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October 30, 2020

VIA HAND DELIVERY & ELECTRONIC MAIL

Luly E. Massaro, Commission Clerk
Rhode Island Public Utilities Commission
89 Jefferson Boulevard
Warwick, RI 02888

RE: Docket 4770 – Application of The Narragansett Electric Company d/b/a National Grid for Approval of a Change in Electric and Gas Base Distribution Rates

Dear Ms. Massaro:

On behalf of The Narragansett Electric Company d/b/a National Grid (Company), please find enclosed the Company's Electric Transportation Initiative Rate Year 2 Annual Report, pursuant to the Amended Settlement Agreement in this proceeding, dated August 15, 2018.

Thank you for your consideration of this request.

Respectfully Submitted,

THE NARRAGANSETT ELECTRIC COMPANY d/b/a NATIONAL GRID

By its attorney,

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Cc: Dkt. 4770 Service List
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National Grid Docket No. 4770 (Rate Application) & Docket No. 4780 (PST)
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ARTICLE II SECTION 17-ELECTRIC TRANSPORTATION

ELECTRIC TRANSPORTATION INITIATIVE
RATE YEAR 2 ANNUAL REPORT

October 30, 2020

Contents

1 INTRODUCTION 3
2 PROGRAM COMPONENTS 8
2.1 Off-Peak Charging Rebate Pilot Program 8
2.1.1 Summary of RY2 8
2.1.2 Lessons Learned 8
2.1.3 Program Improvements 9
2.2 Charging Station Demonstration Program 10
2.2.1 Summary of RY2 10
2.2.2 Lessons Learned 12
2.2.3 Program Improvements 13
2.3 Discount Pilot for DCFC Station Accounts 15
2.3.1 Summary of RY2 15
2.3.2 Lessons Learned 15
2.3.3 Program Improvements 15
2.4 Fleet Advisory Program 16
2.4.1 Summary of RY2 16
2.4.2 Lessons Learned 16
2.4.3 Program Improvements 17
2.5 Budget for the ET Initiative Programs 17
2.6 EV Adoption 18
2.7 Conclusion 18
APPENDIX 1 19
EVALUATION REPORT 19

1 INTRODUCTION

The Narraganset Electric Company (the Company) entered into an Amended Settlement Agreement dated August 16, 2018 (the ASA). The ASA includes an Electric Transportation Initiative (the ET Initiative or Program) to facilitate the growth of Electric Vehicle (EV) adoption and scaling of the market for EV charging equipment to advance Rhode Island's zero emission vehicles and greenhouse gas emissions policy goals.

Section 17(a)(v) of the ASA states in pertinent part:

". . . . Narragansett Electric will produce and publicly present an Annual Evaluation Report using metrics provided in the original filing with appropriate modifications to be made to reflect the programs as approved in this Settlement Agreement within two months following the end of each Rate Year, describing implementation of the electric transportation initiative, and documenting the information gained through this initiative and any recommendations to enhance the program."

The ET Initiative includes the following five components "(i) Off-Peak Charging Rebate Pilot, (ii) Charging Station Demonstration Program, (iii) Discount Pilot for Direct Current Fast Charging (DCFC) Station Accounts, (iv) Fleet Advisory Services, and (v) Electric Transportation Initiative Evaluation." (ASA, Section 17). Rate Year 2 (RY2) of the ET Initiative commenced as of September 1, 2019 and concluded on August 31, 2020. The five components of the ET Initiative are summarized in Section 2 of this report.

The ET Initiative components in RY2 built upon the successes of Rate Year 1 (RY1). For the Off-Peak Pilot, the Company studied a full year's worth of charging data from drivers who were enrolled in RY1. For the Charging Demonstration Program, the Company activated a total 213

ports across RI which brings the cumulative total to 233 ports for RY1 and RY2. The Discount Pilot continued to provide rebates to DCFC site hosts, for a cumulative total of $35,107 for RY1 and RY2. The Fleet Advisory Services program completed four (4) fleet studies and added five (5) new studies during RY2, bringing the cumulative total to nine (9) for RY1 and RY2.

Similar to RY1, the Company worked with Energy & Resource Solutions (ERS) to conduct an independent evaluation of the ET Initiative, which is attached hereto as Appendix 1 (Evaluation Report). For RY2, the evaluation activities include review of program materials, interviews with program staff, and participants, survey of participating EV drivers and analysis of program tracking data and charging data available.

The key achievements and findings from the RY2 Evaluation Report are provided below.

