



SmartCharge Electric Vehicle Program Impact Evaluation

Final Report

prepared for

Con Edison

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February 8, 2019

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SmartCharge Electric Vehicle Program Impact Evaluation Final Report



1 EXECUTIVE SUMMARY

This report describes the results and findings from an impact evaluation of Con Edison's 2018 SmartCharge New York program (the program). The program was designed to reduce electric vehicle (EV) charging during Con Edison's peak period. This evaluation focuses solely on the private vehicle portion of the program,¹ which uses a FleetCarma C2 device to record program participant EV charging events. The impact evaluation calculated the peak demand reductions attributable to the program for two peak periods: the NYISO peak period and the Con Edison summer weekday peak period.²

1.1 Portfolio-Level Impacts

Table 1-1 summarizes the results of the impact evaluation from both peak periods.

Table 1-1. 2018 Con Edison SmartCharge NY Program Demand Reduction

Peak Period	Ex Ante Savings (kW)	Ex Post Gross Savings (kW) ^a	Realization Rate (kW)	NTG Ratio	Savings Goal (kW) ^b	Savings Goal Achieved
NYISO peak	511.7	70.6 (+/- 40.1)	14% (+/- 8%)	NA	1,000	7%
Con Edison summer weekday peak	494.0	35.7 (+/- 40.8)	7% (+/- 8%)	NA	1,000	3.5%

^a The relative margin of error is high at a 90% confidence interval. While this indicates there is statistical uncertainty in the results, it does not change their magnitude. See discussions on Limitations, Sections 1.3 and 4.4.

^b The 1 MW goal is for individual and fleet vehicles. The evaluation only addressed individual vehicles.

Note: Savings were not audited or verified for this program, and the columns were removed for legibility.

To calculate the peak demand reduction, ERS created two 24-hour average per-vehicle load profiles – one for program participant EVs and the other for baseline vehicles – and calculated the reduction as the difference between them over each peak period. The participant profile was

¹ The program also serves fleet vehicles, in which participants program their charging stations to eliminate EV charging during peak periods.

² The TRM defines the NYISO system peak period, for use in program reporting, as the average reduction across the hour ending at 5:00 p.m. on the hottest non-holiday weekday of the summer. In 2018, this was 4:00–5:00 p.m. on August 29. The Con Edison summer weekday peak is 2:00–6:00 p.m. on all summer weekdays, including holidays, and is the peak period that the program intends to shift charging from using incentives.

calculated from metered charging data for 688 program participants provided by the program's implementer, FleetCarma. The baseline profile was based on 85 respondents to a survey of program nonparticipants and recent signups, where respondents were asked to report when they had charged in the previous five days. The resulting per-vehicle demand reduction was 0.1 kW/vehicle for the NYISO peak period, and 0.05 kW/vehicle for the Con Edison summer weekday peak period. Multiplying the per-vehicle demand reduction by the number of participating vehicles yields the program savings reported in Table 1-1, above.³

1.2 Summary of Conclusions and Recommendations

Through this study, ERS has made four conclusions, with four associated recommendations:

- **Conclusion #1:** The calculated reduction per vehicle was 0.1 kW for the NYISO peak period and 0.05 for the Con Edison weekday peak period; this is substantially lower than the program deemed value of 0.7 kW.
 - **Recommendation #1:** Revise the per-vehicle demand reduction deemed value from 0.7 kW to 0.14 kW per vehicle for battery electric vehicles (BEVs) and 0.04 kW per vehicle for plug-in hybrid vehicles (PHEVs).
- **Conclusion #2:** Participants have a 0.3 to 0.5 kW per vehicle reduction between 7:00 p.m. and 12:00 a.m. relative to the baseline for both peak periods.
 - **Recommendation #2:** Consider leveraging the program framework to shift charging in night-peaking residential networks.
- **Conclusion #3:** The evaluation found a negligible difference in overnight charging between the participant and baseline populations.
 - **Recommendation #3:** Consider restructuring the program's layered incentive structure based on the peak period(s) of most concern.
- **Conclusion #4:** On average, demand from BEV charging is three times higher than from PHEV charging.
 - **Recommendation #4:** Target BEV owners for program participation.

In addition, ERS listed a variety of opportunities where additional data, research, or analysis could be used to increase confidence in the results or provide additional granularity. These recommendations can be found in Section 4.3, Future Study Opportunities.

³ The number of participants differs by the peak period. For the NYISO peak, there were 731 participants as of the peak day, August 29. For the Con Edison summer weekday peak, which is an average, ERS used the average number of participants across the summer, 706.

1.3 Summary of Limitations

This study was intended as a first review of EV charging patterns of SmartCharge participants relative to nonparticipating EV owners within Con Edison's service territory. As 15-minute interval data was provided for all program participants, there are no limitations associated with the participant data.

To develop the baseline charging profile, the study utilized a web-based survey; ERS and Con Edison considered several other methods of determining a baseline but discarded them due to issues with data availability or cost-effectiveness. The survey introduced several potential sources of error to the study:

- **The baseline charging profile is based on self-reported survey data, which is less accurate than metered data.** To minimize respondent error, survey respondents were asked to report their charging behavior for the past five weekdays using a simple grid.
- **The baseline analysis required using several assumptions in order to utilize the self-reported data.** These are listed in Section 4.4, along with the rationales for each assumption and potential impact.
- **Relative standard error is large at the 90% confidence interval due to inherent variability in the data and low estimated savings.** While this indicates there is statistical uncertainty in the results, it does not change their magnitude.

Section 4.4 includes a more detailed discussion of these limitations.

2 INTRODUCTION

2.1 Program Description

Con Edison's SmartCharge New York Program (the program), launched in 2017, is designed to encourage off-peak charging of EVs within Con Edison's service territory. Con Edison's summer peak hours are 2:00 p.m. to 6:00 p.m., Monday through Friday, June through September.⁴ The program addresses two participation groups: 1) privately owned EVs utilizing a program-provided on-board device and 2) corporate or government fleets utilizing ChargePoint stations for charging data collection. The program's 2018 goal was 1 MW of peak load reduction between the two groups. This evaluation addresses privately owned vehicles only.

There were 770 privately-owned vehicles enrolled at the end of September 2018, and the program claimed a peak load reduction of 0.54 MW, using a deemed value of 0.7 kW reduction per vehicle.⁵ This portion of the program, implemented by FleetCarma, uses a "C2" device plugged into the vehicle's on-board diagnostic (OBD) port to record charging behavior. As the implementation contractor, FleetCarma manages the device distribution, payment of program incentives, and collection of interval charging data. The program is open to all EV owners who charge at least once per month in Con Edison's territory and have vehicles that are supported by FleetCarma's C2 device. Participants do not need to be Con Edison customers. Con Edison raised incentives levels in October 2017 and again in April 2018, and participants can now earn up to \$500 per year by combining the following offered incentives:

- \$150 to install and register the device
- \$5 each month to maintain the C2 device in the vehicle and charge at least once within the Con Edison territory
- \$20 per month in June through September by not charging during 2:00 p.m. to 6:00 p.m., Monday through Friday
- 10 cents per kWh for any charging between midnight and 8:00 a.m., every day year-round
- \$25 for each satisfaction survey completed
- \$25 for each referral who completes enrollment in the program

⁴ The program rules do not exclude holidays from the summer peak definition, so holidays are included in the analysis.

⁵ The program cites a 2015 M.J. Bradley study prepared for NYSERDA as the genesis of this number. See "Electricity Pricing Strategies to Reduce Grid Impacts from Plug-in Electric Vehicle Charging in New York State," NYSERDA Report 15-17, June 2015.

The incentive payments are provided as SmartCharge Reward™ points, which participants can redeem for electronic gift cards. All participants also have access to data about their EVs via an online portal, including greenhouse gas emissions and savings, charging energy consumption, and downloadable trip data.

2.2 Evaluation Activities

This impact evaluation was designed to accomplish the following primary objective:

- **Estimate 2018 peak demand savings for EVs enrolled in the SmartCharge New York program.** The impact evaluation quantified peak demand reductions for two peak periods:
 - **NYISO system peak** – The average reduction across the hour ending at 5:00 p.m. on the hottest non-holiday weekday of the summer, which is the standard definition from the New York Technical Resource Manual (TRM).⁶ In 2018, this was 4:00–5:00 p.m. on August 29. This is the period that reductions from demand-reducing programs are typically reported to the New York State Department of Public Service (NYS DPS).
 - **Con Edison summer peak** – The average reduction between 2:00 p.m. and 6:00 p.m. on summer weekdays (June through September). This is the period that the program intends to shift charging from using incentives.

In addition, ERS was asked to identify opportunities where additional research, data, or analysis could improve the precision or value of results. These are listed in Section 4.3, Future Study Opportunities.

Table 2-1 shows a summary of the evaluation tasks ERS completed to meet the primary research objective.

Table 2-1. SmartCharge Impact Evaluation Tasks

Evaluation Tasks	Media	Methodology Section
Develop participant charging profile	Python, Excel	3.1
Develop and field baseline survey	Online survey	3.2.1
Analyze survey and develop baseline charging profile	Excel	3.2.2
Analyze demand reduction	Excel	3.3

⁶ See the introduction of the New York TRM, p. 3, “New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs,” version 5.2, April 10, 2018, and effective January 1, 2018.

Accessible at:

<http://www3.dps.ny.gov/W/PSCWeb.nsf/All/72C23DECFF52920A85257F1100671BDD?OpenDocument>

Each of these tasks are described in Section 3, Methodology. Additional details can be found in Appendix A.

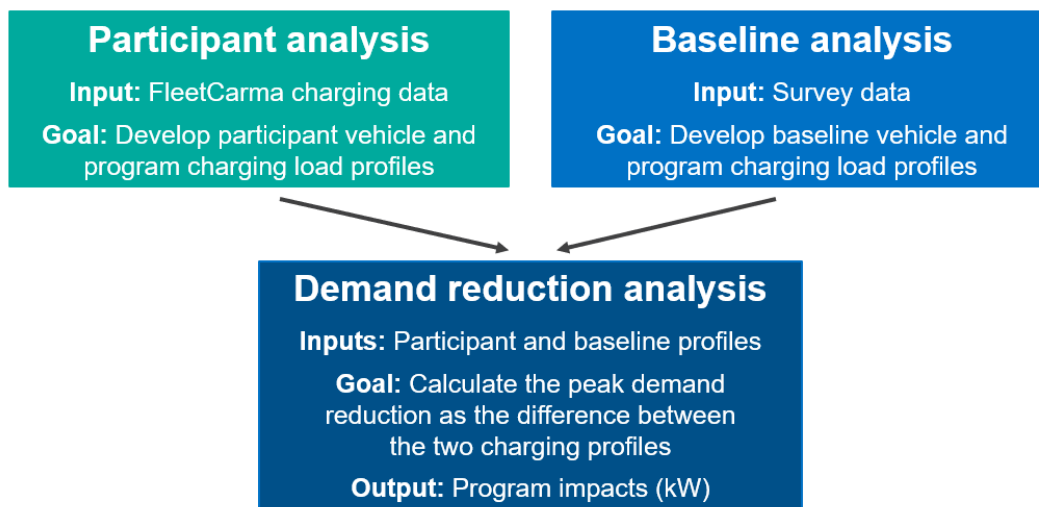
2.3 Report Organization

This report presents ERS's evaluation methodology, findings, conclusions, and recommendations. Section 3 covers the methodology, which is divided into the three key analyses (development of participant profiles, baseline profiles, and the final demand reduction analysis). Section 4 covers the results, findings, and recommendations, and ends with a discussion of the study's limitations and suggestions for future research. The appendices provide further information on the evaluation methodology and survey.

3 METHODOLOGY

ERS's approach to calculating the 2018 peak demand reduction from the SmartCharge program was three-pronged: 1) establish charging profiles for all program participants through an analysis of FleetCarma data, 2) develop a charging baseline profile through surveys, and 3) calculate the peak demand reduction as the difference between the participant and baseline charging profiles. Figure 3-1 provides a visual representation of this process.

Figure 3-1. Impact Evaluation Methodology



Each of these three steps is described in more detail below. Additional details on the methodology can be found in Appendix A.

3.1 Participant Profile Development

To develop a program-level participant charging load profile, ERS received participant charging data from FleetCarma, performed quality control (QC) checks, and aggregated charging session data by vehicle, vehicle type, and overall.

In order to monitor participating vehicles' charging load, FleetCarma's C2 device collects charging data from the host vehicle on 15-minute intervals, which was provided to the evaluators each month for the summer 2018 period. This data informed customer incentives per the program's summer peak/off-peak/shoulder windows and formed the basis of the evaluation's participant charge profile analysis.

First, ERS prepared the data for analysis. During the data cleaning, ERS removed inaccurate data – such as vehicles with unknown makes or models or negative charging load – and filtered the data set to only include charging sessions that occurred on a weekday within Con Edison's service territory. This is because only weekday, in-network charging could contribute to the utility's peak period. The data cleaning left a total of 688 vehicles used to calculate the average profile; Appendix A.2 provides details on the 16 quality control (QC) checks and the number of data points removed at each step in the QC and cleaning process.

Next, ERS aggregated each unique vehicle's charging sessions into a 24-hour array representing the average kW charging load for the summer for that vehicle. Since some vehicles joined the program midway through the summer, ERS calculated the number of weekdays each vehicle was eligible to charge and calculated the average profile using this window.

After developing average charge profiles for each vehicle in the program, ERS aggregated this data across all enrolled vehicles to develop a program-wide 24-hour average load curve for each peak period, representing the average demand in kW on the grid at each hour during the day from the program participants' charging. These hourly profiles are presented on a per-vehicle basis; each hour's value is in units of kW/vehicle. ERS also developed separate program-wide load profiles for battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) to identify possible charging trends that may depend on vehicle type.

Participant Profile Development Steps

Input: FleetCarma data (n=770)



Data cleaning



Vehicle-level profiles



Program-level profiles

Output: 24-hour load profile (n=688)

3.2 Baseline Profile Development

To calculate the demand reduction attributable to the program, the evaluators must determine what the charging demand would have been in the absence of the program. Con Edison and

ERS considered several methods of calculating a baseline charging profile and determined that a web survey to record and assess the charging behavior of EV owners in Con Edison's service territory was most appropriate for this study.⁷

The survey was administered to three different sample populations to maximize the number of survey responses and capture respondents that would reflect both current and future SmartCharge participants. These populations included:

- **Nonparticipants/non-enrollee owners (NEOs)** – Roughly 3,700 potential EV owners within Con Edison's service territory, from a FleetCarma marketing list, new EV owners receiving NYSEERDA's Drive Clean rebates, and EV owners requesting information from Con Edison.
- **New program enrollees** – EV owners who have recently signed up and have not yet installed the C2 device. Their behavior is not yet directly influenced by incentives, but they are easy to reach for survey purposes.
- **Waitlisted signups** – Enrollees with EV models that are not yet supported. As new EV models are introduced, FleetCarma must update its software to be compatible with new models in order to correctly access the charging data.

