, the evaluation team grouped these programs into two different types based on the primary program design features.

²⁵ Asset availability refers to the availability of an asset to provide load curtailment when called upon. In the case of managed charging, the EVSE asset is only available if an EV is charging at the time of the event.

- **Direct Load Control programs:** These programs include DR or managed charging that is delivered primarily through EVSE capable of managed charging or through vehicle telematics.
 - EVSE DR programs: This type of direct load control program typically harnesses EVSE with built-in DR capability, sometimes referred to as *smart chargers* or *networked EVSE*. The load curtailment is generally achieved by throttling the charging load down from the normal kilowatt (kW) rating of a Level 2 EVSE to a modest kW level that more closely resembles a Level 1 charger.
 - Vehicle telematics programs: These direct load control programs incorporate technology from vehicle telematics systems to achieve DR or load management.
- **Pricing-based programs:** These programs rely on some type of pricing structure or signal to achieve load reduction during preferred times. The pricing can be tariff-based (e.g., EV-specific TOU), rewards-based where participants receive financial compensation for following certain charging guidelines, or dynamic (e.g., day-ahead variable).

Some programs contain elements that overlap between the categories defined above. Each of the program types can also be administered in different ways. For example, utilities may coordinate directly with charging network providers to serve as the managed charging administrator, or utilities may coordinate with another aggregator entity. For the purposes of this literature review, Guidehouse believes this grouping is appropriate.

Table 6 below provides a summary of past and current EV managed charging programs reviewed. Each program, including outcomes and lessons learned, are described in more detail in Table 7 through Table 15.

Table 6. Summary of Reviewed Programs – Past/Current Programs

Utility/Operator	State	Year(s) Reviewed	Market Segment	Direct Load Control Type	Pricing Type
Avista Corporation	WA	2016-2019	Residential	EVSE DR	N/A
Massachusetts Municipal Wholesale Electric Company (MMWEC)	MA	2017-present	Residential	EVSE DR	N/A
Green Mountain Power (GMP)	VT	2018-2019	Residential	EVSE DR	N/A
Pepco	MD	2016	Residential	EVSE DR	TOU
Xcel Energy	CO	2013-2014	Residential	EVSE DR	N/A
Pacific Gas and Electric (PG&E) and BMW	CA	2015-2016	Residential	Vehicle telematics	N/A
Enel X and California Independent System Operator (ISO)	CA	2019	Residential	N/A	Rewards
San Diego Gas & Electric (SDG&E)	CA	2017-present	Workplace/ MUD	N/A	Day-ahead/hourly

Con Edison	NY	2017-present	Residential/ Workplace/ MUD/ municipality/ public	N/A	Rewards
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Source: Guidehouse

Table 7. Avista Corporation

Parameter	Description
Program Period Reviewed	2016-2019
Program Type	EVSE DR
Market Segment	Residential
Program Model and Technology	The program included DR events administered by the charging network provider via the EVSE. The EVSE was owned and operated by Avista, and included products from six different vendors. The EVSE were distributed to eligible customers via an application process. No additional incentive was paid to customers for participating in DR events. The goal of the DR events was to achieve 75% <u>curtailment</u> of EV charging load during the event time period, or to reduce charging from about 6.6 kW to 1.8 kW.
Program Size	EVSE was deployed at 226 residential sites.
Experience/Outcome	<p>Avista found that the overall cost of the EVSE with managed charging capability and the reliability limitations of the EVSE to curtail when called upon were potential barriers to broader program expansion.</p> <ul style="list-style-type: none"> About 45% of the chargers did not reliably receive the DR commands due to connectivity issues with the network administrator server. Participants could opt out of DR events by using a phone app managed by the charging network provider, and the opt-out rate was 15%. Customers provided feedback suggesting a preference for more flexible choices for opting out of events, such as the ability to change opt-out status after the initial response. The program achieved about a 50% reduction in peak charging demand during DR events, with the peak period defined as 4pm-8pm and events being called from September 2018 through May 2019. Customer satisfaction remained favorable and the events did not appear to affect customer driving habits.

Source: <https://myavista.com/-/media/myavista/content-documents/energy-savings/electricvehiclesupplyequipmentpilotfinalreport.pdf?la=en>

Table 8. MMWEC

Parameter	Description
Program Period Reviewed	2017-present
Program Type	EVSE DR
Market Segment	Residential
Program Model and Technology	MMWEC offers incentives for qualified ChargePoint Home Model Level 2 chargers in exchange for throttling the charging rate down to 1.25 kW during the period of 5 p.m.-9 p.m. during non-holiday weekdays. Up to 10 emergency curtailment events can be called during times of elevated grid stress, but no events will be called after 9 p.m. Participants agree to share their charging data with the utilities.
Program Size	Unknown
Experience/Outcome	<ul style="list-style-type: none"> In progress

Source: https://munihelps.org/wp-content/uploads/SELCO_ON-Peak-Charging-Agreement-1.pdf

Table 9. GMP

Parameter	Description
Program Period Reviewed	2018-2019
Program Type	EVSE DR
Market Segment	Residential
Program Model and Technology	GMP has a residential EVSE program where participants receive a home Level 2 charger at no cost and pay a flat rate of \$29.99 per month for unlimited charging. GMP has the ability to throttle down the charging rate during peak grid conditions. Participants can opt out of curtailment events but are then charged a premium of \$0.6/kWh during the event period. EVSE data is used to determine which portion of total home energy use is from the EV, and customer bills are adjusted accordingly.
Program Size	More than 400 residential participants
Experience/Outcome	<ul style="list-style-type: none"> • 28 curtailment events were called between June 2018 and January 2019. • Participation reached nearly 80% of chargers for some events, and there were over 400 participants as of late 2019. • The opt-out rate was about 1% during the second half of the pilot.