1. The Program is well-run, and participants are highly satisfied with their experience. Participants expressed that the Company, along with vendors and implementation contractors, provide the necessary support to make their experiences "seamless" and "smooth." ERS found that the RY2 program tracking spreadsheets were easy to navigate for this evaluation, reflecting the implementation of a recommendation from the RY1 Evaluation Report.

2. The Charging Station Demonstration Program has achieved 72% of ET Initiative targets for Level 2 ports and 7% of the target for DCFC ports. The Company activated 233 ports (230 L2 and 3 DCFC) across 122 stations (119 L2 and 3 DCFC) through August 31, 2020. The Program has a strong pipeline of approved projects and projects under development.

3. The Program incentives are helping to encourage customer participation and increase EVSE development in Rhode Island. Most participants interviewed stated that they would not have installed charging stations if the incentives were not available.

4. Some Level 2 segments – such as workplace, environmental justice, government fleet, and multi-unit dwellings (MUD) – are fully, or almost fully, subscribed, while other Level 2 and DCFC segments – such as light duty fleet, public transit, and DCFC stations – will continue to require additional targeted outreach to meet their segment-specific program goals.

5. Off-Peak Charging Rebate Pilot pricing signals have had a statistically significant positive effect on off-peak charging behavior and is succeeding in nudging EV owners to shift their charging to off-peak hours.

6. The Fleet Advisory Services studies are nearing completion, with participants reporting high satisfaction with the Program and final reports. The Company expects direct vehicle conversions within the three-year program time period to be limited. Primary barriers cited by participants included requirements to work within their existing vehicle replacement cycles/lease terms, which does not necessarily coincide with the Program three-year period, and observed utilization decreases due to the COVID-19 pandemic. The Company is conducting follow-up outreach with each participant on an ongoing basis to offer support, capture successes, and to better understand barriers to adoption.

7. The COVID-19 pandemic and its resulting disruption of normal business operations throughout Rhode Island resulted in several key impacts on the ET Initiative, including:
    a. Reduction in reported charging activity;
    b. Changes in driving and charging behavior of Off-Peak Charging Rebate Pilot participants; and
    c. Reluctance to pursue fleet electrification amid uncertainties.

The above findings shed light on the successes of the Program and provide a few recommendations and considerations for the Company to consider. ERS provided the Company with recommended actions it should take to improve the ET Initiative for RY1 as well. The status and updates of those actions for RY1 are include in Table 1 below.

Table 1: Rate Year 1 Electric Transportation Recommendations

Company Action	Status
• Identify required data in tracking spreadsheet when a project is committed • Add a "Read Me" tab defining the content in the spreadsheet, data definitions including status definitions, and whether fields are required or optional, including status dependencies • Confirm these fields are included: host site address, charging station market segment, EVSE provider, first site contact date	**COMPLETE**
• Develop one pager with explanation of DCFC rate discount and post on Company web site	**COMPLETE**
• Include a template of the required data along with the EV Fleet Study Expectations form so study participants can evaluate early whether they are able to provide the required data • The Fleet Study vendor now attempts to collect the data from the study participant but then proposes other means of compiling the information including a drivers' survey/log and vehicle monitoring device	**COMPLETE**
• The Company will begin to report on a quarterly basis to the PST ET Advisory Committee on program enhancements and modifications for their feedback and support. This will help when compiling the list of RY2 program modifications	**COMPLETE**

and gathering additional data and information on potential program changes.	
• Send a station utilization report to site hosts annually including information on organizing a ride and drive event, information on EVs, and Program updates • Host an annual webinar for site hosts including topics such as Program updates, opportunities to expand infrastructure (if possible), introduce the EV CSI vendors and EVSE vendors, and solicit feedback on future programs and offerings • Establish the EV Charging Station Installation program, meeting with these vendors on a regular basis.	**COMPLETE**
• Develop business requirements for a Charging Station Demonstration Program tracking system serving RI, MA and UNY EV Charging Programs • Work with IT team to scope project and costs	**COMPLETE**

The Company continued to meet on a quarterly basis with the Electric Vehicle subcommittee of the PST Advisory Group and monthly with the Division of Public Utilities and Carriers and Rhode Island Office of Energy Resources "to discuss the progress and challenges in the development and implementation of the PST components of the MRP, along with emerging insights and learnings . . . ." (ASA Section 17(e)). The first PST Advisory Group meeting after the end of RY2 occurred on September 10, 2020 and included a review of actions from RY1 as well as the Company's recommendations for any modifications to enhance the ET Initiative for RY2. As noted in the Evaluation Report and as summarized above, the Company had an overall successful RY2. Below is a more in-depth review of the progress, lessons learned and improvements for each of the ET Initiative's components.