The survey was emailed to a census of these populations – all NEOs with valid email addresses, all new applicants, and all existing or new waitlist members – with follow-up emails to increase response rates. All three groups received an incentive of \$25 for completing the survey. Emails were sent to a total of 3,877 email addresses; 151 people completed the survey. Appendix A.3 includes additional information about the survey logistics, including a breakdown of response rates by each population group.

Respondents were asked to mark how many times they charged their EV each day in the past five weekdays. This period was chosen because it provides five data points for the analysis and is more easily recalled by respondents. For each separate "charging event," respondents filled out several data fields that allowed ERS to estimate their charging behavior and associated load, including the hour the charging started, the hour the EV was next unplugged, the starting

⁷ Several of the methods discussed may provide supplementary data on baseline charging behavior and are listed in Section 4.3, Future Study Opportunities. They are also discussed in Appendix A.3.

battery state of charge, the charging level,⁸ and whether the charge occurred in Con Edison's service territory. The survey questionnaire can be found in Appendix B.

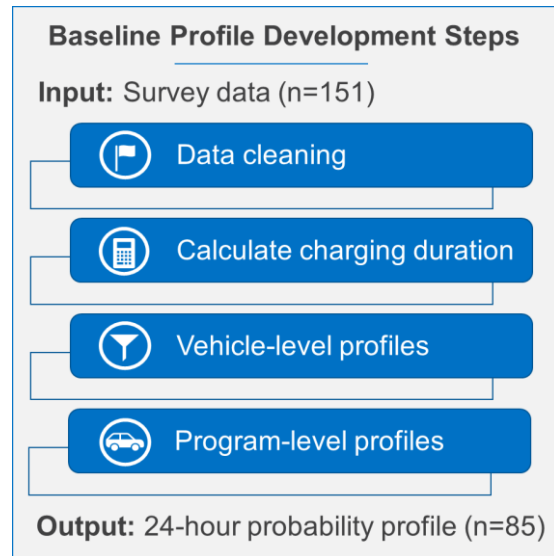
3.2.1 Baseline Survey Analysis

The steps taken for the baseline survey analysis are similar to those for the participant analysis. First, ERS prepared the data for analysis by removing inaccurate data – such as vehicles with unknown makes or models or an unknown charger type – and filtered the data set to remove out-of-network charging events. This process left a total of 85 vehicles used to calculate the average profile; Appendix A.4 provides details on the QC checks and the number of data points removed by each check.

The first analysis step in developing a 24-hour profile was to determine the duration of each charging event. This was done using a combination of self-reported data from the survey – such as the charge start time and other fields described above – and publicly available data on battery capacity and charger acceptance rate for each make/model. Based on these inputs, ERS could calculate how long it would take before the battery would be 100% charged. The duration of each charge event is the lesser of the number of hours the vehicle was plugged in and the number of hours needed to fully charge the battery. Thus, if a car would have needed 10 hours to charge completely but was unplugged after 6 hours, the active charge window would extend for 6 hours from the plug-in time. More details on this calculation and the several assumptions needed to utilize the self-reported data can be found in Appendix A.4.

ERS next aggregated each charging event into an average 24-hour profile representing all five days, first for each vehicle individually and then across all baseline vehicles. ERS also developed separate program-wide profiles for BEVs and PHEVs to identify charging trends that may depend on vehicle type.

The baseline analysis was designed to mirror the participant analysis. The key difference in the survey analysis is that the resulting profile represented a charge probability – the likelihood of a baseline vehicle charging in a given hour (%) – rather than a load profile (kW). This approach allowed ERS to focus on when the baseline vehicles were charging in comparison to the participant vehicles – the primary concern in a program that aims to shift, rather than reduce,



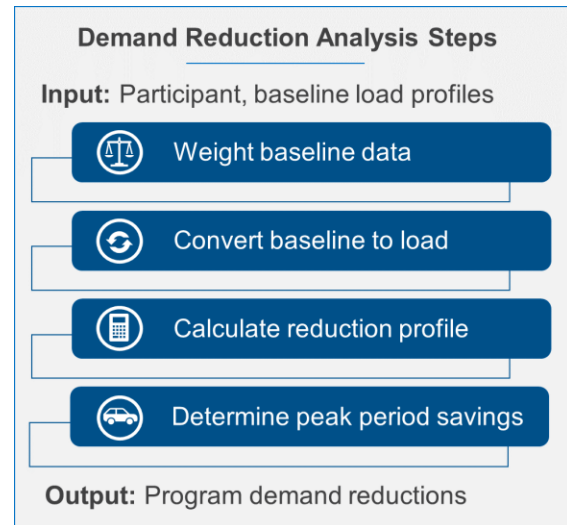
⁸ Level 1, Level 2, Level 3–DC Fast Charging, or Tesla Supercharging.

the load from charging. In the final step of the analysis, described below, this probability profile was converted into a load profile for comparison to the participant population.

3.3 Demand Reduction Analysis

The demand reduction analysis consisted of two major tasks: 1) convert the charge probability profile from the baseline analysis into a form that could be directly compared with the participant load profile, and 2) calculate the program savings.

First, to account for the fact that the participant population had a higher incidence of BEVs than the baseline population, ERS weighted the baseline profile by the participant BEV/PHEV distribution. Next, ERS converted the baseline profile into a load profile, which represents the average kW load per vehicle at each hour. As with the first step, ERS used a participant average charging rate to ensure that the baseline profile represented not only the behavior of the baseline population but also the vehicle characteristics of the participant population at the same time. More details on these two weighting steps can be found in Appendix A.5.



The final piece was to calculate the demand reduction attributable to the program, again in two steps. ERS completed this analysis for each of the two target peak periods, the NYISO system peak and the Con Edison summer peak. First, the evaluation team compared the two profiles, subtracted the participant load from the baseline load, and averaged the difference over the hours of each peak period to arrive at the per-vehicle demand reduction. Next, to determine the overall program's demand reduction, the team multiplied the per-vehicle reduction by the number of participating vehicles for each peak period. For the NYISO peak, this was the 731 vehicles that were active as of August 29, 2018; for the Con Edison summer weekday peak, this was the average number of participants over the summer, or 706. The results of this analysis are presented in Section 4.1.

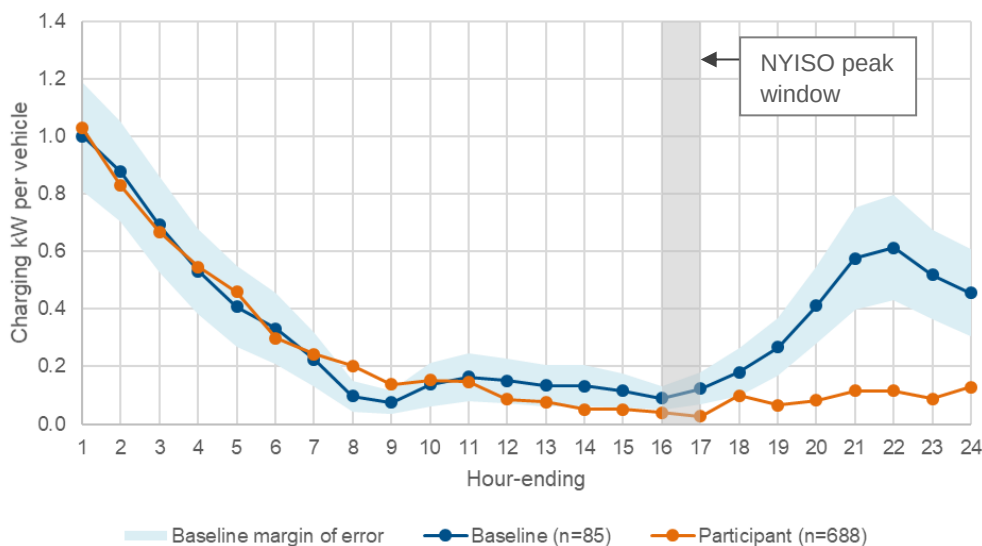
4 IMPACT EVALUATION RESULTS

This section presents details on the resulting demand reduction, 24-hour profiles, and BEV/PHEV subgroup analysis. It is followed by conclusions and recommendations, a list of future study opportunities, and study limitations.

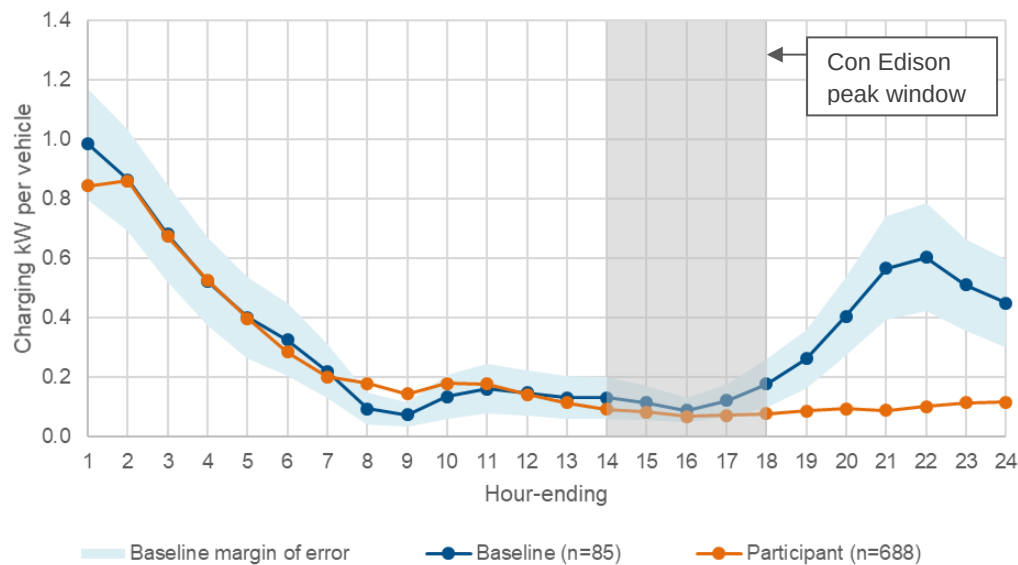
4.1 Ex Post Gross Demand Reduction

ERS calculated the peak demand reduction for the SmartCharge program for the two windows as described in Section 3.3; Figure 4-1 shows the NYISO peak (4:00–5:00 p.m. on the hottest summer day in 2018, August 29), and Figure 4-2 shows the Con Edison peak (2:00–6:00 p.m., all summer weekdays). The peak windows are shaded in gray on both graphs.⁹

Figure 4-1. NYISO Peak Day – Baseline and Participant Profiles



⁹ Each dot on the graph represents the average charging kW per vehicle over the previous hour, i.e., the dot at 16 represents the average charging from 15:00–16:00, or 3:00–4:00 p.m. As a result, the shaded peak periods do not include the dot on the starting hour. Charging during the NYISO peak period is represented by the dot at 17 (4:00–5:00 p.m.) and the Con Edison summer weekday average peak as the four dots at 15, 16, 17, and 18 (2:00–3:00, 3:00–4:00, etc.).

Figure 4-2. Con Edison Summer Weekday Average— Baseline and Participant Profiles

There are three immediately noticeable features in the graphs for both peak periods, moving from left to right:

- Both participant and baseline vehicles show a large increase in charging at midnight (the hour ending at 1:00 a.m.). The overnight period represents the most popular charging period for both populations. While charging overnight makes sense for the participant population – which is incentivized to charge between midnight and 8:00 a.m. – it is not clear why that is also the preferred period for baseline vehicles. The survey did not ask why baseline participants charged when they did.¹⁰
- There is a large drop in average charging during the middle of the day, including during the two peak periods (shaded in gray on the graphs). As anticipated, the participant population showed very little charging occurring over the peak periods, but there was also little charging from the baseline vehicles at these times, so the difference between them is small.
- Baseline vehicles showed a large increase in charging in the evening from 7:00 p.m. to midnight. However, charging from participant vehicles stayed roughly flat over most of the day and only increased at midnight.

¹⁰ Two of the 85 baseline survey respondents used in the analysis indicated they were on a time-of-use (TOU) rate, which similarly incentivizes overnight usage. These two were not excluded from the analysis, as TOU customers are eligible for the program and therefore are representative of that small portion of the nonparticipant population. However, as such a small portion of the overall baseline population, these do not explain the overall overnight charging trend.

To calculate the total program-wide peak reduction, only the peak periods – the gray shaded areas of the graphs – are considered. The per-vehicle peak demand reduction attributable to the program is the difference between the participant and baseline profile curves over the duration of each peak period. That per-vehicle demand reduction (shown in Table 4-1, below) is then multiplied by the number of participating vehicles (for the NYISO peak, this is the number of vehicles as of August 29; for the Con Edison peak, this is the average number of participants over the summer). The ex ante savings are calculated by taking the number of participants for each peak multiplied by the program’s deemed per-vehicle reduction of 0.7 kW/vehicle. Table 4-1 shows the results for each peak period definition, including the margin of error.