Source: <https://greenmountainpower.com/wp-content/uploads/2019/03/IRP-Declining-Electricity-Demand.pdf>;
<https://greenmountainpower.com/wp-content/uploads/2019/03/IRP-Innovative-Customer-Programs.pdf>

Table 10. Pepco

Parameter	Description
Program Period Reviewed	2016 ²⁶
Program Type	Pricing-based (TOU) + EVSE DR
Market Segment	Residential
Program Model and Technology	The program included a combination of whole home TOU rates and EV-specific rates. A subset of 35 participants installed networked EVSE that was capable of participating in DR events. The program included Itron devices that could curtail load from about 6 kW down to about 1.5 kW. Customers received day-of email notification of DR events and could opt out by pressing a button on the charger.
Program Size	35 DR-capable EVSE (101 residential participants in total)
Experience/Outcome	<ul style="list-style-type: none"> • Seven DR events were called, mostly between 2 p.m. and 6 p.m. • Only about 10% of participants were charging their EVs during the events.

Source: <https://www.epri.com/#/pages/product/3002008798/?lang=en-US>

²⁶ The pilot occurred in 2016 and is not ongoing.

Table 11. Xcel Energy

Parameter	Description
Program Period Reviewed	2013-2014 ²⁷
Program Type	EVSE/DLC device DR
Market Segment	Residential
Program Model and Technology	Participants received either a DR-capable Level 2 charger or a DLC device installed on their existing Level 2 charger.
Program Size	20 participants
Experience/Outcome	<ul style="list-style-type: none">• DR events were called between 2 p.m. and 8 p.m.• Xcel quantified the DR impact on a per-vehicle basis, meaning that all 20 EVs were counted for each event. The average DR impact was 0.28 kW per vehicle, which was low due to most EVs not being charged during the event periods.

Source: <https://www.xcelenergy.com/staticfiles/xcelresponsive/Admin/Managed%20Documents%20&%20PDFs/CO-DSM-2014-EV-Pilot-Evaluation.pdf>

²⁷ The pilot occurred in 2013-2014 and is not ongoing.

Table 12. PG&E and BMW

Parameter	Description
Program Period Reviewed	2015-2016 PG&E conducted a two-phase smart charging pilot in partnership with BMW. Only the evaluation of Phase 1 (July 2015-December 2016) is available.
Program Type	Vehicle telematics DR
Market Segment	Residential
Program Model and Technology	Participants must be PG&E residential customers who own qualifying BMW EV models. BMW agreed to provide PG&E with 100 kW of load curtailment, which was delivered by using vehicle telematics to curtail EV charging and was supplemented by a stationary bank of second-life batteries. Participants could opt out of DR events by selecting days in advance or by using a phone app when they received notification of an upcoming event.
Program Size	Phase 1: 100 BMW EVs Phase 2: 350 BMW EVs
Experience/Outcome	<ul style="list-style-type: none"> Phase 1 included 209 DR events between July 2015 and December 2016. About 20% of the load reduction came from EV charging curtailment, and the remaining 80% was delivered by the supplemental battery bank. The majority of events had no opt outs; one event had 3% of participants opt out. The BMW EVs in Phase 1 had a maximum charging capacity of 6.6 kW, but the study found that the actual capacity available for curtailment during events was 4.4 kW due to a portion of vehicles starting or ending a charging session while the DR event was occurring. BMW met PG&E's curtailment requirements for 90% of the events. A number of software and hardware challenges were encountered during the study, which may have contributed to curtailment targets being missed during certain calls from PG&E for an event. The second phase of the program incorporates information from PG&E about renewable generation such that charging can be optimized to meet grid conditions. The Phase 2 evaluation is not yet available.

Source: <https://www.pgecurrents.com/wp-content/uploads/2017/06/PGE-BMW-iChargeForward-Final-Report.pdf>

Table 13. Enel X and California ISO

Parameter	Description
Program Period Reviewed	2019
Program Type	Pricing-based (Rewards DR)
Market Segment	Residential
Program Model and Technology	Enel X is administering a residential EV DR program for the California ISO. Participants' EVSE are connected to Enel X's JuiceNet platform. Participants receive pricing signals and notification of DR events, and they receive a rewards-based financial compensation for participating in (i.e., not opting out) of DR events. The curtailment impacts are aggregated across program participants and can be sold into the California ISO day-ahead and real-time markets.
Program Size	Unknown
Experience/Outcome	<ul style="list-style-type: none"> • DR events average about 2.8 hours in duration. • DR event participation is greater than 90%. • Over 24,000 DR events have been "experienced by EVs" between June and September 2019.

Source: Guidehouse

Table 14. SDG&E

Parameter	Description
Program Period Reviewed	2017-present
Program Type	Pricing-based (Day-ahead/hourly pricing)
Market Segment	Workplace/MUD
Program Model and Technology	SDG&E's Power Your Drive program includes multifamily and workplace charging stations and is an interesting example of a pricing-based program. SDG&E publishes day-ahead, hourly pricing for each charging station based on market and grid conditions. The pricing structure is intended to manage EV charging based on both the location of the charging station and time of day.
Program Size	More than 3,000 charging stations at more than 250 locations, managed by two charging station vendors
Experience/Outcome	<ul style="list-style-type: none"> • A rigorous process was used to select charging service providers that could accommodate all program requirements, including the ability to send the rate information to customers, enable customers to charge as desired, and provide charging data to SDG&E for billing. SDG&E encountered many challenges in this selection process, and only two vendors met all requirements. • The preliminary program findings demonstrate that the pricing structure results in a higher percentage of EV charging to occur in off-peak hours than standard EV TOU or whole home tiered rates. The full evaluation is not yet available.