2 PROGRAM COMPONENTS

2.1 Off-Peak Charging Rebate Pilot Program

2.1.1 Summary of RY2

The Off-Peak Charging Rebate Pilot Program has been available to customers since June 2019. During RY2, the Company compiled a full year (September 2019-August 2020) of on-peak and off-peak charging data for drivers in both the Control Group and Treatment Groups. ERS conducted an interim analysis in May 2020 to develop initial findings to inform program design changes for RY3, as well as assess immediate impacts related to the COVID-19 pandemic. Additionally, a full analysis covering all RY2 data was conducted to evaluate the effectiveness of the off-peak price signal in shifting EV drivers' charging loads to off-peak hours. ERS also surveyed program participants to assess overall program satisfaction. Drivers that were in the Control Group for RY2 will now be transitioned to the Treatment group, as planned, for RY3.

2.1.2 Lessons Learned

Based on the experiences of the implementation team and as discussed in the Evaluation Report, there were a number of lessons learned during RY2. Based on the compiled data, the Company and its evaluation vendor concluded that:

- As noted in the Evaluation Report (see page 4), the Off-Peak Charging Rebate Pilot pricing signal has a statistically significant positive effect on off-peak charging behavior and is succeeding in nudging EV owners to shift their charging to off-peak hours. The Evaluation Report also noted that the effect of the Off-Peak Charging Rebate Pilot pricing signal is not uniform across all vehicle types, with Tesla-BEVs having the biggest shift in charging behavior (0.27 kW per vehicle between 5-9PM, or

40% of their baseline demand), followed by non-Tesla BEVs (0.10 per vehicle, or 27% of baseline demand), and PHEVs (0.8 kW per vehicle, or 29% of baseline demand).

- The COVID-19 pandemic had a significant impact on the overall amount of charging (kWh), particularly in March, April, and May. As seen in the data from April through August 2020, charging activity has not yet returned to pre-pandemic levels; as such, the full impacts on charging behavior cannot be assessed until data through the end of Rate Year 3 (RY3) is available.

2.1.3 Program Improvements

The Company sees two focus areas for future programs on off-peak EV charging and is pursuing one improvement to the existing Off-Peak Charging Program on customer education.

First, when designing TOU rates in the future, the Company will consider the baseline level of off-peak EV charging behavior, as well as the potential for creating new "timer peaks" by concentrating charging load at a single hour around the on-peak to off-peak transition. The baseline charging data indicates a need to shift charging off-peak, and that financial incentives can help do that. Timer peaks may not have a simple solution under a TOU rate and avoiding them may require an active managed charging program, something the Company will continue to investigate. Second, National Grid will focus on research and strategies for shifting BEV charging loads off-peak, in recognition of their greater grid impact (i.e., higher likelihood of using Level 2 chargers at home and greater overall energy consumption) and expected dominance of the future EV market.

To continue to learn new lessons from the current Off-Peak Charging Program, the Company will test the impacts of greater customer education on off-peak charging behavior. For

all vehicle types, there is a persistent amount of on-peak charging that participants are not shifting off-peak. Some participants have suggested that more education explaining the benefits of charging off-peak would help motivate them to charge off-peak. The campaign described below will test whether education and awareness can shift this load and can inform future program designs and customer education efforts. To run this campaign, the Company will focus the strategic electrification fund for RY3 on current participants in the Off-Peak Charging Program. Initially, the Company expected to focus education efforts on recruiting participants into the Program. Given that the Program has reached its enrollment capacity and is no longer accepting new participants, the education effort will focus on increasing the off-peak charging of the existing participants and help them maintain high levels of off-peak charging over time.

2.2 Charging Station Demonstration Program

2.2.1 Summary of RY2

The Charging Station Program has been available to customers and vendors since the beginning of Q4 2019. Per the ASA, the Charging Station Program defines the segments and number of charging stations within each segment to be developed as part of this initiative. In RY2 the Company activated a total of 213 ports, bringing the cumulative total of the ports to 233. The Company reached the segment goal for the Environmental Justice segment by the end of RY2. The Company is projecting to reach its goals for the Workplace, MUD, Government Fleet and Pubic Transit Buses segments. The Company worked closely with the State of Rhode Island's "Electrify RI" program to provide funding for both Level 2 and DCFC stations within several of these segments. Table 2 below shows the Company's progress through RY2 and a projection of projects that are expected to be committed and/or activated in RY3.