Table 4-1. Peak Demand Reductions – NYISO and Con Edison Peak Periods

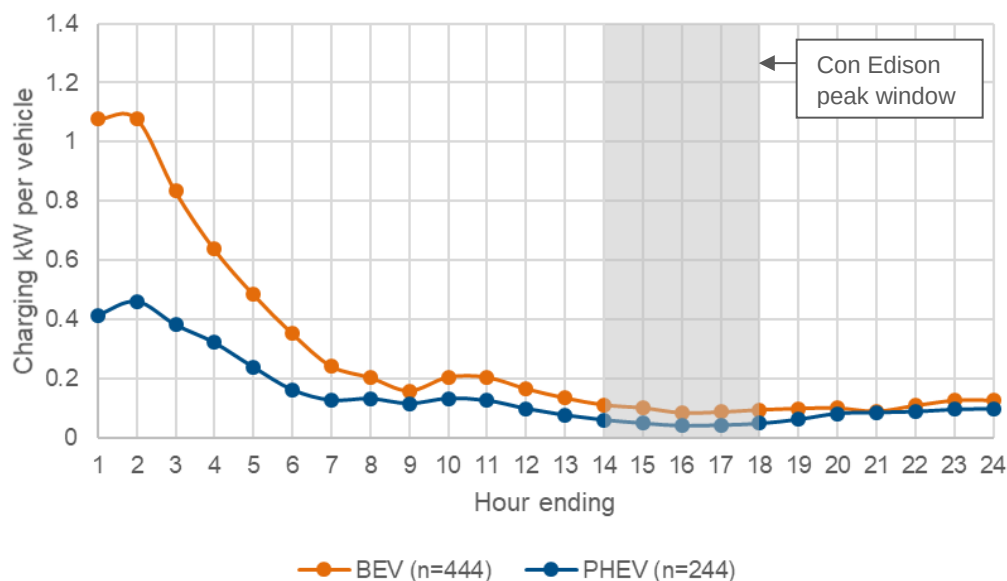
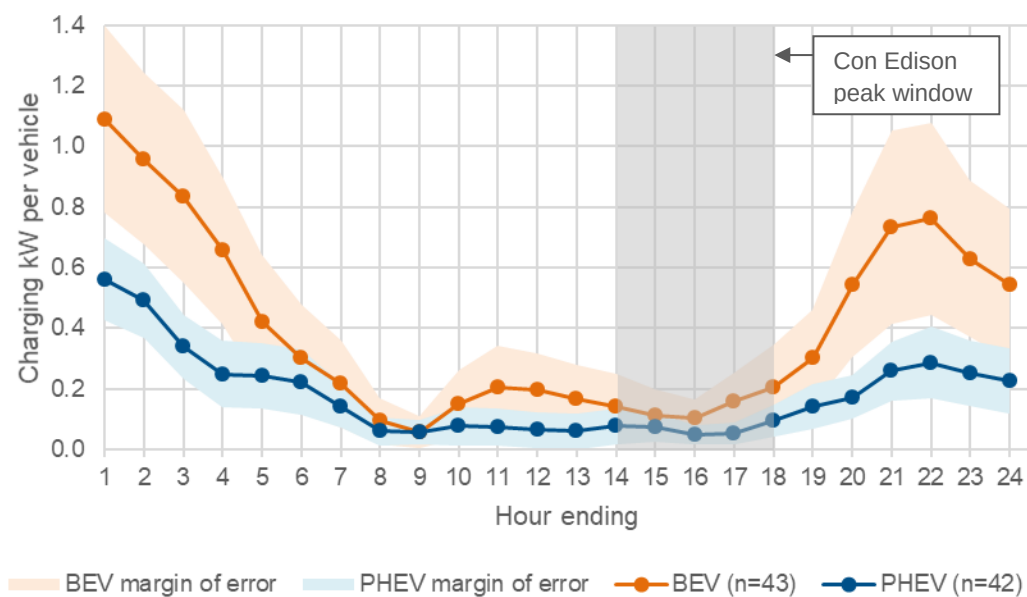
Peak Period	Number of Participants	Per-Vehicle Demand Reduction (kW per vehicle)	Ex Ante Savings (kW)	Ex Post Gross Savings (kW)	Realization Rate
NYISO peak	731	0.1 (+/- 0.05)	511.7	70.6 (+/- 40.1)	14% (+/- 8%)
Con Edison summer weekday peak	706	0.05 (+/- 0.06)	494.0	35.7 (+/- 40.8)	7% (+/- 8%)

Note that the margins of error are high at a 90% confidence interval. This error comes from estimating the baseline population from a survey sample.¹¹ As discussed in more detail in Section 4.4, Limitations, EV owners charged on very different schedules; from a statistical perspective, this creates a much greater variability than normally seen in evaluations and leads to a high margin of error. However, it is important to note that this represents uncertainty in the magnitude of the results, rather than invalidity.

The evaluation team also examined charging profiles by BEV and PHEV segments to view differences in behavior and load. Figure 4-3, below, shows the average charging kW per vehicle for participant BEV and PHEVs, and Figure 4-4 shows the average charging kW per vehicle for surveyed nonparticipant BEVs and PHEVs. Again, Con Edison’s summer weekday peak window is shaded in gray on both graphs.¹²

¹¹ Data was available for a census of participants, so there was no sampling, and the margin of error is thus negligible on the participant data.

¹² Each dot on the graph represents the average charging kW per vehicle over the previous hour, i.e., the dot at 16 represents the average charging from 15:00–16:00, or 3:00–4:00 p.m. As a result, the shaded peak periods do not include the dot on the starting hour. Charging during the Con Edison summer weekday average peak is represented by the four dots at 15, 16, 17, and 18 (2:00–3:00, 3:00–4:00, etc.).

Figure 4-3. Summer Weekday Average – Participant BEV and PHEV Profiles**Figure 4-4. Summer Weekday Average – Baseline BEV and PHEV Profiles**

Here, it is most important to note that there is a large difference in the charging kW load between BEVs and PHEVs, with BEVs drawing far more power while charging than PHEVs.

The remainder of this section discusses the implications of this research and further opportunities for refinement.

4.2 Conclusions and Recommendations

In addition to quantifying the program reduction, the study resulted in four conclusions with four associated recommendations, listed below.

- **Conclusion #1:** The calculated peak reduction per vehicle was 0.1 kW for the NYISO peak period and 0.05 kW for the Con Edison weekday peak period; this is substantially lower than the program deemed value of 0.7 kW.
 - **Recommendation #1:** Revise the per-vehicle demand reduction deemed value from 0.7 kW to 0.14 kW per vehicle for BEVs and 0.04 kW per vehicle for PHEVs. ERS recommends using these values derived from the NYISO peak period, as this is the TRM-defined period used to report savings from demand programs to the NYS DPS. Con Edison should use different values for BEVs and PHEVs to account for their significant differences in grid impact. This also provides insurance in case the program's BEV/PHEV distribution shifts. Future studies may be used to further investigate baseline charging behavior, as described in Section 4.3, below.
- **Conclusion #2:** Participants have a 0.3 to 0.5 kW per vehicle reduction between 7:00 p.m. and 12:00 a.m. relative to the baseline for both peak periods. The baseline vehicles showed a secondary charging peak during these hours that did not exist for the participant vehicles, with its maximum at the hour from 9:00–10:00 p.m. This indicates that the program is, in fact, delivering reductions, but it is occurring during the early evening rather than the afternoon. The program's incentives may be leading EV owners to forego plugging in as soon as they get home and pushing those charges to overnight, the weekend, or outside of the Con Edison service territory. While Con Edison's overall peak is from 2:00 to 6:00 p.m., a number of the utility's residential networks experience peaks between 7:00 and 11:00 p.m. and could benefit from a reduction in evening charging.
 - **Recommendation #2:** Consider leveraging the program framework to shift charging in night-peaking residential networks. One possibility using the existing program is selective targeting – using marketing to increase participation within those networks.
- **Conclusion #3:** The evaluation found a negligible difference in overnight charging between the participant and baseline populations. On average, there is a 32% chance that a baseline vehicle is charging between midnight and 8:00 a.m. For participants, this number is only slightly higher, at 35%. The participant overnight peak would be expected as the program incentivizes charging between midnight and 8:00 a.m. However, the baseline survey data shows that much of this overnight charging would occur even in the absence of the program and its incentives. This suggests that Con Edison is paying for charging that is already occurring.

- **Recommendation #3: Consider restructuring the program's layered incentive structure based on the peak period(s) of most concern.** It appears from the analysis that Con Edison is overpaying for charging that is already occurring overnight. However, it is possible that the reduction in the evening peak described in Conclusion #2 results from the midnight-to-8 a.m. charging incentive. In order to more cost-effectively use program funding, the program should test which of its layered incentives provide the greatest leverage for each of the afternoon and evening peaks, and alter the incentives based on which peak period is being targeted.
- **Conclusion #4: On average, demand from BEV charging is three times higher than from PHEV charging.** Due to a combination of larger batteries and more powerful onboard chargers, BEVs had an average active charging load of 4.0 kW, compared to 1.3 kW for PHEVs. BEVs, therefore, represent a greater impact on the grid and better targets for load reduction. The program already has a greater percentage of BEVs than the general population – Con Edison's service territory has a roughly equal percentage of BEVs and PHEVs, but the program participant population is closer to 65% BEVs and 35% PHEVs – which indicates that the program is seeing a greater load reduction than it would with a 50/50 population.
- **Recommendation #4: Target BEV owners for program participation.** As BEVs are responsible for a much greater load when charging than PHEVs, shifting BEV charging represents a greater demand reduction benefit to the program.

4.3 Future Study Opportunities

The evaluation team identified additional data collection, research, or analysis enhancements that could be used to increase confidence in the peak reduction results or provide additional granularity. However, given constraints in budget and schedule, these enhancements could not be practically incorporated at the time of this study but should be considered in future iterations as the program evolves.

- **Opportunity #1: Use additional data to complement the baseline survey data set.** The team investigated multiple data sources when considering how to best develop a baseline profile. Some of these methods could be utilized in the future:
 - **ChargePoint:** ChargePoint was willing to share anonymized charging data for its stations in the Con Edison territory. This would cover charging in public locations as well as some home locations.¹³
 - **Con Edison pilot:** A 2012–2016 EV metering pilot yielded interval charging data for its 50 participants, of which about a quarter were not on TOU rates. This data is immediately available and could be used as a “gut check,” with the caveat that it is several years old.
 - **Open Vehicle-Grid Integration Platform (OVGIP):** The Con Edison team investigated the potential of receiving charging data directly from several EV manufacturers through OVGIP. This data would be similar to what was obtained from FleetCarma’s C2 device, but for a census of vehicles of the particular make/model. This data is not immediately available but will be in the future.
 - **Control group:** Creating a program control group in which EV owners would be incentivized to maintain the C2 device but not enable its charge-shifting capabilities would produce some of the best quality charging data. While it was not originally feasible for the evaluation due to lower program participation and timing, the program staff has indicated this is an area of interest for future study.
 - **Additional surveying:** Another option for collecting self-reported data would be to provide a paper sheet or an app to ask respondents to record more exact data on their charging behavior when they plug in or unplug their vehicles (for example, the exact time, state of charge, etc.) for the week after they receive the survey. While this would provide more reliable data than asking owners to recall their past behavior, it is more expensive, requires more time to collect responses, and likely to have far lower response rates as it is more burdensome on the survey respondent.
- **Opportunity #2: Use additional analysis techniques to enhance the baseline analysis.** The evaluation team identified a few opportunities for additional data checks or more sophisticated analysis methods but could not pursue them due to study constraints. These opportunities included:
 - **Self-reporting:** Nineteen participants were inadvertently included in the nonparticipant survey population and took the survey. Their self-reported responses

¹³ Con Edison has also recently identified a number of participants with “smart” charging stations and is considering requesting charging data prior to their enrollment in the SmartCharge program.

- could be matched with their actual charging interval data from the C2 device to assess how reliable the self-reported responses were.
- **“Don’t know” data:** Survey respondents could select “don’t know” for the vehicle’s starting state of charge and their charging level to minimize inaccuracies from guessing. These charging events were removed from the analysis as there was not enough information to determine their charging duration. However, Con Edison could explore statistical methods to estimate those missing values.
- **Opportunity #3: Use the substantial existing data sets to analyze subsectors of the population.** Both the participant and baseline data sets are rich with additional variables that could not be explored in detail in this analysis but could yield additional insights for the programs. These include:
- **Network location:** FleetCarma has a “geofence” variable that lists the name of the Con Edison network in which the vehicle is charging. Con Edison could assess how much charging occurs on constrained networks for inclusion in non-wires alternatives considerations, or build a 24-hour map to understand where and when charging is occurring in its territory.
 - **Make/model:** For both the participant and baseline data sets, Con Edison could analyze differences in charging behavior and/or load by make/model and/or long-range versus short-range BEV.

4.4 Limitations

This section discusses the limitations of the two primary data sets used for this study, how the evaluators attempted to overcome them, and opportunities for refinement (also discussed in the section above).

For the participant charging data, the program staff and the evaluators had access to 15-minute interval charging data for all vehicles currently participating in the program. As a result, no sampling was required to achieve a statistically significant charging profile. The only limitation from this participant data was missing values, such as unknown make/model or location, or inaccurate charge monitoring (for example, when the C2 device recorded hundreds of charging events spanning one minute each for a single vehicle). These data points were removed from the analysis but should be investigated by FleetCarma to determine ways to troubleshoot data-collection errors with participants.

Most of the study’s limitations originate from the baseline portion of the study. There are three main limitations, each described below.

1. **The baseline charging profile is based on self-reported survey data, which is less accurate than metered data.** The data reported is only as good as the respondents' ability to recall their behavior from the past week. This could lead to data that is not entirely reflective of the respondents' true behavior, only their (possibly flawed) remembrance of it. To minimize respondent guessing, which would most negatively impact accuracy, questions where respondents might not remember the true value included a "do not know" option; those responses were not used in the analysis.
2. **The baseline analysis required making assumptions to account for imprecision in the survey responses, which could introduce error into the results.** These assumptions, which are described more in Appendix A, Section A.4, fell into three categories:
 - a. **Categorical responses:** To maximize the respondents' ability to remember details about their charging, the team built the survey using drop-downs rather than asking for exact details. However, these ranges had to be converted into single values in order to calculate charging duration. ERS took the midpoint in those cases to account for the fact that it was equally likely for an EV owner to report a value at the low end as the high end. This assumption could either over- or underestimate charging durations for each session, but it may cancel each other out on aggregate.
 - b. **Overnight charging:** The survey only included a single eight-hour bracket between midnight and 8:00 a.m. The evaluation team set charging occurring in this time period to midnight for several reasons described in Appendix A.4. This is the most conservative estimate, as it means that the baseline and participant profiles closely match and that the differences (i.e., reductions/increases) between the curves are low. It may overestimate baseline charging at midnight and underestimate charging during the early morning before 8:00 a.m., but the total amount of charging occurring is the same.
 - c. **Charge rates:** ERS assumed a constant rate of charge in the calculations (i.e., the charge rate did not decrease as the battery approached a full charge). This is primarily a consideration for Tesla Supercharging. The analysis may, therefore, underestimate the charging duration in those cases, but the total amount of energy drawn from the grid will remain the same.
3. **Relative standard error is large at the 90% confidence interval due to inherent variability in the data and a low realization rate, which represents uncertainty in the results.** EV owners charged on very different schedules; from a statistical perspective, this is a greater variability than normally seen in evaluations. Consider this example: if there were 100 survey respondents, only 10 of them might have charged at all during a

certain hour. There would be 90 respondents with a value of 0 and 10 respondents with probability values between .1 and 1.0 for that hour. This leads to a high standard deviation and a high margin of error relative to the low average value, especially if some of the 10 customers who charged during that hour did so every day. In addition, the relative standard error is also high because the calculated reduction was low. For example, the result could be 70 kW +/- 35 kW, for savings between 35 and 105 kW (a relative margin of error of 50%, and an absolute margin of error of 35 kW). However, if the result was 500 kW (a realization rate of around 100%) +/- the same absolute margin of error (35 kW), then the relative margin of error would only be 7%.

Future research might focus on additional sources of NYC-specific baseline data that could be used to supplement the research performed here, described more in Section 4.3.

APPENDIX A: ADDITIONAL DETAIL ON METHODOLOGY

This appendix provides additional detail and context for the methodology described in Section 3.

A.1 Participant Data

The FleetCarma C2 device records data only when the vehicle is charging. When charging, data is recorded in 15-minute intervals aligned with each quarter hour. Thus, for a charge session starting at 8:39 a.m. and lasting one hour, data is reported for the following intervals: 8:39–8:45 a.m., 8:45–9:00 a.m., 9:00–9:15 a.m., 9:15–9:30 a.m., and 9:30–9:39 a.m. Accordingly, the “middle intervals” of a charge session are all roughly 15 minutes in duration, while the first and last intervals in a charge session vary in duration based on when the vehicle was plugged in or unplugged, respectively. The example one-hour charge session above consists of five “intervals.”