Source: https://www.sdge.com/sites/default/files/regulatory/FINAL%20September%202018%20Power%20Your%20Drive%20Semi-Annual%20Rpt_0.pdf

Table 15. Con Edison

Parameter	Description
Program Period Reviewed	2017-present
Program Type	Pricing-based (Rewards)
Market Segment	All
Program Model and Technology	Con Edison offers a rewards-based charging program available to anyone who owns or leases an EV and charges in Con Edison's service territory. Participants are not required to be Con Edison customers. The program provides participants with financial rewards for charging their vehicles during the preferred hours. EV owners can receive \$0.10 per kWh of charging during off-peak hours (12 a.m.-8 a.m.). Furthermore, participants receive a bonus payment of \$20 per month if they do not charge their EV between 2 p.m. and 6 p.m. on weekdays from June through September. A FleetCarma C2 connected device is installed in the vehicle's onboard diagnostic port and is used to monitor charging behavior for rewards accrual. Participants receive monthly award payments via PayPal.
Program Size	Unknown
Experience/Outcome	<ul style="list-style-type: none"> In progress

Source: <https://www.coned.com/en/save-money/rebates-incentives-tax-credits/rebates-incentives-tax-credits-for-residential-customers/electric-vehicle-rewards>

Guidehouse also collected information about several utility programs that are in early rollout or planning stages. These programs are summarized in Table 16 and further described in the section following the table.

Table 16. Summary of Reviewed Programs – Future Programs

Utility/Operator	State	Market Segment	Direct Load Control Type	Pricing Type
PG&E	CA	Workplace/MUD	EVSE DR	N/A
Duke Energy	FL	Public/workplace/MUD	EVSE DR	N/A
AEP	OH	Workplace/MUD/municipality	EVSE DR	N/A
Exelon (Delmarva, Pepco)	MD	Residential	EVSE DR	N/A
Xcel Energy	CO	Residential/public	Vehicle telematics	N/A

Source: Guidehouse

- **PG&E** has a large EV Charge Network Load Management program and is deploying more than 7,000 Level 2 chargers in the multifamily and workplace segments. PG&E is planning for DR events and will enroll participants into DR pilot programs in the future.
- **Duke Energy Florida** offers an EV charging infrastructure program that will ultimately include about 200 charging parts for the multifamily sector. The charging stations are networked EVSE, and the company has plans to offer DR programs in the future.
- **AEP Ohio** is planning to offer incentives for about 300 managed charging-capable Level 2 chargers, with some portion being in the multifamily housing segment. AEP is planning to

install separate submetering devices to record the energy consumption from the chargers and to use for billing purposes.

- **Exelon** utilities in Maryland (**Delmarva, Pepco**) are planning residential EV DR programs with incentivized Level 2 chargers. Current plans indicate EV charging will be throttled down by 50%, and participants will receive event notification via automated phone messages and emails.
- **Xcel Energy** is preparing to offer a pilot program in partnership with BMW, Ford, General Motors, and Honda. For this program (called Charging Perks), Xcel will interact directly with the auto OEMs to perform managed charging at residential and possibly utility-owned charging stations. The OEMs will deliver curtailment or pricing signals to participants, and because the curtailment will occur via the vehicle telematics system, the participants can enroll with a variety of different home charging configurations (e.g., non-networked, Level 1). The program may be designed to target customers on the residential TOU rate plans, and incentives may be paid based on the kW level of the customer charger.

More information about the status and savings achieved from these programs will be available next year.

Considerations

This section identifies key considerations from the participant survey and literature review conducted for Eversource's 2019 EVSE DLC demonstration.

Participant Communications

Participants who responded to the survey were generally very satisfied with their program experiences to-date. To refine program delivery in response to feedback:

- Consider providing a post-enrollment welcome packet or email to participants with information related to event notification options and how to enable them, reminder of how the demonstration works, and where to go online for questions.
- Consider sending monthly emails with brief updates on program accomplishments, learnings and/or impacts to-date in the context of environmental and/or community benefits.

Participant Characteristics

The 2019 participant survey provided an opportunity to learn about customer motivations for participating and their acceptance of interventions, as well as to ascertain information about participant vehicle types, home charging patterns, and access to and use of charging outside of the home. With the growth of the demonstration and testing of additional event times and seasons:

- Consider conducting additional participant surveys to continue to learn about participants and the factors impacting their charging behavior.