Table 2: Charging Demonstration Program Progress and Projections

Level 2 Segment	Segment Port Targets	RY1 Activated	RY2 Activated	RY3 Approved/Projected
Corporate light-duty fleet	24	-	2	12
Government light-duty fleet	24	-	20	4
Public transit stations	60	-	14	29
Environmental Justice	36	-	36	-
MUD	36	-	32	4
Workplaces	140	20	106	14
Total L2 Ports	320	20	210	63

DCFC Segment	Segment Port Targets	RY1 Activated	RY2 Activated	RY3 Approved/Projected
Municipal school buses	3	-	-	2
Other heavy-duty (port, airport)	8	-	-	2
Rideshare company hub	5	-	-	0
Public transit buses	10	-	-	10
Public DCFC	20	-	3	8
Total DCFC Ports	46	-	3	22

2.2.2 Lessons Learned

As shown above and noted at the June 11, 2020 PST meeting, the Company is projecting to reach its goals in four of the six level 2 segments and in one of the DCFC segments by the end of RY3. The table below outlines the adoption barriers the Company has observed in the harder-to-reach segments and highlights completed tactics, results, and ongoing actions to address these barriers.

Table 3: Hard to Reach Segments

Hard to Reach Segments			
Segment	**Barriers to Adoption**	**Completed Tactics & Results**	**Ongoing Actions**
Corporate Fleet	• Initial EV Car Cost (no State RI rebate), • EV charging network costs • EV car knowledge	• Met with car OEMs to reduce EV costs • Enrolled customers in Fleet Advisory Services program • Worked with internal sales to promote ET programs • Removed networked station requirement	Continue to work with internal sales staff to promote fleet study and charging program with their customers
Public Transit	• Awareness of parking garage owners • Identifying available commuter locations	• Activated (2) Park and Ride locations. • Promoted installation of Level 1 solutions to specific customers (airports, park and rides, ferry, etc.) • Worked with RIDOT on Park and Ride locations, • Identified garage owners near public transit for specific marketing	• Continue working with RIDOT and others on Park and Ride locations. • Specific marketing and outreach to parking garage owners near public transit
Other Medium/Heavy Duty	• Lack of EV market availability for all vehicle types • Cost of EVs for Medium/Heavy Duty, Knowledge of use cases, COVID-19 impact on Airports	• Targeted airport/shipping port for a Fleet Study • Created simplified port applications • Worked with commercial delivery companies	Continue conversation with commercial delivery companies.

Rideshare Hub	• Initial EV Car Cost (no State RI rebate for rideshare drivers or TNCs) • COVID-19 had large impact on Rideshare companies • Rhode Island not being "hotspot" for Rideshare	• Met with UBER/LYFT to assist in identifying barrier (rebate offers on cars was identified as helping in other states) • Presented potential Company-owned locations to Rideshare which they could use as HUB location	Continue outreach to Rideshare companies who have been hard hit by COVID-19
Municipal School Bus	• School bus EV cost much higher than gas/diesel bus • COVID-19 has impacted schools' budgets greatly	• Leveraged DERA/Demand Response funding to make economical case to towns. Multiple towns were engaged and interested but COVID-19 continues to consume much of their time/budget	Continuing conversation with interested towns/bus providers for post-COVID deployment
Public DCFC	• Costs of DCFC stations • Costs of electrical bill for site hosts	• Electrify RI has provided funding to reduce the initial DCFC station costs • DCFC discount program will help reduce electrical bill for site hosts for (3) years	Working with Electrify RI to identify potential locations

2.2.3 Program Improvements

Based on the Evaluation Report and the implementation team's experience the Company is proposing the following for hard to reach segments in an effort to reduce overall costs and increase participation in the Program:

- For corporate, government, medium/heavy duty fleet or other select segments where the charging station networking costs are the key barrier to charging station adoption and where networking capabilities are not providing benefits to EV drivers or site hosts, the Company proposes that the networking services be optional in RY3. Site hosts will be required to provide some or all of the following information depending on the situation: provide mileage records for the EV fleets, respond to survey

questions, allow the Company to monitor charging station usage via a mechanism of the Company's choice, and/or supply other relevant information to the Company. The Company is proposing this approach as a one-time test to determine whether waiving the networking costs materially increases participation among these hard-to-reach segments by reducing the overall project cost for these customers.