Each row of the provided FleetCarma data set represents a charge interval, which is a subset of a charge session. The FleetCarma device stores 20 pieces of data for every charge interval in a charge session. The data values reported for each interval fall into three general categories, as follows:

- **Data identification** – Numerical identifiers that indicate the participant, vehicle, and charge session to which the charging data belongs.
- **Vehicle specifications** – Data points that specify the vehicle’s make, model, model year, and trim. The trim value contains additional information about the specific vehicle’s configuration, such as the battery size or additional interior features (e.g., “Luxury SE”).
- **Charge data** – Data related to a specific charge interval, including when and where it took place and the level of charging activity during the interval (e.g., kWh and maximum kW).

Table A-1, below, provides a breakdown of the FleetCarma data fields that were used in this analysis, including a description of each data field and the category to which it belongs.

Table A-1. FleetCarma Data Dictionary

Column	Field Name	Field Description	Field Category
1	User key	A unique numerical identifier provided to each participant, or user, enrolled in the program.	Data identification
5	Vehicle key	A unique numerical identifier provided to each vehicle enrolled in the program. Some participants may have more than one vehicle enrolled in the program.	Data identification
6	Make name	The vehicle make.	Vehicle specifications
7	Model name	The vehicle model.	Vehicle specifications

Column	Field Name	Field Description	Field Category
8	Model year	The vehicle model year.	Vehicle specifications
9	Trim name	The vehicle trim (if available).	Vehicle specifications
10	Charge session key	A unique numerical identifier for each unique charge session. A participant who charged with a single vehicle 100 times over the course of the summer period would produce 100 unique charge session keys, each of which could contain a different number of charge intervals depending on the session duration.	Data identification
12	Geofence name	The name of the Con Edison network in which the charge session took place. Out-of-network or inaccurately identified charge sessions are shown as "Inaccurate GPS," "No GPS," or "Out of territory."	Charge data
13	Interval start date	The interval's starting timestamp, in M/D/YYYY HH:MM:ss format.	Charge data
14	Interval end date	The interval's ending timestamp, in M/D/YYYY HH:MM:ss format.	Charge data
15	Charge energy kwh	The charge energy recorded during the interval, in kWh.	Charge data
16	Charge energy loss kwh	The charge energy losses recorded during the interval, in kWh.	Charge data
17	Max charge power kw	The max charge rate during the interval, in kW.	Charge data
19	Start SOC percent	The state of charge (SOC, %) at the beginning of the interval.	Charge data
20	End SOC percent	The SOC (%) at the end of the interval.	Charge data

A.2 Participant Profile Development

ERS conducted the majority of the participant data analysis in Python, a programming language selected for its readability, scalability, and processing speed; ERS completed the final portion of the analysis in Excel to take advantage of its flexibility, accessibility, and ease of use for future analysis by Con Edison.

The analysis of the participant data consisted of three components:

- Development and application of QC checks to determine data quality and validity and to remove invalid data from the analysis (Python)
- Construction of 24-hour charge session profiles for each charge session recorded in the months of June through September (Python)
- Aggregation of unique 24-hour charge profiles into 24-hour participant vehicle-level and program-level average charging profiles (Excel)

The FleetCarma charging data served as the input to the Python script, and the output consisted of two Excel files. The first contained the original data along with the QC flag values as applied by the script; the second contained charge profiles for each charge session in the data set, along with metadata to identify the charge session's time, place, and vehicle.

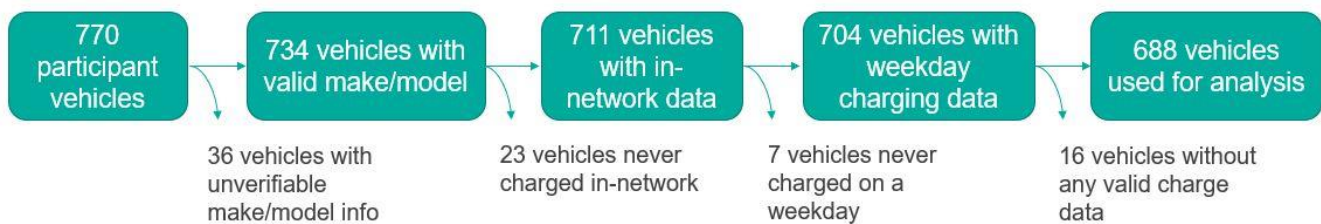
The above components are described in greater detail in the following sections.

Quality Control

ERS developed 16 QC checks to determine the validity of the provided data and to flag invalid charge intervals for removal from the analysis. ERS tracked several additional values of interest for inclusion in the final aggregated analysis and to facilitate potential future investigation of data anomalies. The primary aim of this process was to identify and remove data points that failed specific range and relational checks; an additional goal was to flag data from vehicles and participants with non-unique or inaccurate identifying information. Following the application of QC flags, only charge intervals that had passed all QC checks were considered in the development of participant charge profiles.

Figure A-1 provides a visual representation of the QC process in a compressed form. Several of the 16 QC checks are incorporated into the final step, where vehicles were removed for not having any valid charge data.

Figure A-1. Participant Data Flow Map



Note that because the focus of this evaluation was weekday peak charging in Con Edison's service territory, weekend and out-of-network charging sessions were not included in the analysis.¹⁴

The QC checks developed for this analysis are shown below, in Table A-2. The checks that removed out-of-network and weekend charging data are not included in this list, as they were applied in the final analysis stage in Excel. Note that many of these checks did not result in any data points being removed.

¹⁴ The 7 weekend-only chargers were removed as a result of filtering out weekend-only data, rather than directly flagging them for removal. Con Edison's program staff pointed out that these 7 weekend-only chargers do help the program, as they are not contributing to the peak. Including them in the analysis would slightly decrease the participant profile and increase the reductions attributable to the program. However, as they would represent fewer than 1% of the data points comprising the participant profile, their effect would be very small.

Table A-2. Participant Data QC Checks

QC Check	Description
Month flag	Remove charge intervals where timestamps occurred outside the months of June through September (the program window)
Year flag	Remove charge intervals for which timestamps occurred outside the year 2018
Unique email flag	Remove users who had multiple email addresses tied to a single user key
Unique first name flag	Remove users who had multiple first names tied to a single user key
Unique last name flag	Remove users who had multiple last names tied to a single user key
Dummy user flag	Remove a non-participant FleetCarma user with two vehicles (Note: these vehicles are not included in the total number of participants [770] referenced throughout the report)
Vehicle flag	Remove vehicles with unidentifiable make and model information; for these vehicles, the make was listed as "UNKNOWN MANUFACTURER," the model was listed as "UNKNOWN MODEL," and the model year was listed as 0
Charge energy (kWh) flag	Remove charge intervals with blank or negative charge energy (kWh) values
Charge rate (kW) flag	Remove charge intervals with blank or negative charge rate (kW) values
Starting SOC flag	Remove charge intervals with starting state of charge (SOC, %) values falling outside the range of [0, 100]
Ending SOC flag	Remove charge intervals with ending state of charge (SOC, %) values falling outside the range of [0, 100]
Delta SOC flag	Remove charge intervals for which the change in SOC fell outside the range of [0, 100]
Charge ratio flag	Remove charge intervals in which the average charge rate (calculated) exceeded the max recorded charge rate by greater than 15%. Theoretically, the average charge rate should at most equal the max charge rate. A 15% allowance was included to account for uncertainty regarding how the charge kWh and max charge kW were measured by the C2 device.
Phantom charging flag	Remove charge intervals representing "phantom charging," or negligible charging load on the grid. Applied to intervals during which the battery was nearly full (more than 98.5%) and the charge rate was low (less than 0.35 kWh). The battery was assumed to be effectively full at this point, and any remaining low-power charging was assumed to represent a floating, parasitic load that is delivering little real energy to the battery, rather than "active charging."
Non-unique charge ID flag	Remove charge intervals tied to a non-unique charge ID
Non-unique charge session key flag	Remove charge intervals tied to a non-unique charge session key

Profile Development

Developing a program-level participant profile required several steps. First, the evaluation team developed charging profiles for each of the charge sessions over the course of the summer.

Constructing these profiles required the translation of interval data from the FleetCarma data

set into 24-hour charge profiles for each charge session. As these profiles were developed, interval metadata¹⁵ was brought into each single-session profile to facilitate tracking of the vehicle that recorded the charge session, the charge session location, and the charge session's beginning and ending timestamps.

Following the development of daily profiles for each charge session, ERS aggregated each unique vehicle's charging sessions into a 24-hour array representing the average kW charging load for the summer for that vehicle. Since some vehicles joined the program midway through the summer, taking a straight average across the number of weekdays in the four summer months would artificially decrease the average for those newer participants, as it would appear they did not charge at all until they joined the program. Instead, the evaluation team calculated an eligible charge window for each vehicle, representing the number of weekdays on which the vehicle could have been charged between the date of the vehicle's first recorded charge and the end of the summer (September 30). The team then used that window to calculate the average profile for each vehicle. These 24-hour profiles were developed for all 688 vehicles enrolled in the program with valid data; the profiles include information (such as make/model and charge location) that could be used to develop segmented profiles.

After developing average charge profiles for each vehicle in the program, ERS aggregated this data across all enrolled vehicles to develop a program-wide 24-hour average load curve for each peak period, representing the average demand in kW on the grid at each hour during the day from the program participants' charging. These hourly profiles are presented on a per vehicle basis; each hour's value is in units of kW/vehicle. ERS also developed separate program-wide load profiles for battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

A.3 Baseline Surveys

Prior to the start of the project, the Con Edison and ERS teams researched several potential methods of determining a baseline and determined that a survey of nonparticipating EV owners was the most appropriate for this study. A survey was the most cost-effective method that was also the simplest to implement and would likely best represent the different EV use cases, given the budget constraints and data availability. The other methods considered are included below,

¹⁵ Metadata is defined as "data that provides information about other data" in the Merriam-Webster dictionary. Here, the metadata is used to tag each profile with information that can be used later to identify 1) who did the charging, 2) where the charging took place, and 3) when the charging took place. This information is used for filtering and for determining each vehicle's charge window, for example.

along with the rationale for why it was insufficient, on its own, to develop a representative baseline profile.

- **Method:** A control group that would be given incentives to install the FleetCarma device but not shift their charging. **Rationale:** *A control group was infeasible given low participation in the first year of the program, which made sampling challenging.*
- **Method:** Interval charging data sets from ChargePoint. **Rationale:** *The ChargePoint data included mostly public and some home charging; as many owners charge their vehicles at home, it would underestimate this population and the effect of their charging.*
- **Method:** Interval charging data sets from the Open Vehicle-Grid Integration Platform (OVGIP). **Rationale:** *The OVGIP data was not yet available. It will also only include data from the 2-3 manufacturers participating, so charging data will not be available for Tesla EVs, for example.*
- **Method:** Interval charging data available from a prior Con Edison pilot program. **Rationale:** *The prior Con Edison pilot program included only home charging and too few participants.*
- **Method:** Other studies from national labs or research firms. **Rationale:** *Other studies were not sufficiently detailed nor NYC-specific.*

The team notes, however, that these methods can and should be used to supplement this study's data collection.

Although surveys are not free from biases and limitations (described in Section 4.4 and addressed in the survey description below), the other methods were deemed to be more skewed in the populations for which data would be available. ERS and Con Edison therefore decided to use self-report surveys to gather charging behavior from New York EV owners not yet fully participating in the program in order to develop a 24-hour baseline profile, as described below.

Target Baseline Populations

The survey was administered to three different sample populations to maximize the number of survey responses and capture respondents that would reflect both current and future SmartCharge participants. These populations included:

- **Nonparticipants/non-enrollee owners (NEOs)** – Con Edison possesses a marketing list of roughly 3,700 potential EV owners within their territory. The list included contact information from a combination of new EV owners receiving NYSERDA's Drive Clean rebates, customer data provided by FleetCarma targeting likely EV owners; and EV owners requesting information from Con Edison. Program staff update the list periodically, and NYSERDA provides quarterly updates on rebate recipients to Con

Edison each quarter. The ideal baseline population would include all program-eligible EV owners, which includes any owner who charges at least once per month within Con Edison territory, regardless of whether they are customers. These out-of-territory owners make up slightly less than 10% of participants. The marketing list was limited to EV owners within Con Edison's service territory. However, both other target populations included out-of-territory owners; the survey responses utilized by the evaluation team had roughly 11% out-of-territory owners across the three target populations.

Since these customers do not currently participate in the SmartCharge program, they are ideal study subjects, as their behavior is not influenced by program incentives. However, they have received information about the program through marketing emails, so they may be aware of the program's goals and the peak period. It is possible that the marketing may indirectly influence these EV owners' behaviors (i.e., nonparticipant spillover), but future study would be needed to determine if this effect is substantial.

The marketing list was purchased from a third party and included suspected EV owners; this meant that a number of people on the list did not actually own an EV and had to be filtered out while conducting the survey. Out of the 209 people that began the survey, 78 of them (37%) indicated they did not own an EV and were screened out.

- **New program enrollees** – EV owners who have recently signed up and have not yet installed the C2 device are in a “sweet spot” – their behavior is not yet directly influenced by the program's incentives. As with the NEOs, it is possible that knowledge of the program's structure may indirectly influence the EV owners' charging patterns. FleetCarma included a link to the survey within the program acceptance email sent to each of the 66 new participants added during the survey period.
- **Waitlisted signups** – Enrollees with EV models that are not yet supported are waitlisted. As new EV models are introduced, FleetCarma must update its software to be compatible with new models in order to correctly access the charging data. This group included a backlog of waitlisted enrollees prior to the start of the study, and new enrollees added to the waitlist during the research period.

The sample frame and completes from each population are described in the Survey Logistics section below. Note that the survey was emailed to a census of these populations – all NEOs with valid email addresses, all new applicants, and all existing or new waitlist members – with follow-up emails to increase response rates. All three groups received an incentive of \$25 for completing the survey.

Survey Logistics

Con Edison retained TRC Market Research to implement the survey, including design assistance, programming, and tracking responses. Once programming was completed, TRC, Con Edison, and ERS conducted QC testing to ensure that all skip patterns and answer choices were working. Each survey version was soft-launched with a sub-sample before being finalized.

The survey sequence included the following components:

- An email with a link to the web survey. Depending on the sample population, these emails could be sent by Con Edison or FleetCarma, as shown in Table A-3 below.
- One follow-up reminder with another survey link 2-3 weeks after the initial survey if there had been no response. These were sent by TRC.
- A \$25 gift card to all survey respondents sent roughly 6-8 weeks after the study was completed.