Monitoring and Learning from Other Utilities

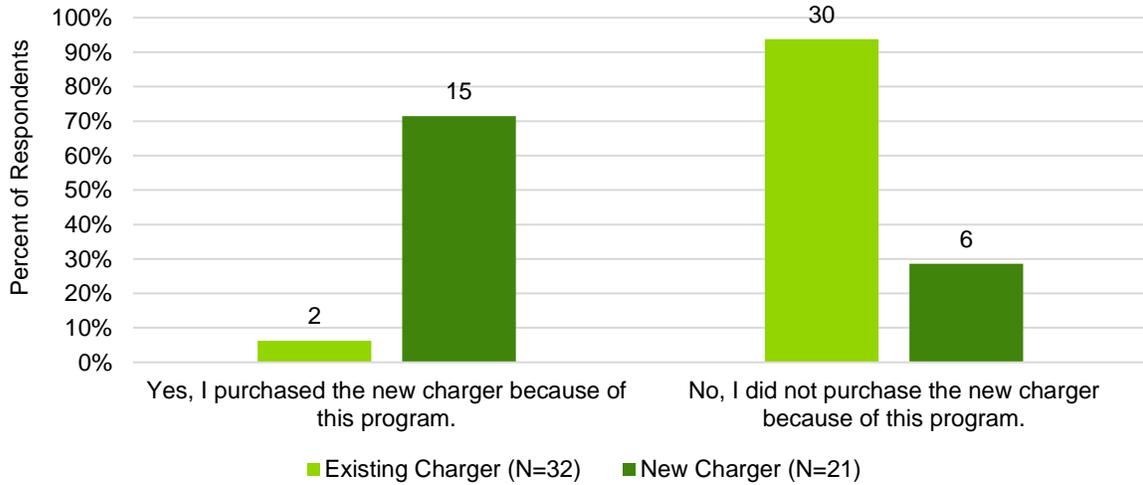
The managed charging ecosystem continues to evolve at a rapid pace. To remain informed of key developments in managed charging program capabilities:

- Consider annual updates to the managed charging literature review, with a focus on identifying new program designs and sharing new evaluation findings to gather best practices and lessons learned by other utilities.
- Consider performing a more in-depth assessment of individual programs that are of interest to Eversource. This detailed assessment could include interviews with utility staff, and vendor staff who are familiar with the other programs

Appendix A. Supplemental Survey Results

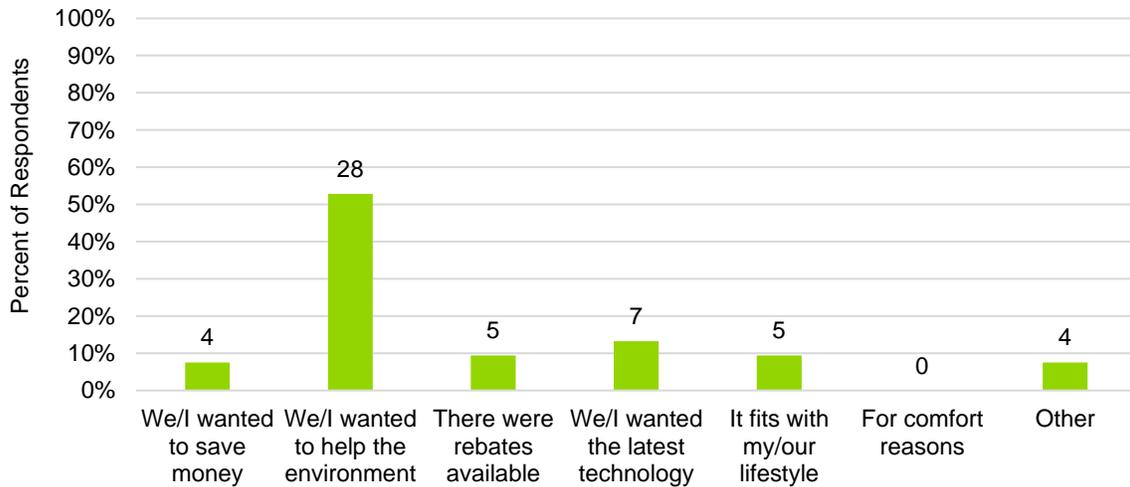
Motivations

Figure 13. Did the program influence your decision to purchase the new charger?



Source: Guidehouse

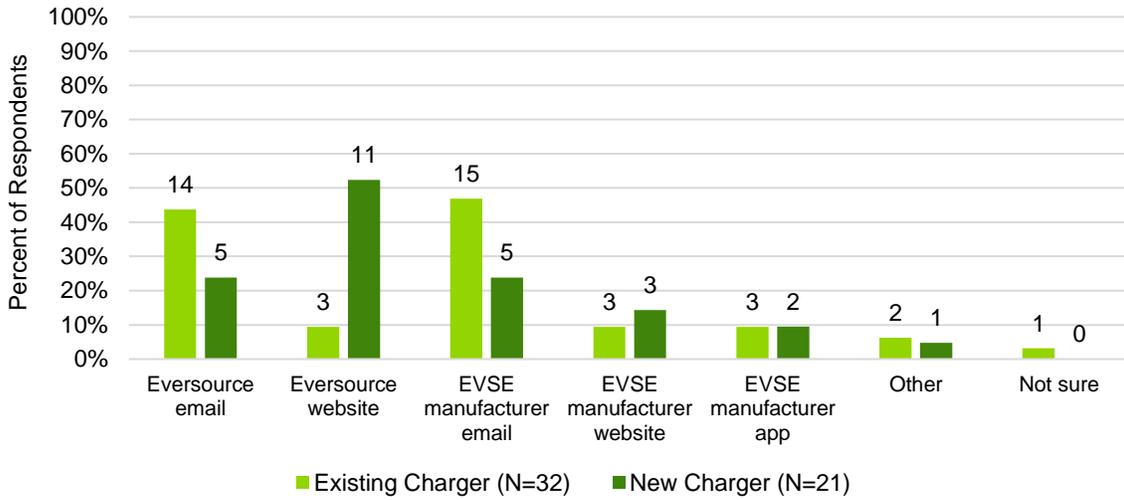
Figure 14. What was your household's top motivation for buying the electric vehicle? (n=53)