- Continue to focus direct outreach on program participants in remaining available segments by developing segment-specific marketing materials and leveraging the experience of existing site hosts in these segments to highlight the benefits of participating in the program.
- Continue to provide resources to participating and potential site hosts about eligible EVSE providers to encourage EVSE supplier diversity. The Company and participating vendors are actively providing site hosts with resources on EVs and EVSE, but additional information on all available EVSE technologies for all customers can help promote further participation and encourage use of other vendors. As noted in the Evaluation Report, some interviewed site hosts indicated that they only purchase charging equipment from the State of Rhode Island's Master Price Agreement (MPA) and currently there is only one EVSE provider on that list. Expansion of that list to other providers could encourage more supplier diversity, however, given that it is a Rhode Island state contract, any specific action on this finding would fall outside the Companies purview.

2.3 Discount Pilot for DCFC Station Accounts

2.3.1 Summary of RY2

In RY2 there were two customers approved for the Discount Pilot for DCFC Station Accounts, which allowed them to be eligible for credits on their electric bills equal to one hundred percent (100%) of the distribution demand charge for a period of three years from the start of service. The total amount of credits paid to these customers in RY2 were $21,694. During RY2, one of the customers chose to switch to a different rate class, which is not eligible for this program. Therefore, at the end of RY2, one customer is enrolled in the Discount Pilot.

2.3.2 Lessons Learned

Some of the stations that were activated in RY2 were placed on the non-demand C-06 rate, making them ineligible for the demand discount. Based on this customer's usage, the non-demand rate is more cost effective as it lowers their overall electric bill, thereby allowing these site hosts to offer a competitive $/kwh charge to EV drivers.

2.3.3 Program Improvements

For RY3 the Company is proposing to maintain the current discount level (100% for a period of three years) because DCFC vendors and customers believe this program addresses a key concern associated with DCFC stations. The discount will work together with both the Charging Demonstration Program and the State's "Electrify RI" Program to help site hosts install and operate DCFC stations across RI. The Company expects increased participation in the Program in RY3, as more DCFC stations will be built with support from these two programs.

Lastly, the Company intends to comply with the ASA requirement that "twenty five percent (25%) of the stations receiving the discount shall be in stations that enable electric public transit" with

continued collaboration with Rhode Island's Public Transit Authority ("RIPTA"), as well as cities and towns interested in purchasing electric school buses.

2.4 Fleet Advisory Program

2.4.1 Summary of RY2

The Fleet Advisory program has been available to customers since Q4, 2018. There have been four studies completed with another five slated for completion in early RY3. Of the five ongoing studies, three involve government or public transit fleets and two involve private universities. Segments included in studies to date include government, public transit, colleges/universities, corporate fleets and a school bus transportation vendor. A total of 1,933 cars have been evaluated with 125 of those vehicles being recommended for replacement with an electric vehicle. Average lifetime savings per vehicle was calculated to be $7,000 and a total potential lifetime cost of ownership savings was calculated to be $1.0 million. The Company hopes to enroll one to two more participants in the program before the end of RY3.

2.4.2 Lessons Learned

As noted in the Evaluation Report, participants reported high satisfaction with the Fleet Advisory program but face barriers for fleet conversions. The primary barrier cited by participants was their requirement to work within their existing vehicle replacement cycles/lease terms, which may not coincide with the three-year term of the Program. Other barriers noted by participants include utilization decreases from the COVID-19 pandemic and concerns about rapidly changing technologies and high replacement costs for EVs.

2.4.3 Program Improvements

The Evaluation Report suggests that the Company should consider a long-term engagement approach to help support participants through their vehicle lifecycles and continue outreach to ensure electrification stays a priority for participants. The Company is implementing this suggestion by re-engaging participants six months after their respective study has been completed.

2.5 Budget for the ET Initiative Programs

The ET Initiative has a three-year budget for its programs with both OPEX and CAPEX spend. As shown in Table 4 below, the Company has provided updated actual spend through RY2 in comparison to the budgets through RY2. The ET Initiative as a whole is under budget for both OPEX and CAPEX spend although some components are over budget.