The fielding was consistent across the three populations, with variations in timing and the party responsible for initial contact with the customer depending upon the sample population, as shown in Table A-3:

Table A-3. Survey Logistics by Sample Frame

Activity	Sample Population			
	NEO	Waitlist Backlog	Waitlist New Enrollee	New Enrollee
Initial survey sent by	Con Edison		FleetCarma	
Follow-up reminder sent by	TRC		TRC	
Timing of initial email	Weekly		As enrolled	
Survey period	Aug 10 – Sep 25		Aug 23 – Oct 10	

Table A-4 lists the number of vehicles in each population and survey completes from each.

Table A-4. Baseline Survey Population and Completes

Population	Total Population	Sample Frame	Survey Completes	Response Rate
Non-enrollee owners (NEOs)	8,934 ^a	3,640	64	57% ^b
New program enrollees	66	60	14	23%
Waitlisted signups	187	177	73	41%
Total	N/A	3,877	151	4%

^a NYSEDA compiles data on EV registrations from the New York Department of Motor Vehicles. Summary tables can be accessed at <https://www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/EV-Registration-Tables.xlsx>. The database was accessed in early December 2018 and had been updated

through September at that point. NYSEDA only reports current data by county, so this number is larger than what the EV population was at the beginning of this study (May).

^b Calculated using AAPOR Calculator Response Rate 3 to account for the high percentage of NEO respondents who did not own EVs.

Survey Instrument

Con Edison and ERS developed a web survey to capture self-reported charging behavior. The survey questions (included in Appendix B) were designed to capture all data required to estimate weekday charging behavior and associated load. The team developed multiple versions of the survey that were identical across the three target populations except for screening questions to ensure that respondents were eligible for the survey and included in the correct target group. The critical portion of the survey, after a number of screening questions, was a grid where respondents were asked to mark how many times they charged their EV each day in the past five weekdays. For each separate “charging event,” up to three per day, respondents filled out six data fields that allowed ERS to estimate their charging behavior and associated load:

1. The hour the charging started
2. The hour that the owner unplugged the EV¹⁶
3. The approximate battery state of charge (SOC) when the owner plugged the vehicle in (in gradations of 0%–24%, 25%–49%, 50%–74%, and 75%–100%)
4. The charging type (Level 1, Level 2, Level 3–DC Fast Charging, or Tesla Supercharging)
5. The location (whether or not the charging occurred in Con Edison’s service territory)
6. The charger type (home, public charging station, work charging station, etc.)

The survey also asked for the make, model, and year of the respondent’s EV, if not already known, as well as a number of questions for marketing purposes (including nonparticipants’ awareness of the program).¹⁷ The full survey instrument can be found in Appendix B.

¹⁶ A charge session can end either because the EV’s battery is fully charged or because the owner unplugged the vehicle before the charge had completed. ERS calculated the former (see the Calculating Charge Duration discussion below in Section A.4) and compared it to the self-reported answer for the latter. Whichever occurred first was used in the analysis.

¹⁷ Con Edison performed analysis on these questions and the findings are therefore not contained in this study.

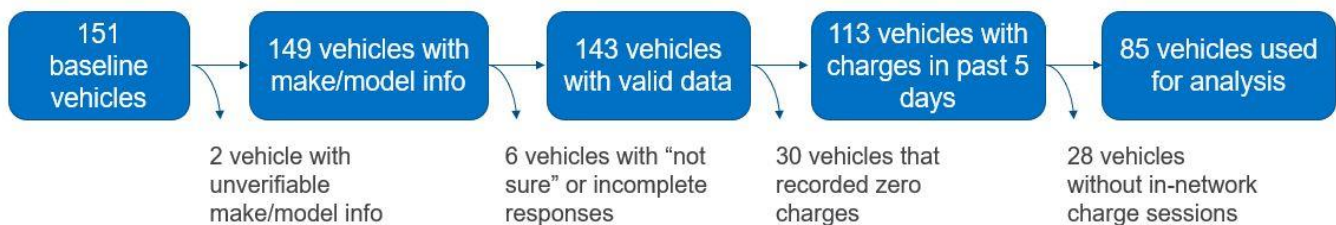
A.4 Baseline Profile Development

Several steps were required to develop baseline charge profiles; they are discussed in the following subsections.

Quality Control

As with the participant analysis, ERS developed QC checks to determine the validity of the provided survey data and to flag invalid responses for removal from the analysis. Figure A-2 provides a visual representation of the QC and cleaning process in a compressed form.

Figure A-2. Baseline Data Flow Map



Note that most vehicles removed from analysis were because they did not charge in Con Edison’s service territory or at all during the five previous weekdays.¹⁸ These could not be used in the analysis for two reasons. First, it was not possible to determine if they would be eligible for the program, as vehicles must charge once per month in Con Edison’s service territory. Second, including them in the analysis would artificially lower the baseline profile, as it would incorrectly indicate that these vehicles had a 0% probability of ever charging.

The QC checks developed for this analysis are shown below, in Table A-5. The filter for out-of-network charging events is not included in this list, as it was applied separately in the analysis.

Table A-5. Baseline Data Flow Map

QC Check	Description
Vehicle flag	Remove charge sessions with unidentifiable vehicle make and model information, such as a vehicle’s model being listed as “Other”
Plug-in time flag	Remove charge sessions for which the respondent did not provide a plug-in time
Unplug time flag	Remove charge sessions for which the respondent did not provide an unplug time
Charger power flag	Remove charge sessions for which the respondent did not provide a charger type or responded “Not sure”
Starting SOC flag	Remove charge sessions for which the respondent did not provide a starting SOC or responded “Not sure”

¹⁸ Ten surveys included in the analysis reported early October charging information. The evaluation team does not expect that their behavior would be different from late September and they were kept in the analysis.

Calculating Charge Duration

The surveys used to inform the baseline analysis provided data on five weekdays' worth of charging, which ERS used to develop an average 24-hour baseline profile for each respondent. Unlike the participant interval data, the survey data did not provide definitive start and end times or real-time charge rate (kW) values for each charging event. Instead, the surveys prompted respondents for information they would be more likely to remember, such as the time they plugged in and unplugged, the type of charger they used, and the state of charge (SOC), all of which was used to calculate how long it would take for the EV's battery to be charged.

Using the self-reported survey data required the team to make several assumptions in order to convert categorical or binned responses into data that could be used in calculations. For example, for the starting SOC data field, the survey prompted users to select one of four responses from a dropdown (0%–24%, 25%–49%, 50%–74%, or 75%–100%), rather than asking for a numerical input that vehicle owners may not have known with much accuracy. These assumptions included:

- 1. Starting and ending times:** The survey provided one-hour blocks (i.e., 8:00 – 8:59 p.m.) for charge start and ending times. ERS took the midpoint of the selected hour block (i.e., 8:30 p.m.) as the starting charge time to account for the fact that it was equally likely for an EV owner to start charging at 8:01 p.m. as 8:58 p.m. This approach differs for events starting at midnight, as described below.
- 2. Midnight to 8:00 a.m. charging start:** To reduce the length of the survey, the period between midnight and 8:00 a.m. was shortened to a single bracket, rather than eight hour-long bins. Unlike for the single-hour bins, the evaluation team could not assume that it is equally likely for an EV to start charging at midnight as 4:30 a.m. In the absence of additional information from survey respondents, ERS referenced other available EV charging load curves from national reports reviewed during project initiation; the team found that the overnight charging in all of those cases peaked at midnight.¹⁹ ERS therefore set the charging over this period to start at midnight. This is also the most conservative estimate, as it means that the baseline and participant profiles closely match and that differences (i.e., reductions/increases) between the curves are low. It is

¹⁹ U.S. Department of Energy, "Evaluating Electric Vehicle Charging Impacts and Customer Charging Behaviors – Experiences from Six Smart Grid Investment Grant Projects," December 2014, accessed at: https://www.smartgrid.gov/files/B3_revised_master-12-17-2014_report.pdf; Idaho National Laboratory, "Plugged In: How Americans Charge their Electric Vehicles," December 2015, accessed at: <https://avt.inl.gov/sites/default/files/pdf/arra/PluggedInSummaryReport.pdf>.

probable that not all charging starts right at midnight, but ERS does not have any data to suggest how staggered it is.

3. **Starting state of charge:** As with the starting/ending charge period referenced above, ERS took the midpoint of the provided starting SOC response as the actual value. That is, if a respondent selected 50%–74%, ERS used the midpoint value of 62% in the analysis.
4. **Charging rate:** ERS assumed a constant rate of charge in the calculations; that is, the charge rate did not decrease as the battery approached a full charge. (This is primarily a consideration for Tesla Supercharging, which tapers off after the battery reaches an 80% state of charge; different make/models may also experience decreased charge rates.) Modeling the tapering effect would have added considerable complexity to the analysis and was not attempted due to budget constraints.

The possible effects of these assumptions are described in Section 4.4, Limitations.

ERS calculated the duration of each charging event using the survey-derived variables described above as well as vehicle-specific values. Because EV battery sizes and onboard chargers differ depending on the vehicle make, model, year, and configuration, ERS built a reference table to pull in the battery capacity and charger acceptance rate for each respondent's vehicle based on publicly available data.²⁰

After calculating how long it would take for the EV's battery to be fully charged, ERS compared this to the self-reported time that the owner next unplugged the vehicle. The duration of each charging event was calculated as the lesser of:

- The number of hours the vehicle was plugged in, using the provided plug-in and unplug times
- The number of hours necessary to fully charge the battery, given vehicle-specific battery size (kWh), starting SOC, and the lesser of the on-board and external charge rates (kW)

Using the charging start time and the calculated charge duration, ERS could then translate the data into a 24-hour profile, described in the next section.

Profile Development

The steps to develop a baseline profile mirrored those in the participant analysis. The data was translated into a series of 24-hour profiles and aggregated, first for each respondent and then

²⁰ ClipperCreek, an EV charger manufacturer, put together tables for all BEVs and PHEVs of their battery size and acceptance rate (including differences by year and configuration) that are accessible here: <https://www.clippercreek.com/charging-times-chart/>.

across the entire survey group. Separate aggregations were also developed based on the vehicle type: BEV or PHEV.

The detailed steps in this process included:

- Mapping the active charge windows calculated from the survey responses to a 24-hour profile of binary charge/no-charge values.
- Aggregating the binary charging event profiles for each respondent to develop 24-hour charge probability profiles for each respondent. This profile represents the average probability that a respondent's vehicle would be actively charging in each hour of the day for the five days' worth of responses.
- Aggregating across all respondents to create average 24-hour profiles for the baseline, including an overall profile and BEV- and PHEV-specific profiles.

The resulting profile represented the probability that an average baseline EV was charging in each hour of the day. In the final step of the analysis, described below, this probability profile was converted into a load profile for comparison to the participant population.

A.5 Demand Reduction Analysis

In order to determine the peak demand reduction attributable to the program, it was first necessary to convert the charge probability profile from the baseline analysis into a load curve so that it could be compared directly with the load curve from the participant data. Since the vehicle makeup of the baseline differed from that of the program, ERS also used this step to weight the baseline to make it more representative of vehicles in the participant population.

The size of the vehicle's battery (and therefore its mileage range on a single charge) is one of the most important factors influencing an EV owner's charging behavior, and therefore the factor used to weight the data. While segmenting by make and model of vehicle would be ideal, there was not enough data for each make and model for this to be feasible. Instead, the evaluation team split the populations into BEVs and PHEVs. BEVs tend to have larger batteries, more powerful onboard chargers, and longer driving range between charges than PHEVs. The survey respondents with usable charging data were 51% BEVs and 49% PHEVs, which compares well to the general population in Con Edison's service territory at 49% BEVs and 51% PHEVs. However, the participant population has a higher percentage of BEVs at 65%.

Using the BEV distribution as the weighting factor, ERS converted the baseline probability curve into a load profile in two steps:

- First, ERS calculated a weighted average of the survey PHEV and BEV profiles so that the baseline represented an average charging behavior from 65% BEVs and 35% PHEVs, matching the program's makeup.

- Next, the weighted charge probability profile was multiplied by a constant average charging rate from the participant analysis. The average charging rate is the average load on the grid from the participant vehicles when they are actively charging. The active charging rates are shown in Table A-6.

Table A-6. Participant Average Charging Rates

Vehicle Type	NYISO Peak (8/29/18) (kW)	Con Edison Weekday Peak (kW)
BEV	4.3	4.0
PHEV	1.5	1.3
Participant average	3.1	3.1

The combination of these steps yields a baseline load profile that represents the baseline population's charging behavior and the participant population's vehicle characteristics and charging rates. This is an important distinction, as the program does not attempt to alter the car, the charger, or the amount of charging occurring – only when it is occurring.

Following the development of a modified, weighted baseline charging profile, the evaluation team compared it with the participant charging profile to determine the demand reduction per vehicle at each hour of the day. ERS completed two analyses for each of the two target peak periods:

- For the NYISO peak period, ERS compared the baseline profile to the average participant profile for all charge sessions that took place on August 29, 2018, which was the hottest non-holiday weekday of the summer. ERS calculated the demand reduction on a per-vehicle basis for each hour of the day on a per-vehicle basis and determined the total demand reduction (kW) achieved during the hour ending at 5:00 p.m. on that day, using the number of enrolled participants in the month of August (731).
- For the Con Edison summer weekday peak period, ERS compared the baseline profile to the average participant profile to determine the demand reduction achieved in each weekday hour from 2:00 p.m. to 6:00 p.m. ERS calculated the demand reduction on a per-vehicle basis and also determined the total demand reduction (kW) achieved in each month, using the average number of vehicles enrolled across the summer (706).

The results of the analysis are presented in Section 4.1.

APPENDIX B: SURVEY QUESTIONNAIRE

Electric Vehicle Charging Behavior Research

Research Questionnaire

TRC 15932

Use TRC – CE2 template

Final: 8/22/18

Research Objective	- Find the baseline (pre-participation) charging behavior of EV owners to assess the effectiveness of Con Edison's electric vehicle program. - Con Edison can then compare that baseline behavior to the in-program charging behavior of participants to see if the incentives are leading to beneficial changes in when cars are charged.
Method	240 10-minute quantitative online interviews. - Survey is designed to be mobile-friendly.
Target/ Sample	- Three sources of completes: New Program Enrollees (NPEs), Non-Enrollees-Owners (NEOs), Program Wait-list (Backlog and New). - FleetCarma to send emails to NPEs and new wait-list, TRC to send reminders. Con Edison will send advance emails (possibly with unique link) to NEOs and back-log wait-list. TRC will email NEOs and back-log Wait-List. - Email addresses provided by Con Edison, who will be identified as survey sponsor.