Source: Guidehouse

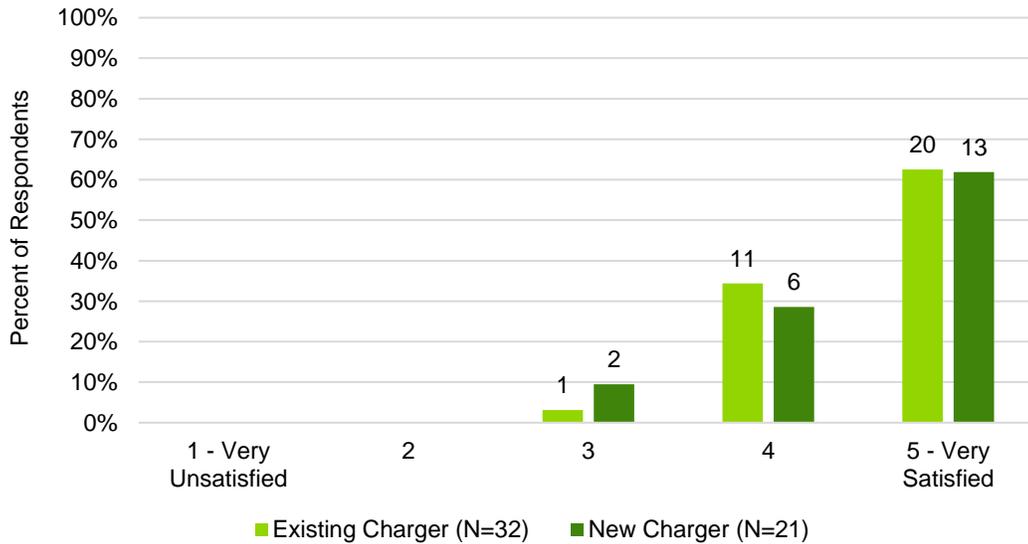
Enrollment Experience

Figure 15. How did you learn about Eversource’s ConnectedSolutions EV Home Charger Demand Response Program?



Note: This question allowed multiple responses; therefore, percentages may sum to greater than 100%
 Source: Guidehouse

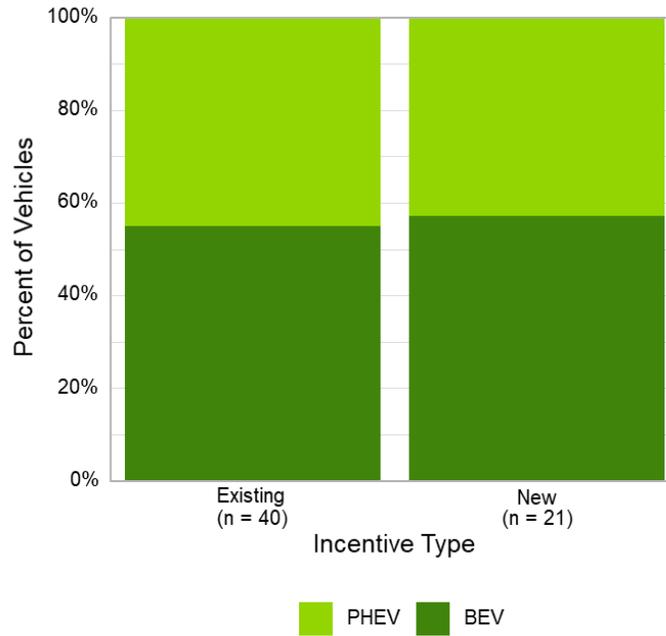
Figure 16. Using a scale of 1 to 5 where 1 indicates Very Unsatisfied and 5 indicates Very Satisfied, how satisfied were you with the process of enrolling in the program?



Source: Guidehouse

Participant EV Types

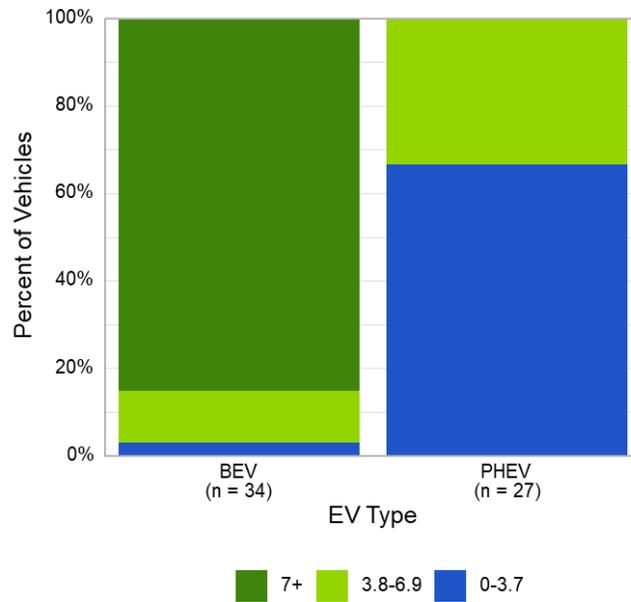
Figure 17. EV Type by Incentive Type



Note: This chart shows counts of vehicles associated with existing and new chargers (rather than the counts of chargers) – e.g., 40 survey respondent EVs are associated with an existing charger. Of those, close to 60% are BEVs. Chargers are considered “New” if their activation date was 6/1/2019 or later.