Table 4: ET Initiative Budgets through RY2

	RY1 (ACTUAL)	RY2 (ACTUAL)	RY1 and 2 (ACTUAL)	RY1 and 2 (BUDGET)	VARIANCE
OPEX					
Off-peak Charging Rebate	$218,763	$178,209	$396,971	$310,665	-$86,306
Discount Pilot for DC Fast Charging	$13,413	$21,694	$35,107	$274,272	$239,165
Customer Fleet Advisory Services	$51,050	$88,659	$139,709	$110,000	-$29,709
Charging Demonstration	$66,118	$597,437	$663,555	$829,213	$165,658
Initiative Evaluation	$6,775	$63,461	$70,236	$60,000	-$10,236
TOTAL OPEX	$356,118	$949,460	$1,305,578	$1,584,150	$278,572
CAPEX					
Charging Demonstration	$75,204	$1,711,110	$1,786,314	$2,243,943	$457,629
TOTAL CAPEX	$75,204	$1,711,110	$1,786,314	$2,243,943	$457,629
TOTAL OPEX and CAPEX	$431,322	$2,660,570	$3,119,803	$3,828,093	$708,290

2.6 EV Adoption

The Company provided data on the number of Electric Vehicles in operation in Rhode Island through June of 2020 in its "Performance Incentive Mechanism Midyear Report, Period January 2020 through June 2020" dated September 1, 2020. The Company continues to track EV registrations and will have updated data in the RY3 annual report.

Table 5 and 6: Consumer and Fleet EVs Registered in RI as of June 30, 2020

Consumer EV Type	2020 Registered Consumer EV Forecast	Registered Consumer EVs as of June 30, 2020
BEV	1,654	1,067
PHEV	2,209	1,340
Total	3,863	2,407

Fleet Type	2020 Registered Fleet EV Forecast	Registered Fleet EVs as of June 30, 2020
Government		48
Commercial		121
Total	205	169

2.7 Conclusion

The Company had a successful RY2 for its ET Initiative. It had over a tenfold increase of activated ports through its Charging Demonstration Program, going from a total of 20 ports in RY1 to 233 in RY2, including activating its first DCFC stations. It compiled a full year of charging data for its Off-Peak Charging Program, helping to determine that pricing signals do have a statistically significant impact on off-peak charging behavior. The Company also completed four studies for fleet customers in its Fleet Advisory Program, with 125 cars being identified for an electrification opportunity. The DCFC discount continued to provide credits to DCFC site hosts, helping to reduce the operating costs for these sites. The Company will continue its successes into the final year of the ET Initiative while continuing to stay under the budget agreed upon in ASA.

APPENDIX 1

EVALUATION REPORT

Rhode Island Electric Transportation Initiative Evaluation Final Report – Rate Year 2

prepared for

National Grid

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Contents

1 EXECUTIVE SUMMARY 1
1.1 PROGRAM ACHIEVEMENTS 2
1.2 PROGRAM CHALLENGES AND BARRIERS 4
1.3 FUTURE PROGRAM CONSIDERATIONS 5
2 INTRODUCTION 7
2.1 ELECTRIC TRANSPORTATION INITIATIVE 7
2.2 EVALUATION OBJECTIVES 10
3 METHODOLOGY 11
3.1 OFF-PEAK CHARGING REBATE PILOT ANALYSIS METHODOLOGY 12
4 RESULTS AND FINDINGS 16
4.1 OFF-PEAK CHARGING REBATE PILOT (SMARTCHARGE RHODE ISLAND, OR SCRI) 16
4.1.1 Program Implementation Approach 16
4.1.2 Off-Peak ChargingRebate Pilot Participant Survey Results 16
4.1.3 Off-Peak Charging Rebate Pilot Data Analysis 26
4.1.4 Upcoming Activities for RY3 46
4.2 CHARGING STATION DEMONSTRATION PROGRAM 46
4.2.1 Program Implementation Approach 46
4.2.2 Program Results 47
4.2.3 Charging Demonstration Program Evaluation Key Findings 56
4.2.4 Upcoming Activities for RY3 58
4.3 DISCOUNT PILOT FOR DCFC STATION ACCOUNTS 58
4.3.1 Program Implementation Approach 58
4.3.2 Program Results 58
4.3.3 Upcoming Activities for RY3 59
4.4 FLEET ADVISORY SERVICES 59
4.4.1 Program Implementation Approach 59
4.4.2 Program Results 60
4.4.3 Fleet Advisory Services Program Interview Results 60
4.4.4 Upcoming Activities for RY3 62

APPENDIX A: PROJECT-LEVEL UTILIZATION METRICS

APPENDIX B: ELECTRIC VEHICLE POPULATION BREAKDOWN BY ZIP CODE

APPENDIX C: DAILY EV CHARGING LOAD DISTRIBUTION

Rhode Island Electric Transportation Initiative Evaluation Final Report: Rate Year 2

1 Executive Summary

This report presents the evaluation results and findings for Rate Year 2 (RY2) for National Grid Rhode Island's Electric Transportation Initiative. This is a three-year initiative[1] containing four programs: The Off-Peak Charging Rebate Pilot, Charging Station Demonstration Program, Discount Pilot for Direct Current Fast Charging (DCFC) Station Accounts, and Fleet Advisory Services Program. Collectively, these programs are designed to accelerate electrification in Rhode Island by scaling the market for electric transportation charging equipment and increasing electric vehicle (EV) adoption. RY2 covers the period between September 1, 2019, and August 31, 2020.