Quotas and sample variables

Quotas	Specifications	Quota Type	Target n=	PD notes
Total EV Owners		Hard	340	
New Program Enrollees	QSamp1=1 and QS3b=1	Hard	40	
Non-Enrollees-Owners	QSamp1=2 and QS3b=1	Hard	200	<i>Aim for 120-200 completes</i>
Program Wait-list	QSamp1=3 and QS3b=1	Hard	100	<i>Aim for 50-100 completes</i>
Wait-list: Backlog	QSamp1=3 and QSamp2=1 and QS3b=1	Hard	100	<i>May fall naturally based on sample received.</i>
Wait-list: New	QSamp1=3 and QSamp2=2 and QS3b=1	Hard	100	
Supported vehicles	QS3b=1	Hard	9999	
Unsupported vehicles	QS3b=2	Hard	9999	Unsupported vehicle completes to receive incentive and count as terminates

[[SINGLE CHOICE]]

- QSamp1 Participant type
- 1 New Program Enrollees
 - 2 Non-Enrollees-Owners
 - 3 Program Wait-list

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

IF QSAMP1=3 (Program Wait-list)

- QSamp2 Program Wait-list type
- 1 Backlog
 - 2 New

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

- QDate Date survey was completed
- 1 [[TEXTBOX]]

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

[[SINGLE CHOICE]]

IF QSamp1=2 OR (QSamp1=3 and QSamp2=1) (Non-Enrollees-Owners or Wait-List Backlog)

- QEmail Email address for non-enrollees-owners
- 1 [[TEXTBOX]]

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

IF QSamp1=3 and QSamp2=1 (Program Wait-list Backlog)

- QManu Manufacturer of vehicle
- 1 Audi
 - 2 BMW
 - 3 Cadillac
 - 4 Chevrolet
 - 5 Chrysler
 - 6 Fiat
 - 7 Ford
 - 8 Honda
 - 9 Hyundai
 - 10 Kia
 - 11 Mercedes-Benz
 - 12 Mini Cooper
 - 13 Mitsubishi
 - 14 Nissan
 - 15 Porsche
 - 16 Smart

- 17 Tesla
- 18 Toyota
- 19 Volkswagen
- 20 Volvo
- 21 Other

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]**IF QSamp1=3 and QSamp2=1 (Program Wait-list Backlog)**

QModel Model of vehicle

- 1 A3 e-tron
- 2 i3
- 3 X5 xDrive40e
- 4 225xe
- 5 530e
- 6 i8
- 7 330e
- 8 740e
- 9 ELR
- 10 Bolt
- 11 Spark EV
- 12 Volt
- 13 Pacifica PHEV
- 14 500e
- 15 C-Max Energi
- 16 Focus Electric
- 17 Fusion Energi
- 18 Fit EV
- 19 Clarity BEV
- 20 Clarity PHEV
- 21 Ioniq BEV
- 22 Ioniq PHEV
- 23 Sonata PHEV
- 24 Soul EV
- 25 Niro PHEV
- 26 Optima PHEV
- 27 B-Class Electric Drive
- 28 S 550e
- 49 GLE 550e
- 29 SE Countryman ALL4
- 30 iMiEV
- 31 Outlander PHEV
- 32 eNV200
- 33 Leaf
- 34 Cayenne S E-Hybrid
- 35 Fortwo ED
- 36 Model S

- 37 Model X
- 38 Model 3
- 39 Roadster
- 40 Mirai
- 41 Prius Plug-in
- 42 Prius Prime
- 43 RAV4 EV
- 50 Highlander Hybrid
- 44 e-Golf
- 45 Golf GTE
- 46 Passat GTE
- 47 XC90 T8 PHEV
- 48 Other

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

IF QSamp1=3 and QSamp2=1 (Program Wait-list Backlog)

QYear Year of vehicle

- 1 2018
- 2 2017
- 3 2016
- 4 2015
- 5 2014
- 6 2013
- 7 2012
- 8 2011
- 9 2010 or earlier

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

IF QSamp1=3 and QSamp2=1 (Program Wait-list Backlog)

QSupp Vehicle is supported/Unsupported by program

- 1 Supported
- 2 Unsupported

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]

IF QSamp1=3 and QSamp2=1 (Program Wait-list Backlog)

QTrim Trim/battery applies to vehicle

- 0 No
- 1 Yes

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

Screener**[[INFORMATION]]**

QIntro Thank you for participating in our survey on behalf of Con Edison!

At TRC we take data privacy seriously. The data we collect will be used for the purposes of market research and survey analysis – no one will sell to you as a result of your participation. Information we are required to provide you, as described in the General Data Protection Privacy Directive, is available to you in our privacy notice at www.trchome.com/privacy-policy. For any questions related to data privacy, to contact us, or to assert your rights, please see the contact details in our privacy policy.

The survey should take about 10 minutes of your time. Please make every effort to complete the survey during one session. You will need to re-start the survey if you leave and return later. *Please select one.*

- 1 Proceed with survey
- 2 Decline to participate [[TERMINATE]]

[[PROGRAMMING INSTRUCTIONS]]

If respondent leaves the session and returns more than 5 days later to complete, blank out their previous responses.

[[SINGLE CHOICE]]

QMobile HIDDEN: Detect device screen size. *Please select one.*

- 1 Mobile device [[If small screen device detected. Render for mobile device.]]
- 2 Non Mobile device [[If large device detected. Render for normal screen device.]]

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: BACKGROUND

[[SINGLE CHOICE]]**QSAMP1=2 (Non-Enrollees-Owners)**

QS1 Do you currently own an electric vehicle? *Please select one.*

- 1 Yes
- 2 No [[TERMINATE]]

[[PROGRAMMING INSTRUCTIONS]]**[[SINGLE CHOICE]]****QSAMP1=1 (New Program Enrollees)**

QS2 Just to confirm, have you enrolled in Con Edison's electric vehicle program? *Please select one.*

- 1 Yes, but I haven't installed my C2 device yet
- 2 Yes and I installed my C2 device [[TERMINATE]]
- 3 No [[TERMINATE]]

[[PROGRAMMING INSTRUCTIONS]]

If respondent left session and returned more than 5 days later, terminate if QS2=2.

[[SINGLE CHOICE]]

QSAMP1=3 (Program Wait-List)

QS2a Con Edison's records show that you are on the waiting list for the Smart Charge electric vehicle program [[IF QSAMP1=3 and QSAMP2=1: for your [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]]]. We'd like to know where you currently are in the process: *Please select one.*

- 1 I am still on the waiting list
- 2 I was accepted (my car is now supported) but have not installed my C2 device
- 3 I was accepted and have installed my C2 device [[TERMINATE]]
- 4 No, some other reason (please specify): [[TEXTBOX]] [[TERMINATE]]

[[PROGRAMMING INSTRUCTIONS]]

ANSWER 4: SHOW 40 CHARACTERS FOR TEXTBOX.

[[MULTIPLE CHOICE WITH RADIO BUTTON]]

QS3 Please select the **manufacturer**, **model** and **year** of [[IF QSAMP1=1,3: the electric vehicle you enrolled in Con Edison's program/IF QSAMP1=2: your **most recently purchased electric vehicle**]] in the drop-down lists below.

[[IF QSAMP1=1 OR (QSAMP1=3 and QSamp2=2): Please complete this survey for the electric vehicle that was **most recently accepted** into the program.

If you had more than one vehicle accepted at this time, choose one of the vehicles using the following priorities:

1. Choose an accepted vehicle over a wait-listed vehicle.
2. If 2 or more have been accepted, choose the vehicle with the darkest paint color.
3. If all the most recent vehicles are wait-listed, choose the one with the darkest paint color.]]

Please select one for each.

1 Electric vehicle manufacturer:

[[Drop-down list items:

- 1 Audi
- 2 BMW
- 3 Cadillac
- 4 Chevrolet
- 5 Chrysler
- 6 Fiat
- 7 Ford
- 8 Honda
- 9 Hyundai
- 10 Kia
- 11 Mercedes-Benz
- 12 Mini Cooper
- 13 Mitsubishi
- 14 Nissan
- 15 Porsche
- 16 Smart
- 17 Tesla
- 18 Toyota
- 19 Volkswagen
- 20 Volvo
- 21 Other]]

- 2 [[DISPLAY IF QS3/1=1-20: Electric vehicle model:
 [[Drop-down list items:
- 1 [[IF QS3/1=1: A3 e-tron]]
 - 2 [[IF QS3/1=2: i3]]
 - 3 [[IF QS3/1=2: X5 xDrive40e]]
 - 4 [[IF QS3/1=2: 225xe]]
 - 5 [[IF QS3/1=2: 530e]]
 - 6 [[IF QS3/1=2: i8]]
 - 7 [[IF QS3/1=2: 330e]]
 - 8 [[IF QS3/1=2: 740e]]
 - 9 [[IF QS3/1=3: ELR]]
 - 10 [[IF QS3/1=4: Bolt]]
 - 11 [[IF QS3/1=4: Spark EV]]
 - 12 [[IF QS3/1=4: Volt]]
 - 13 [[IF QS3/1=5: Pacifica PHEV]]
 - 14 [[IF QS3/1=6: 500e]]
 - 15 [[IF QS3/1=7: C-Max Energi]]
 - 16 [[IF QS3/1=7: Focus Electric]]
 - 17 [[IF QS3/1=7: Fusion Energi]]
 - 18 [[IF QS3/1=8: Fit EV]]
 - 19 [[IF QS3/1=8: Clarity BEV]]
 - 20 [[IF QS3/1=8: Clarity PHEV]]
 - 21 [[IF QS3/1=9: Ioniq BEV]]
 - 22 [[IF QS3/1=9: Ioniq PHEV]]
 - 23 [[IF QS3/1=9: Sonata PHEV]]
 - 24 [[IF QS3/1=10: Soul EV]]
 - 25 [[IF QS3/1=10: Niro PHEV]]
 - 26 [[IF QS3/1=10: Optima PHEV]]
 - 27 [[IF QS3/1=11: B-Class Electric Drive]]
 - 28 [[IF QS3/1=11: S 550e]]
 - 29 [[IF QS3/1=11: GLE 550e]]
 - 30 [[IF QS3/1=12: SE Countryman ALL4]]
 - 31 [[IF QS3/1=13: iMiEV]]
 - 32 [[IF QS3/1=13: Outlander PHEV]]
 - 33 [[IF QS3/1=14: eNV200]]
 - 34 [[IF QS3/1=14: Leaf]]
 - 35 [[IF QS3/1=15: Cayenne S E-Hybrid]]
 - 36 [[IF QS3/1=16: Fortwo ED]]
 - 37 [[IF QS3/1=17: Model S]]
 - 38 [[IF QS3/1=17: Model X]]
 - 39 [[IF QS3/1=17: Model 3]]
 - 40 [[IF QS3/1=17: Roadster]]
 - 41 [[IF QS3/1=18: Mirai]]
 - 42 [[IF QS3/1=18: Prius Plug-in]]
 - 43 [[IF QS3/1=18: Prius Prime]]
 - 44 [[IF QS3/1=18: RAV4 EV]]
 - 50 [[IF QS3/1=18: Highlander Hybrid]]
 - 44 [[IF QS3/1=19: e-Golf]]

- 45 [[IF QS3/1=19: Golf GTE]]
- 46 [[IF QS3/1=19: Passat GTE]]
- 47 [[IF QS3/1=20: XC90 T8 PHEV]]
- 48 Other]]
- 3 [[DISPLAY IF QS3/2=2,33,36,37,44: [[IF QS3/2=2: Battery Type:]] [[IF QS3/2=33,44: Charger Type:]] [[IF QS3/2=36,37: Battery/Charger Type:]]]]
 - [[Drop-down list items:
 - 1 [[IF QS3/2=2: 60 Ah]]
 - 2 [[IF QS3/2=2: 90 Ah]]
 - 3 [[IF QS3/2=33: 3.3 kW]]
 - 4 [[IF QS3/2=33: 6.6 kW]]
 - 5 [[IF QS3/2=36: 60]]
 - 6 [[IF QS3/2=36,37: 60D [[IF QS3/2=36: - all wheel drive]] [[IF QS3/2=37: - 11.5 kW charger (standard)]]]]
 - 7 [[IF QS3/2=37: 60D – 17.3 kW charger (upgrade)]]
 - 23 [[IF QS3/2=37: 60D – unsure of charger]]
 - 8 [[IF QS3/2=36: 70]]
 - 9 [[IF QS3/2=36: 70D [[IF QS3/2=36: - all wheel drive]]]]
 - 10 [[IF QS3/2=36: 75]]
 - 11 [[IF QS3/2=36,37: 75D [[IF QS3/2=36: - all wheel drive]] [[IF QS3/2=37: - 11.5 kW charger (standard)]]]]
 - 12 [[IF QS3/2=37: 75D – 17.3 kW charger (upgrade)]]
 - 24 [[IF QS3/2=37: 75D – unsure of charger]]
 - 13 [[IF QS3/2=36: 85]]
 - 14 [[IF QS3/2=36: 85D or P85D - all wheel drive]]
 - 15 [[IF QS3/2=36: 90]]
 - 16 [[IF QS3/2=36: 90D or P90D - all wheel drive]]
 - 25 [[IF QS3/2=37: 90D – 11.5 kW charger (standard)]]
 - 17 [[IF QS3/2=37: 90D – 17.3 kW charger (upgrade)]]
 - 26 [[IF QS3/2=37: 90D – unsure of charger]]
 - 27 [[IF QS3/2=37: P90D]]
 - 18 [[IF QS3/2=36,37: 100D or P100D [[IF QS3/2=36: - all wheel drive]]]]
 - 19 [[IF QS3/2=44: 3.6 kW]]
 - 20 [[IF QS3/2=44: 7.2 kW]]
 - 21 Other
 - 22 Not sure]]
- 4 [[DISPLAY IF QS3/1=1-20 AND QS3/2=1-47, 49, 50: Electric vehicle year:
 - [[Drop-down list items:
 - 1 2018
 - 2 2017
 - 3 2016
 - 4 2015
 - 5 2014
 - 6 2013
 - 7 2012
 - 8 2011
 - 9 2010 or earlier]]

[[PROGRAMMING INSTRUCTIONS]]

REQUIRE RESPONSES FOR QS3 ANSWERS 1 AND 2,. ALLOW TO CONTINUE IF QS3 ANSWER 3=22 (Not sure) OR NOT ANSWERED AND/OR IF QS3 ANSWER 4 IS NOT ANSWERED.

ANSWERS 1-3: DROP-DOWN LISTS.

DO NOT SHOW QS3 FOR QSamp1=3 and QSamp2=1 RESPONDENTS. AUTO-PUNCH ANSWERS 1/2/4 VIA SAMPLE BACKGROUND INFORMATION FROM QMANU, QMODEL and QYEAR.

[[MULTIPLE OPEN ENDS WITH RADIO BUTTON]]

IF QS3/1=21 OR QS3/2=48 (Have an electric vehicle not on the list)

QS3a Please identify the [[IF QS3/1=21: **manufacturer**,]] **model** and **year** of your electric vehicle below. *Please enter a response for each.*

- 1 [[IF QS3/1=21: Manufacturer: [[TEXTBOX]]]]
- 2 Model: [[TEXTBOX]]
- 3 Year:

[[Drop-down list items:

- 1 2018
- 2 2017
- 3 2016
- 4 2015
- 5 2014
- 6 2013
- 7 2012
- 8 2011
- 9 2010 or earlier]]

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOXES: SHOW 40 CHARACTERS.