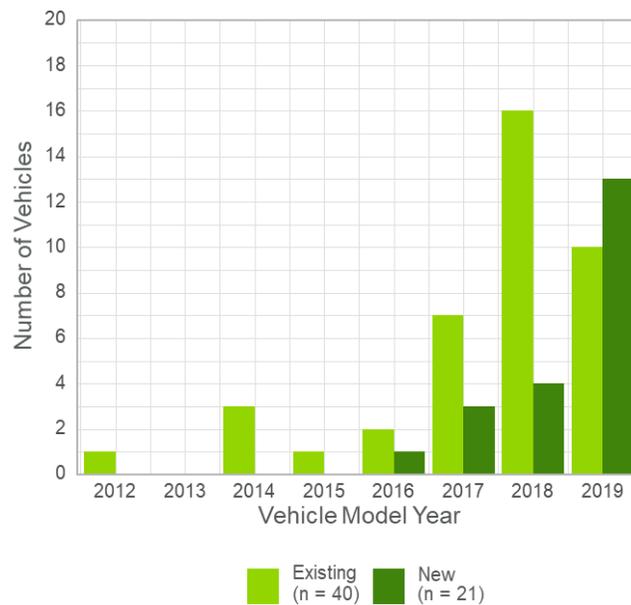
Source: Guidehouse

Figure 18. Onboard Power Draw (kW) by EV Type



Note: Vehicle battery capacity was determined based on self-reported vehicle make, model, and year.
 Source: Guidehouse

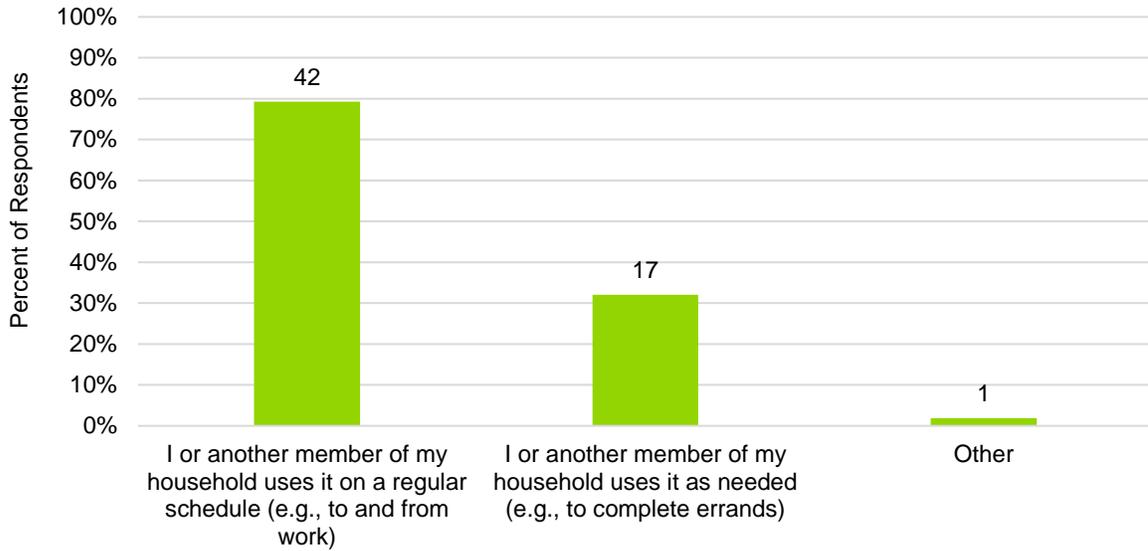
Figure 19. Model Year by Incentive Type



Note: This chart shows counts of vehicles associated with existing and new chargers (rather than the counts of chargers) – e.g., 40 survey respondent EVs are associated with an existing charger. Chargers are considered “New” if their activation date was 6/1/2019 or later
 Source: Guidehouse

Driving Behavior

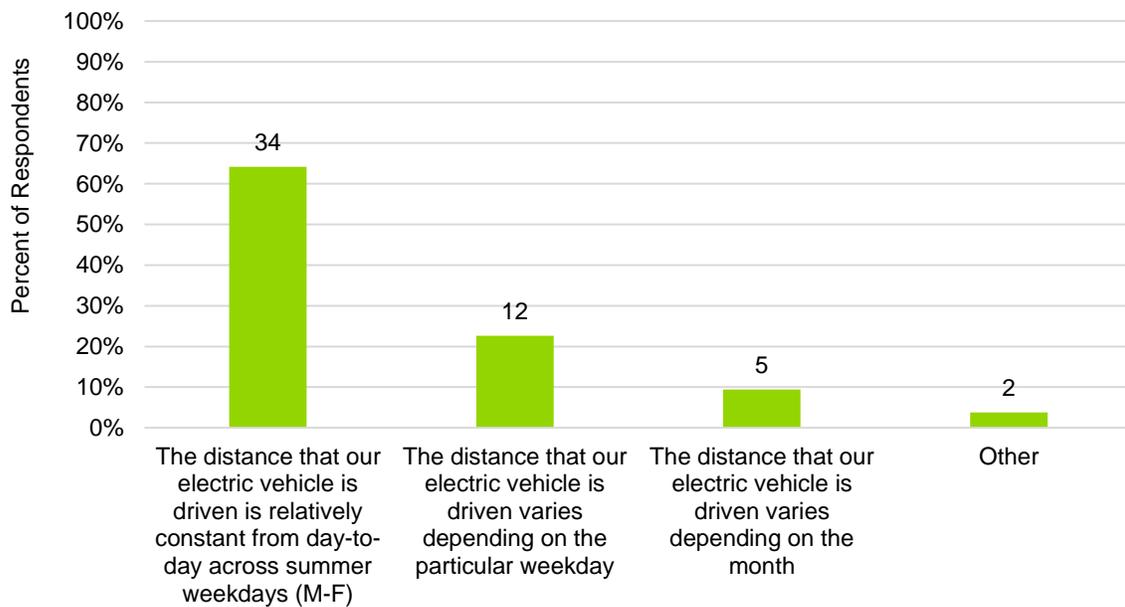
Figure 20. Which of the following best describes how your household typically uses your electric vehicle on weekdays (M-F) during the summer (June through August)? (n=53)*