The ERS Team completed the following evaluation activities for RY2:

- Reviewed and analyzed program materials, such as program tracking data and score cards.
- Conducted in-depth interviews with 12 program participants of the Charging Station Demonstration Program ("Infrastructure Program") and Fleet Advisory Services Program.
- Analyzed charging station utilization data provided by 4 electric vehicle supply equipment (EVSE) suppliers and covering 211 individual program-supported charging ports.
- Conducted web-based survey of Off-Peak Charging Rebate Pilot (SmartCharge Rhode Island) participants.
- Analyzed Off-Peak Charging Rebate Pilot program data to assess the effectiveness of the off-peak charging rebate in shifting EV charging load off-peak. ERS also completed several rounds of random allocation of Off-Peak Charging Rebate Pilot program participants during RY2 to support program implementation.

The ERS Team used these RY2 evaluation activities, synthesized with RY1 activities, to develop the following RY2 program findings, recommendations, and considerations grouped into program achievements, program challenges and barriers, and future program considerations.[2]

[1] National Grid is proposing extending the initiative to a fourth year (RY4).
[2] Additional details on the RY1 activities can be found in the RY1 Annual Report, http://www.ripuc.ri.gov/eventsactions/docket/4770-NGrid-ElectricTransportation%20RY1%20Annual%20Report%20(10-31-19).pdf.

1.1 Program Achievements

Finding #1: Well-Managed Programs. The programs are well-run, and participants are highly satisfied with their program experience. Program participants who were interviewed and surveyed all spoke very positively about the program they participated in and of the implementation processes. Participants expressed that National Grid staff, along with vendors and implementation contractors, provide the necessary support to make their experiences "seamless" and "smooth." Most interviewees had no program changes to recommend. ERS found that the RY2 program tracking spreadsheets were easy to navigate for this evaluation, reflecting an improvement in standardization of program tracking.

Finding #2: Successful Implementation. The Charging Station Demonstration Program has activated 233 ports (230 Level 2 and 3 DCFC) across 122 stations (119 Level 2 and 3 DCFC) and 62 sites (60 Level 2 and 2 DCFC) through August 31, 2020. This represents 72% of the overall program target for Level 2 ports and 7% of the target for DCFC ports. The program has a strong pipeline of approved projects and projects under development, discussed in greater detail in Section 4.2.2.

Finding #3: Incentive Success. The Charging Station Demonstration Program incentives are helping to encourage customer participation and increase EVSE development in Rhode Island. Most participants interviewed stated that they would not have installed charging stations if the incentives were not available.

- **Consideration:** Many interviewees indicated that the entire cost of the charging hardware and infrastructure was covered by the Infrastructure Program and supplemental funding sources such as Electrify RI; they specified that they would not have been able to move forward with the projects without full funding. As National Grid cannot offer full funding for all segments, continued availability of supplemental funding sources such as Electrify RI will be critical to achieving program goals. Particularly for the environmental justice and public sectors, interviewees reported that full funding is critical to their participation and can help contribute to program equity.

Finding #4: Off Peak Rebates Work. The Off-Peak Charging Rebate Pilot pricing signal has a statistically significant positive effect on off-peak charging behavior and is succeeding in nudging EV owners to shift their charging to off-peak hours.

- The program resulted in a shift of 49,848 kWh away from the on-peak hours of 1 p.m.–9 p.m. (all days). By vehicle type, 12,419 kWh were shifted away from the on-peak period for PHEVs, 12,582 kWh were shifted for Non-Tesla BEVs, and 24,847 kWh were shifted for Tesla BEVs.