ANSWER 3: DROP-DOWN LIST.

REQUIRE RESPONSES FOR QS3a ANSWERS 1 AND 2. ALLOW TO CONTINUE IF QS3a ANSWER 3 IS NOT ANSWERED.

[[SINGLE CHOICE]]

QSamp1=3 and QSamp2=1 and QTrim=1 (Wait-list Backlog and trim/battery applies to vehicle)

QS3c Please select the [[IF QModel=2: **battery type**]] [[IF QModel=33,44: **charger type**]] [[IF QModel=36,37: **battery/charger type**]] that you have in your vehicle from the drop down list below. *Please select one.*

- 1 [[Drop-down list items:
 - 1 [[IF QMODEL/2=2: 60 Ah]]
 - 2 [[IF QMODEL/2=2: 90 Ah]]
 - 3 [[IF QMODEL/2=33: 3.3 kW]]
 - 4 [[IF QMODEL/2=33: 6.6 kW]]
 - 5 [[IF QMODEL/2=36: 60]]
 - 6 [[IF QMODEL/2=36,37: 60D [[IF QMODEL/2=36: - all wheel drive]] [[IF QMODEL/2=37: - 11.5 kW charger (standard)]]]]
 - 7 [[IF QMODEL/2=37: 60D – 17.3 kW charger (upgrade)]]
 - 23 [[IF QMODEL/2=37: 60D – unsure of charger]]
 - 8 [[IF QMODEL/2=36: 70]]
 - 9 [[IF QMODEL/2=36: 70D [[IF QS3/2=36: - all wheel drive]]]]
 - 10 [[IF QMODEL/2=36: 75]]
 - 11 [[IF QMODEL/2=36,37: 75D [[IF QMODEL/2=36: - all wheel drive]] [[IF QMODEL/2=37: - 11.5 kW charger (standard)]]]]

- 12 [[IF QMODEL/2=37: 75D – 17.3 kW charger (upgrade)]]
- 24 [[IF QMODEL/2=37: 75D – unsure of charger]]
- 13 [[IF QMODEL/2=36: 85]]
- 14 [[IF QMODEL/2=36: 85D or P85D - all wheel drive]]
- 15 [[IF QMODEL/2=36: 90]]
- 16 [[IF QMODEL/2=36: 90D or P90D - all wheel drive]]
- 25 [[IF QMODEL/2=37: 90D – 11.5 kW charger (standard)]]
- 17 [[IF QMODEL/2=37: 90D – 17.3 kW charger (upgrade)]]
- 26 [[IF QMODEL/2=37: 90D – unsure of charger]]
- 27 [[IF QMODEL/2=37: P90D]]
- 18 [[IF QMODEL/2=36,37: 100D or P100D [[IF QMODEL/2=36: - all wheel drive]]]]
- 19 [[IF QMODEL/2=44: 3.6 kW]]
- 20 [[IF QMODEL/2=44: 7.2 kW]]
- 21 Other
- 22 Not sure]]

[[PROGRAMMING INSTRUCTIONS]]

TRC Note: We will show QS3c data with QS3 data.

[[SINGLE CHOICE]]

QS3b Hidden: Vehicle supported/unsupported.

- 1 Supported (QS3/1=1-20 AND QS3/2=1-18,19,20,21-35,36,37,38,39,40,41,42-44,45,46,47,48-50) OR QS3/1=21 OR QSupp=1,2
- 2 Unsupported

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

All Unsupported vehicles should move to the Marketing questions (starting at QP1). All Supported vehicles should move on to QS5.

Trc note: As of 8/9, all respondents will be punched as “Supported”.

[[OPEN END]]

QS5 What is your 5-digit home zip code? *Please enter a response below.*

- 1 [[TEXTBOX]]

[[PROGRAMMING INSTRUCTIONS]]

REQUIRE A 5-DIGIT NUMBER.

[[SINGLE CHOICE]]

QS4 Hidden: Borough/county based on zip code. *Please select one.*

- 1 Brooklyn
- 2 The Bronx
- 3 Manhattan
- 4 Queens
- 5 Staten Island
- 6 Westchester County
- 7 Outside Con ED service territory

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

[[SINGLE CHOICE]]

QS4=1-6 (Inside Con Ed's territory)

QS6 Which type of **residential electric rate** do you currently have for your home? *Please select one.*

- 1 Standard residential rate (most customers)
- 2 Time of Use (TOU) rate
- 5 Electric vehicle Time of Use (TOU) rate
- 3 Other, please specify: [[TEXTBOX]]
- 4 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

Main survey

[[SINGLE CHOICE]]

QDate Hidden: Calendar dates to pipe. *Please select one.*

- 1 [[Pipe date for 5 weekdays before survey start date]]
- 2 [[Pipe date for 4 weekdays before survey start date]]
- 3 [[Pipe date for 3 weekdays before survey start date]]
- 4 [[Pipe date for 2 weekdays before survey start date]]
- 5 [[Pipe date for 1 weekdays before survey start date]]

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

SEE DATE LIST UNDER SEPARATE COVER.

[[PIVOTED GRID]]

QCH1 Next, we'd like to learn how often, if at all, you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]]
[[PIPE QManu]] [[PIPE QModel]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE
QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE
QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]]]] during the **five most recent weekdays**.

How many times each day between midnight and 11:59 PM did you **plug in for a charge**? *Please provide answers to all items.*

[[ANSWERS]]

- 1 [[PIPE QDATE=1]]
- 2 [[PIPE QDATE=2]]
- 3 [[PIPE QDATE=3]]
- 4 [[PIPE QDATE=4]]
- 5 [[PIPE QDATE=5]]

[[SCALES]]

- 0 Didn't plug in this day
- 1 Once
- 2 Twice
- 3 3 times or more

[[PROGRAMMING INSTRUCTIONS]]

[[MULTIPLE CHOICE]]

QCH1a Hidden: Charge days to ask about. *Please select one.*

- 1 [[PIPE QDATE=1]]
- 2 [[PIPE QDATE=2]]
- 3 [[PIPE QDATE=3]]
- 4 [[PIPE QDATE=4]]
- 5 [[PIPE QDATE=5]]
- 6 Didn't charge past five weekdays

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

If QCH1/scale 1=1-3, punch 1. If QCH1/scale 2=1-3, punch 2. If QCH1/scale 3=1-3, punch 3. If QCH1/scale 4=1-3, punch 4. If QCH1/scale 5=1-3, punch 5. If QCH1/scales 1-5=0, punch 6.

[[SINGLE CHOICE]]

QCH1b Hidden: Number of charges. *Please select one.*

- 0 0
- 1 1
- 2 2
- ...
- 15 15

[[PROGRAMMING INSTRUCTIONS]]

QUESTION: HIDDEN

SUM THE VALUES OF THE ANSWERS IN QCH1 AND FILL HERE.

MIN VALUE: 0 (ALL 5 SCALES = 0)

MAX VALUE: 15 (ALL 5 SCALES = 3)

[[SINGLE CHOICE]]

QCH1c Just to confirm, you [[IF QCH1b=1-15: plugged in for a charge [[PIPE QCH1b]] times/IF QCH1b=0: didn't plug in for a charge at any time]] during the five most recent weekdays?

- [[PIPE QDATE=1]] – [[PIPE SCALE SELECTED FOR QCH1/ANSWER 1]]
- [[PIPE QDATE=2]] – [[PIPE SCALE SELECTED FOR QCH1/ANSWER 2]]
- [[PIPE QDATE=3]] – [[PIPE SCALE SELECTED FOR QCH1/ANSWER 3]]
- [[PIPE QDATE=4]] – [[PIPE SCALE SELECTED FOR QCH1/ANSWER 4]]
- [[PIPE QDATE=5]] – [[PIPE SCALE SELECTED FOR QCH1/ANSWER 5]]

Please select one.

- 1 Yes, that's correct
- 2 No, something's incorrect – please allow me to update my answer(s)

[[PROGRAMMING INSTRUCTIONS]]

IF QCH1c=2, RETURN TO QCH1 WITH ANSWERS PRE-POPULATED.

[[INFORMATION]]

QCH1b=1-15 (Charged during past 5 weekdays)

QCHIN Next, we'd like to learn a little about **how you've charged your electric vehicle over the past five weekdays**, such as the charge start time, the power level used, as well as some other information related to the time(s) your vehicle was charging.

[[PROGRAMMING INSTRUCTIONS]]

[[PIVOTED GRID]]

QCH1a=1 (Charged 5 weekdays ago)

QCH2a Please indicate how you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]]]] on [[PIPE QDATE=1]]. If you are unsure, provide your best estimate. *Please provide answers for all items.*

[[SCALES]]

- 1 [[IF QCH1/1=1-3: [[IF QCH1/1=1: Your charge]] [[IF QCH1/1=2-3: First charge]]]]
- 2 [[IF QCH1/1=2,3: Second charge]]
- 3 [[IF QCH1/1=3: Third charge]]

[[ANSWERS WITH DROP-DOWN LISTS]]

- 1 **Charge Start Time:**
[[Drop-down list items: 12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM]]
- 2 **Time Charger was Unplugged:**
[[Drop-down list items: 12:00 AM – 7:59 AM same day, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM, 12:00 AM – 7:59 AM the next day, After 8:00 AM the next day]]
- 3 **Charging Power Level:**
[[Drop-down list items: Level 1 - 120v outlet, Level 2 - 208v or 240v and 30-50 amps, Level 3 - 480v (DC Fast Charging (CHAdEMO or SAE Combo)), [[IF QS3=17: Tesla Supercharging]], Not sure]]
- 4 **Battery Percentage at Charge Start:**
[[Drop-down list items: 0-24%, 25-49%, 50-74%, 75-100%, Not sure]]
- 5 **Charge Station Location:**
[[Drop-down list items: Private home garage, Multi-family building garage, At work, Public fast charging station, Public garage or parking lot, At a train station, At a store or retail location, Other]]
- 6 **Charge Location:**
[[Drop-down list items: Manhattan/Bronx/Brooklyn/Queens/Staten Island/Westchester, Other]]

[[PROGRAMMING INSTRUCTIONS]]

PROGRAMMER: SEE GRID AT END OF DOCUMENT FOR EXAMPLE.

ANSWER 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 1 (CANNOT SELECT AN HOUR EARLIER).

IF ANSWERING FOR SCALE 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1.

IF ANSWERING FOR SCALE 3: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1 AND 2.

[[SINGLE CHOICE]]

QCH2a/answer 5 (CHARGE STATION LOCATION)=OTHER (Charged in location other than those provided)

QCH3a You mentioned you charged at a charge station location other than the locations listed. Where was the location of the station that you charged at? *Please select one.*

1 [[TEXTBOX]]

9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

[[PIVOTED GRID]]

QCH1a=2 (Charged 4 weekdays ago)

QCH2b Please indicate how you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]] on **[[PIPE QDATE=2]]**. If you are unsure, provide your best estimate. *Please provide answers for all items.*

[[SCALES]]

1 [[IF QCH1/2=1-3: [[IF QCH1/2=1: Your charge]] [[IF QCH1/2=2-3: First charge]]]]

2 [[IF QCH1/2=2,3: Second charge]]

3 [[IF QCH1/2=3: Third charge]]

[[ANSWERS]]

USE SAME ANSWERS AS QCH2a

[[PROGRAMMING INSTRUCTIONS]]

ANSWER 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 1 (CANNOT SELECT AN HOUR EARLIER).

IF ANSWERING FOR SCALE 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1.

IF ANSWERING FOR SCALE 3: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1 AND 2.

[[SINGLE CHOICE]]

QCH2b/answer 5 (CHARGE STATION LOCATION)=OTHER (Charged in location other than those provided)

QCH3b You mentioned you charged at a charge station location other than the locations listed. Where was the location of the station that you charged at? *Please select one.*

1 [[TEXTBOX]]

9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

[[PIVOTED GRID]]

QCH1a=3 (Charged 3 weekdays ago)

QCH2c Please indicate how you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]]]] on **[[PIPE QDATE=3]]**. If you are unsure, provide your best estimate. *Please provide answers for all items.*

[[SCALES]]

- 1 [[IF QCH1/3=1-3: [[IF QCH1/1=1: Your charge]] [[IF QCH1/3=2-3: First charge]]]]
- 2 [[IF QCH1/3=2,3: Second charge]]
- 3 [[IF QCH1/3=3: Third charge]]

[[ANSWERS]]

USE SAME ANSWERS AS QCH2a

[[PROGRAMMING INSTRUCTIONS]]

ANSWER 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 1 (CANNOT SELECT AN HOUR EARLIER).
 IF ANSWERING FOR SCALE 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1.
 IF ANSWERING FOR SCALE 3: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1 AND 2.

[[SINGLE CHOICE]]

QCH2c/answer 5 (CHARGE STATION LOCATION)=OTHER (Charged in location other than those provided)

QCH3c You mentioned you charged at a charge station location other than the locations listed. Where was the location of the station that you charged at? *Please select one.*

- 1 [[TEXTBOX]]
- 9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

[[PIVOTED GRID]]

QCH1a=4 (Charged 2 weekdays ago)

QCH2d Please indicate how you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]]]] on **[[PIPE QDATE=4]]**. If you are unsure, provide your best estimate. *Please provide answers for all items.*

[[SCALES]]

- 1 [[IF QCH1/4=1-3: [[IF QCH1/4=1: Your charge]] [[IF QCH1/4=2-3: First charge]]]]
- 2 [[IF QCH1/4=2,3: Second charge]]
- 3 [[IF QCH1/4=3: Third charge]]

[[ANSWERS]]

USE SAME ANSWERS AS QCH2a

[[PROGRAMMING INSTRUCTIONS]]

ANSWER 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 1 (CANNOT SELECT AN HOUR EARLIER).
 IF ANSWERING FOR SCALE 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1.

IF ANSWERING FOR SCALE 3: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1 AND 2.

[[SINGLE CHOICE]]

QCH2d/answer 5 (CHARGE STATION LOCATION)=OTHER (Charged in location other than those provided)

QCH3d You mentioned you charged at a charge station location other than the locations listed. Where was the location of the station that you charged at? *Please select one.*

- 1 [[TEXTBOX]]
- 9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

[[PIVOTED GRID]]

QCH1a=5 (Charged most recent weekday)

QCH2e Please indicate how you charged your [[IF QSAMP1=3 and QSAMP2=1: [[PIPE QYear]] [[PIPE QManu]] [[PIPE QModel]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a NOT ASKED: [[PIPE QS3/4]] [[PIPE QS3/1]] [[PIPE QS3/2]]/IF QSAMP1=1,2 OR (QSAMP1=3 AND QSAMP2=2) AND QS3a ASKED: [[PIPE QS3a/3]] [[PIPE QS3a/1]] [[PIPE QS3a/2]]]] on [[PIPE QDATE=5]]. If you are unsure, provide your best estimate. *Please provide answers for all items.*

[[SCALES]]

- 1 [[IF QCH1/5=1-3: [[IF QCH1/5=1: Your charge]] [[IF QCH1/5=2-3: First charge]]]]
- 2 [[IF QCH1/5=2,3: Second charge]]
- 3 [[IF QCH1/5=3: Third charge]]

[[ANSWERS]]

USE SAME ANSWERS AS QCH2a

[[PROGRAMMING INSTRUCTIONS]]

ANSWER 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 1 (CANNOT SELECT AN HOUR EARLIER).