Note: This question allowed multiple responses; therefore, percentages may sum to greater than 100%

Source: Guidehouse

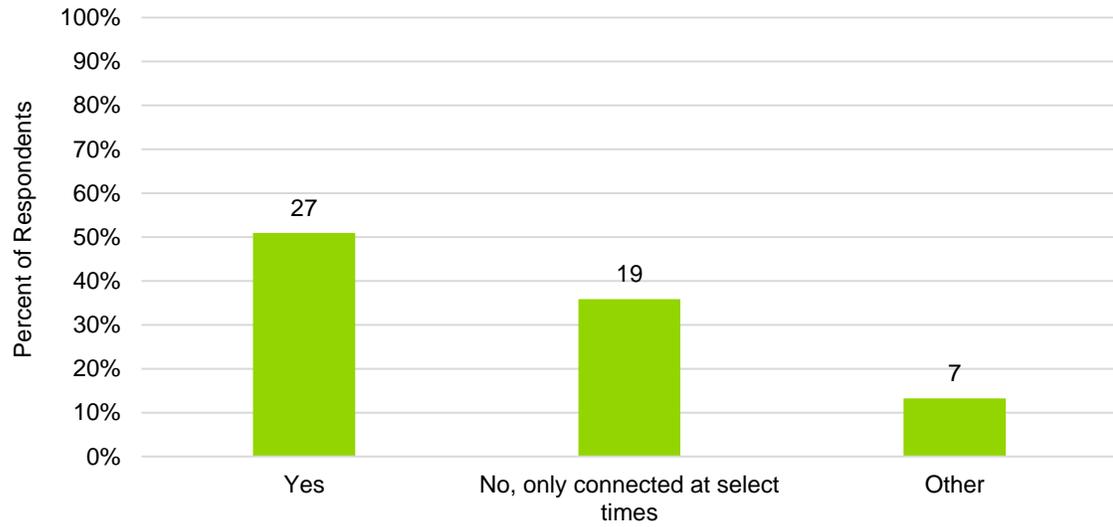
Figure 21. Ignoring short-term vacations (<2 weeks), is the total distance (miles) your electric vehicle is driven by you and other household members relatively constant across summer weekdays (M-F) or does it vary? (n=53)



Source: Guidehouse

Charging Behavior

Figure 22. When your electric vehicle is home and is not being used, is it typically connected to your home charging station? (n=53)



Source: Guidehouse

Appendix B. Survey Instrument

Eversource Electric Vehicle Charging Load Management Demonstration Post-Season Survey

December 13, 2019 – DRAFT

Statement of purpose: This post-season survey will be used to obtain feedback on how residential customers learned about Eversource’s **ConnectedSolutions** electric vehicle (EV) home charger demand response program, what their motivations for enrolling were, and any challenges they may have encountered during the enrollment process. The survey will also ask questions aimed at characterizing the types of EVs that are enrolled in the program and participants’ driving and charging patterns during the summer (June through August).

Qualified respondent: All 2019 program participants who enrolled in the program.

Survey timeline: The survey will be open from December 4, 2019 to December 13, 2019.

Table 1. Research Objectives

Research Objective	Survey Questions
What is the primary motivation for customers to enroll?	Q1
What program marketing approaches are effective for engaging and enrolling customers in the program?	Q2-Q4
Did customers experience any challenges during the enrollment process?	Q5-Q8
Why are customers opting out?	Q29-Q32
What types of EVs to participants have (e.g., BEV or PHEV, power acceptance rate)?	Q9
What are typical charging patterns for residential chargers during the DR evaluation period (both during DR event periods and outside of DR event periods)?	Q19-Q24_1, Q25-Q27
What is typical participant driving behavior? E.g., average distances, variation by time of day or day of week	Q11-Q18
What participant characteristics impact charging and driving patterns? E.g., type of EV, access to workplace EVSE	(previously mentioned)
Are certain customer segments more likely to participate? How likely are customers to continue to participate in the program in the future?	Q41
What suggestions or recommendations do customers have related to program improvement?	Q35-Q39, Q42-Q44

The table below lists the variables within this survey.

Table 2. Survey Variables

Sample Variable	Description	Values
ENROLL_DATE	Enrollment Date	August 1 – November 8

[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.

Enrollment Process

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

{RESPONSE OPTION ORDER TO BE 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: **[open ended]** _____
-
2. 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 (specify) **[open ended]** _____
 - d. **[EVSE manufacturer]** email
 - e. **[EVSE manufacturer]** website
 - f. **[EVSE manufacturer]** app
 - g. **[DRMS provider]** website
 - h. Friend/family/neighbor
 - i. Other, please specify: **[open ended]** _____
 - j. Not sure
-
3. 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 = b, CONTINUE. ELSE SKIP TO Q5]

4. What additional information would you like to see? **[open ended]**
-
5. 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 = a, CONTINUE. ELSE SKIP TO Q7]

6. What challenges or difficulties did you encounter during the enrollment process? **[open ended]**

7. 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
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[If Q7 = a-b, CONTINUE. ELSE SKIP TO Q8_1]

8. What was less than satisfactory about the enrollment experience? **[OPEN-ENDED]**

- 8_1. Approximately when did you purchase the charger that you enrolled in the program? (e.g., “May 2019”)
 - a. Approximate purchase date: **[OPEN-ENDED]**
 - b. Don’t know

- 8_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.