IF ANSWERING FOR SCALE 2: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1.

IF ANSWERING FOR SCALE 3: MUST SELECT SAME OR LATER HOUR THAN SELECTED IN ANSWER 2 FOR SCALE 1 AND 2.

[[SINGLE CHOICE]]

QCH2e/answer 5 (CHARGE STATION LOCATION)=OTHER (Charged in location other than those provided)

QCH3e You mentioned you charged at a charge station location other than the locations listed. Where was the location of the station that you charged at? *Please select one.*

- 1 [[TEXTBOX]]
- 9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

TEXTBOX: SHOW 40 CHARACTERS.

[[SINGLE CHOICE]]

QSAMP1=2 (Non-Enrollees-Owners)

QP1 Are you aware of Con Edison's Smart Charge Program in which enrollees receive rewards for charging their electric vehicle during off peak hours? *Please select one.*

- 1 Yes
- 2 No
- 9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

[[SINGLE CHOICE]]

QP1=1 (Non-Enrollees-Owners and aware of Con Edison electric vehicle program)

QP2 Have you considered enrolling in Con Edison's electric vehicle program? *Please select one.*

- 1 Yes
- 2 No
- 9 Not sure

[[PROGRAMMING INSTRUCTIONS]]

[[OPEN END]]

QSamp1=2 and QP2=1 (Non-Enrollees-Owners who considered enrolling)

QP3 Why haven't you enrolled in Con Edison's electric vehicle program? *Please be as detailed as possible.*

[[TEXTBOX]]

[[PROGRAMMING INSTRUCTIONS]]

ALLOW TO CONTINUE WITHOUT ANSWERING.

[[SINGLE CHOICE GRID]]**QP2=1 (Non-Enrollees-Owners who considered enrolling)**

QP5 Below are reasons other electric vehicle owners chose not to enroll in Con Edison's electric vehicle program. Please indicate, how much, if at all, each of the following reasons [[IF QSamp1=2: affected your decision/IF QS3b=2: would affect your decision]]. [[IF QSamp1=2: (We realize you may have already mentioned some of these – please indicate the extent to which it is a barrier.)]] *Please select one for each.*

[[SCALES]]

- 1 Not a barrier to enrolling
- 2 Somewhat of a barrier
- 3 Definitely a barrier to enrolling
- 9 Not sure

[[ANSWERS]]

- 1 Don't want to change when I charge my vehicle
- 2 Prefer not to share my charging information with Con Edison
- 3 Too much hassle to sign up
- 4 Financial incentives aren't worth the effort
- 5 Program is confusing/complicated rules for charging and incentives
- 6 Don't have enough information about it
- 7 Unsure how to enroll
- 8 Concerned that installing the C2 device may void my vehicle's warranty
- 98 Other, please specify: [[TEXTBOX]] [[ANCHOR]]

[[PROGRAMMING INSTRUCTIONS]]

ANSWERS: RANDOMIZE.

ONLY ALLOW SCALE 9 (NOT SURE) FOR ANSWERS 1-8.

ANSWER 98: SHOW TEXTBOX IF SCALE 2 OR 3 SELECTED. ALLOW TO CONTINUE IF NO SCALE SELECTED, OR SCALE SELECTED BUT TEXTBOX LEFT BLANK.

[[GRID]]

QSAMP1=2 (Non-Enrollees-Owners)

QCH4 Con Edison is considering new programs that offer financial incentives to electric vehicle drivers for charging their vehicles at times when demand for power is not at its highest. How likely would you be to participate in an electric vehicle charging incentive program if Con Edison offered: *Please select one for each.*

[[SCALES]]

- 1 Not at all likely
- 1 Not very likely
- 2 Moderately likely
- 3 Very likely
- 4 Extremely likely
- 9 Not sure

[[ANSWERS]]

- 1 A program using the vehicle's own telematics to tell when, where and how much charging energy is consumed
- 2 A Wi-Fi-enabled home Smart Charging Station to tell when and how much charging energy is consumed
- 3 A device that would plug into your charging electric outlet or attach to your home charging station to tell when and how much charging energy is consumed

[[PROGRAMMING INSTRUCTIONS]]

ANSWERS: RANDOMIZE.

[[MULTIPLE OPEN-ENDS WITH RADIO BUTTON]]

QSAMP1=1 OR (QSAMP1=3 AND QSAMP2=2) (New Program Enrollees and Wait-List New)

QIncen2 Please provide your name and the email address where you would like to receive your \$25 Amazon.com e-gift card. Your responses will remain confidential. You can expect to receive your e-gift card via email after the study is completed, in approximately 4 to 6 weeks. *Please enter a response for each item.*

- 1 First name [[TEXTBOX]]
- 2 Last name [[TEXTBOX]]
- 3 Email address [[TEXTBOX]]
- 4 Confirm email address [[TEXTBOX]]
- 5 Do not send me a gift card [[RADIO BUTTON]]

[[PROGRAMMING INSTRUCTIONS]]

ITEM 3: CHECK FOR VALID EMAIL ADDRESS FORMAT (@ and .) ITEM 4 MUST MATCH ITEM 3.
IF ITEM 5 IS SELECTED, ITEMS 3 & 4 MUST BE BLANK. ITEMS 1 & 2 MAY OR MAY NOT BE ANSWERED.
SHOW 40 CHARACTERS IN TEXTBOXES.

[[MULTIPLE OPEN-ENDS WITH RADIO BUTTON]]

QSAMP1=2 OR (QSAMP1=3 AND QSAMP2=1) (Non-Enrollees-Owners or Wait-List Backlog)

QIncen2a In order to receive your \$25 Amazon.com e-gift card, please provide your name and confirm your email address. Your responses will remain confidential. You can expect to receive your e-gift card via email after the study is completed, in approximately 4 to 6 weeks. *Please enter a response for each item.*

- | | | |
|---|----------------------------|---|
| 1 | First name | [[TEXTBOX]] |
| 2 | Last name | [[TEXTBOX]] |
| 3 | Email address | [[PIPE EMAIL ADDRESS FROM SAMPLE]] [[DROP DOWN BOX for “Use this address” and “Use a different address”]] |
| 4 | New email address | [[TEXTBOX]] [[DISPLAY IF IF ITEM 3=Use a different address]] |
| 5 | Confirm email address | [[TEXTBOX]] [[DISPLAY IF IF ITEM 3=Use a different address]] |
| 6 | Do not send me a gift card | [[RADIO BUTTON]] |

[[PROGRAMMING INSTRUCTIONS]]

ITEMS 4 & 5 ARE DYNAMICALLY TRIGGERED IF ITEM 3 = “Use a different address”. IF ITEM 3 = “Use this address” ITEMS 4 & 5 MUST BE BLANK.

ITEM 4: CHECK FOR VALID EMAIL ADDRESS FORMAT (@ and .) ITEM 5 MUST MATCH ITEM 4.

IF ITEM 6 IS SELECTED, ITEMS 4 & 5 MUST BE BLANK. ITEMS 1, 2, 3 MAY OR MAY NOT BE ANSWERED.

SHOW 40 CHARACTERS IN TEXTBOXES.

[[INFORMATION]]

QOutro Thank you very much for participating in this survey. Please hit the “next” button below to enter your responses.

[[PROGRAMMING INSTRUCTIONS]]

Zip code list

Bronx	10451	SI	10301	Queens	11361	WC	10501
Bronx	10452	SI	10302	Queens	11362	WC	10502
Bronx	10453	SI	10303	Queens	11363	WC	10503
Bronx	10454	SI	10304	Queens	11364	WC	10504
Bronx	10455	SI	10305	Queens	11354	WC	10505
Bronx	10456	SI	10306	Queens	11355	WC	10506
Bronx	10457	SI	10307	Queens	11356	WC	10507
Bronx	10458	SI	10308	Queens	11357	WC	10509
Bronx	10459	SI	10309	Queens	11358	WC	10510
Bronx	10460	SI	10310	Queens	11359	WC	10511
Bronx	10461	SI	10312	Queens	11360	WC	10512
Bronx	10462	SI	10314	Queens	11365	WC	10514
Bronx	10463	Manhattan	10001	Queens	11366	WC	10516
Bronx	10464	Manhattan	10002	Queens	11367	WC	10517
Bronx	10465	Manhattan	10003	Queens	11412	WC	10518
Bronx	10466	Manhattan	10004	Queens	11423	WC	10519
Bronx	10467	Manhattan	10005	Queens	11432	WC	10520
Bronx	10468	Manhattan	10006	Queens	11433	WC	10521
Bronx	10469	Manhattan	10007	Queens	11434	WC	10522
Bronx	10470	Manhattan	10009	Queens	11435	WC	10523
Bronx	10471	Manhattan	10010	Queens	11436	WC	10524
Bronx	10472	Manhattan	10011	Queens	11101	WC	10526
Bronx	10473	Manhattan	10012	Queens	11102	WC	10527
Bronx	10474	Manhattan	10013	Queens	11103	WC	10528
Bronx	10475	Manhattan	10014	Queens	11104	WC	10530
Bronx	10803	Manhattan	10016	Queens	11105	WC	10532
Brooklyn	11201	Manhattan	10017	Queens	11106	WC	10533
Brooklyn	11203	Manhattan	10018	Queens	11374	WC	10535
Brooklyn	11204	Manhattan	10019	Queens	11375	WC	10536
Brooklyn	11205	Manhattan	10020	Queens	11379	WC	10537
Brooklyn	11206	Manhattan	10021	Queens	11385	WC	10538
Brooklyn	11207	Manhattan	10022	Queens	11691	WC	10540
Brooklyn	11208	Manhattan	10023	Queens	11692	WC	10541
Brooklyn	11209	Manhattan	10024	Queens	11693	WC	10542
Brooklyn	11210	Manhattan	10025	Queens	11694	WC	10543
Brooklyn	11211	Manhattan	10026	Queens	11695	WC	10545
Brooklyn	11212	Manhattan	10027	Queens	11697	WC	10546
Brooklyn	11213	Manhattan	10028	Queens	11004	WC	10547
Brooklyn	11214	Manhattan	10029	Queens	11005	WC	10548
Brooklyn	11215	Manhattan	10030	Queens	11411	WC	10549
Brooklyn	11216	Manhattan	10031	Queens	11413	WC	10550
Brooklyn	11217	Manhattan	10032	Queens	11422	WC	10551
Brooklyn	11218	Manhattan	10033	Queens	11426	WC	10552
Brooklyn	11219	Manhattan	10034	Queens	11427	WC	10553
Brooklyn	11220	Manhattan	10035	Queens	11428	WC	10560
Brooklyn	11221	Manhattan	10036	Queens	11429	WC	10562
Brooklyn	11222	Manhattan	10037	Queens	11414	WC	10566
Brooklyn	11223	Manhattan	10038	Queens	11415	WC	10567
Brooklyn	11224	Manhattan	10039	Queens	11416	WC	10570
Brooklyn	11225	Manhattan	10040	Queens	11417	WC	10573
Brooklyn	11226	Manhattan	10044	Queens	11418	WC	10576
Brooklyn	11228	Manhattan	10065	Queens	11419	WC	10577
Brooklyn	11229	Manhattan	10075	Queens	11420	WC	10578
Brooklyn	11230	Manhattan	10128	Queens	11421	WC	10579
Brooklyn	11231	Manhattan	10280	Queens	11368	WC	10580

EV Charging Behavior

Brooklyn	11232
Brooklyn	11233
Brooklyn	11234
Brooklyn	11235
Brooklyn	11236
Brooklyn	11237
Brooklyn	11238
Brooklyn	11239

Queens	11369	WC	10583
Queens	11370	WC	10587
Queens	11372	WC	10588
Queens	11373	WC	10589
Queens	11377	WC	10590
Queens	11378	WC	10591
		WC	10594
		WC	10595
		WC	10596
		WC	10597

	<u>Your/First Charge</u>	<u>Second Charge</u>	<u>Third Charge</u>
Charge Start Time:	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM]]	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM]]	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM]]
Time Charger was Unplugged:	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM, 12:00 AM – 7:59 AM the next day, After 8:00 AM the next day]]	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM, 12:00 AM – 7:59 AM the next day, After 8:00 AM the next day]]	[[12:00 AM – 7:59 AM, 8:00 – 8:59 AM, 9:00 – 9:59 AM, 10:00 – 10:59 AM, 11:00 – 11:59 AM, 12:00 – 12:59 PM, 1:00 – 1:59 PM, 2:00 – 2:59 PM, 3:00 – 3:59 PM, 4:00 – 4:59 PM, 5:00 – 5:59 PM, 6:00 – 6:59 PM, 7:00 – 7:59 PM, 8:00 – 8:59 PM, 9:00 – 9:59 PM, 10:00 – 10:59 PM, 11:00 – 11:59 PM, 12:00 AM – 7:59 AM the next day, After 8:00 AM the next day]]
Charging Power Level:	[[Level 1 - 120v outlet, Level 2 - 208v or 240v and 30-50 amps, Level 3 - 480v (DC Fast Charging (CHAdeMO or SAE Combo), Tesla Supercharging, Not sure]]	[[Level 1 - 120v outlet, Level 2 - 208v or 240v and 30-50 amps, Level 3 - 480v (DC Fast Charging (CHAdeMO or SAE Combo), Tesla Supercharging, Not sure]]	[[Level 1 - 120v outlet, Level 2 - 208v or 240v and 30-50 amps, Level 3 - 480v (DC Fast Charging (CHAdeMO or SAE Combo), Tesla Supercharging, Not sure]]
Battery Percentage at Chart Start:	[[0-24%, 25-49%, 50-74%, 75-100% Not sure]]	[[0-24%, 25-49%, 50-74%, 75-100% Not sure]]	[[0-24%, 25-49%, 50-74%, 75-100% Not sure]]
Charge Station Location:	[[Private home garage, Multi-family building garage, At work, Public fast charging station, Public garage or parking lot, At a train station, At a store or retail location, Other]]	[[Private home garage, Multi-family building garage, At work, Public fast charging station, Public garage or parking lot, At a train station, At a store or retail location, Other]]	[[Private home garage, Multi-family building garage, At work, Public fast charging station, Public garage or parking lot, At a train station, At a store or retail location, Other]]
Charge Location:	[[Manhattan/Bronx/Brooklyn/Queens/Staten Island/Westchester, Other]]	[[Manhattan/Bronx/Brooklyn/Queens/Staten Island/Westchester, Other]]	[[Manhattan/Bronx/Brooklyn/Queens/Staten Island/Westchester, Other]]