EV Characteristics and Driving Behavior

9_0. How many licensed drivers are there in your household? _____[ENTER NUMERIC]

9. 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. ELSE SKIP TO 9_2]

9_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. ELSE SKIP TO 9_3]

9_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. ELSE SKIP TO 9_4]

9_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. ELSE SKIP TO 9_5]

9_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. ELSE SKIP TO 9_6]

9_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. ELSE SKIP TO 9_7]

9_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. ELSE SKIP TO 9_8]

9_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. ELSE SKIP TO 9_9]

9_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. ELSE SKIP TO Q10]

9_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.

10. 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

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

{RESPONSE OPTION ORDER TO BE 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. Other, please specify: **[open ended]** _____

12. {REMOVED}

13. 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 how your vehicle is typically used on weekdays)
_____ **[open-ended]**

14. 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) _____ **[open-ended]**

[IF Q14 = a, CONTINUE. ELSE SKIP TO Q16]

15. 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. > 150 miles

[IF Q14 = b, CONTINUE. ELSE SKIP TO Q17]

16. 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				
g. 101-150 miles				
h. > 150 miles				

[IF Q14 = c, CONTINUE. ELSE SKIP TO Q18]

17. 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]**

18. {Blank}

Charging Behavior

19. 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) _____ **[open ended]**
 - c. Other, please specify: _____ **[open ended]**
 - d. Not sure
20. 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: **[open ended]**

21. {Blank}

22. 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.

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	9. Do not use home charger on this day	9. Do not use home charger on this day	9. Do not use home charger on this day	9. Do not use home charger on this day

- b. It varies depending on the month
- c. Not sure

22_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 = a, CONTINUE. ELSE SKIP TO Q24]

23_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 23_0 = a, CONTINUE. ELSE SKIP TO Q23]

23_00. Why isn't your household's EV ever charged at a workplace? **[OPEN-ENDED]**

[IF 23_0 <> a, CONTINUE. ELSE SKIP TO Q24]

23. 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.

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	9. Do not use workplace charger on this day	9. Do not use workplace charger on this day	9. Do not use workplace charger on this day	9. Do not use workplace charger on this day

- b. It varies depending on the month
- c. Not sure
- d. Not applicable

[IF Q23 <> always 9 "do not use" OR d, CONTINUE. ELSE SKIP TO Q24]

23_1. What are your motivations for using **workplace charging stations**? _____ [open ended, optional]

23_2. Are there any barriers for you or your household members to use **workplace charging stations** to charge your electric vehicle? _____ [open ended, optional]

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

- a. _____ [open ended]
- b. I rarely/never use public charging stations on weekdays during the summer

Behavior During Events

[IF ENROLL_DATE > [DATE OF MOST RECENT EVENT], SKIP TO Q44. ELSE CONTINUE]

25_A. The Eversource **Connected Solutions** 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, NUMERIC]

[IF Q25_A > 0, CONTINUE. OTHERWISE SKIP TO Q41]

25_B. Since enrolling, did you ever receive advance notifications about Events?

- a. Yes
- b. No

[IF Q25_B = a, CONTINUE. OTHERWISE SKIP TO Q25]

25_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: [OPEN ENDED]
- d. Don't know

25_D. Are there ways that Event notification could be improved? [OPEN-ENDED, OPTIONAL]

25. 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

26. 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) **[OPEN ENDED]**
 - a. Went elsewhere during the event to charge my BEV/PHEV (e.g., public or workplace charging)
 - c. Had to defer or reschedule activities so we/I could wait to charge the BEV/PHEV after the Event
 - d. Other, please specify: **[OPEN ENDED]**
 - e. Don't know
27. Did your household take any other actions in response to being notified that an Event was going to occur? **[OPEN ENDED, OPTIONAL]**
28. 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 = a, CONTINUE. OTHERWISE SKIP TO Q35]

29. 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 = a AND Q29 <> e, CONTINUE. OTHERWISE SKIP TO Q35]

30. {Blank}

31. For what reason(s) did you opt-out or override the charging setting during the Event(s)? **[OPEN ENDED]**

32. 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
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[IF Q32 = a-b (1-2), CONTINUE ELSE SKIP TO Q35]

33. What issues did you encounter when trying to opt-out or override a scheduled Event(s)?
[OPEN ENDED]

Program Satisfaction

34. {Blank}

35. 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)						

[Q35b = a-b (1-2), CONTINUE. ELSE SKIP TO Q37]

36. Please let us know why you are not satisfied with the number of Events.
[OPEN ENDED]

[Q35c = a-b (1-2), CONTINUE. ELSE SKIP TO Q38]

37. Please let us know why you are not satisfied with the length of Events.
[OPEN ENDED]

[Q35d = a-b (1-2), CONTINUE. ELSE SKIP TO Q40]

38. Please let us know why you are not satisfied with the timing of Events.
[OPEN ENDED]

39. {Blank}

40. 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
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[IF Q40 = a OR b, CONTINUE. OTHERWISE SKIP TO Q42]

41. What change(s) to the Eversource **ConnectedSolutions** EV Home Charger Demand Response Program would encourage you to continue participating? **[OPEN ENDED, OPTIONAL]**

[IF Q40 = c - f, CONTINUE. OTHERWISE SKIP TO Q43]

42. What recommendations would you make to help improve the Eversource **ConnectedSolutions** EV Home Charger Demand Response Program going forward? **[OPEN ENDED, OPTIONAL]**

Closing

43. 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]**

44. 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: **[OPEN ENDED]**
- b. I prefer not to provide my email address

[Survey close] Thanks again!