- Plug-in hybrid electric vehicle (PHEV) owners in the treatment group charged 9.6% more (63.0% treatment vs. 53.4% control) of their kWh and initiated 7.0% more (48.0% treatment vs. 41%% control) of their charging sessions off-peak than the control group, based on regression results. Battery electric vehicle (BEV) owners shifted even more charging off-peak; their incremental off-peak shifts are discussed in Finding #5.
- The program has also effectively reduced the peak coincidence of EV charging, with a demand reduction of 0.068 kW/vehicle for PHEVs (statistically significant), 0.078 kW/vehicle for Non-Tesla BEVs (not statistically significant), and 0.179 kW/vehicle for Tesla BEVs (statistically significant). These demand reductions correspond to 28.7%, 25.8%, and 31.6% reductions, respectively, relative to the control group per-vehicle charging demand during the on-peak period.
- The above findings are supported by the Off-Peak Charging Rebate Pilot survey: 69% of respondents in the treatment group self-reported that they charge their vehicles during the 9 p.m.–8 a.m. time window, compared to 35% of control group respondents. While these percentages don't match the quantitative data analysis (discussed in Finding #9, below), they reflect the outcome that treatment group respondents more frequently charge off-peak.

Finding #5: Non-Uniformity of Off-Peak Charging Load Shifts. The effect of the Off-Peak Charging Rebate Pilot pricing signal is not uniform across all vehicle types. For example, Tesla and Non-Tesla BEV owners in the treatment group tend to initiate more of their charging sessions off-peak than PHEV owners in the treatment group (12.7% more for Non-Tesla BEVs and 11.5% more for Tesla BEVs). The Off-Peak Charging Rebate Pilot survey found that 76% of BEV (Tesla + Non-Tesla) drivers were aware of tools and features for controlling their EV charging vs. 58% for PHEV drivers; this difference is statistically significant.

- As EV technology continues to mature and drivers gravitate to larger and longer-range EVs,[3] per-vehicle energy and demand impacts are expected to increase both due to these vehicles' larger batteries (which require more kWh to refuel) and drivers' need for faster charging (higher peak kW). It is thus promising that Tesla and Non-Tesla BEVs are more responsive to the off-peak charging rebate.
    - **Consideration:** National Grid should continue to focus on research and strategies for shifting BEV charging load off-peak in recognition of their greater grid impact and likely dominance in the future EV market.

[3] FleetCarma, "Electric Vehicle Growing Pains," page 3, 2020, available here: https://www.fleetcarma.com/resources/electric-vehicle-growing-pains/

1.2 Program Challenges and Barriers

Finding #6: Targeted Segment Outreach. The Charging Station Demonstration Program is experiencing challenges recruiting light duty fleet and public transit Level 2 segments as well as DCFC stations. Some Level 2 segments – such as environmental justice, government fleet, and multi-unit dwellings (MUD) – are fully, or almost fully, subscribed, while other Level 2 and DCFC segments – such as light duty fleet, public transit, and DCFC stations – will continue to require additional targeted outreach to meet their segment-specific program goals.

- **Recommendation:** Continue to focus direct outreach on program participants in underperforming segments. The program can develop marketing materials specifically for these segments and leverage existing site hosts in these segments to highlight the benefits of participating in the program.

Finding #7: COVID-19 Impacts. The COVID-19 pandemic and its resulting disruption of normal business operations throughout Rhode Island resulted in several key impacts on the Electric Transportation Initiative program suite, including:

- **Reduction in reported charging activity**. The total per-port charging load recorded at all actively reporting ports funded through the Charging Station Demonstration Program in April 2020 was 56% lower than the pre-pandemic charging load (February 2020), indicating that COVID-19-related shutdowns significantly impacted the driving and charging behavior of National Grid customers in Rhode Island. Workplace charging, the most active segment, saw an approximately 51% reduction in charging as a result of the pandemic (average of April and May compared to February), and all charging at site host facilities continues to be lower compared to pre-pandemic levels (August per-port charging load remains 36% lower than February).
- **Off-Peak Charging Rebate Pilot charging impacts**. The amount of charging done by participants in the Off-Peak Charging Rebate Pilot was also significantly impacted by the pandemic, dropping 63% in April relative to February. The data shows that the impacts to EV charging are still being felt; while the amount of EV charging has increased from its low in April 2020, the charging load in August was still 37% lower than in February. Survey respondents corroborated this analysis; they reported reduced charging and driving activity during COVID-19 shutdowns and uncertainty about future behaviors given the potential for additional shutdowns, prolonged remote work, and other unknowns. This ongoing uncertainty due to COVID-19 could affect future analyses, particularly the identification of seasonality or other trends.
- **Reluctance to pursue fleet electrification amid uncertainty**. Fleet Advisory Services Program interviewees observed continued reduced usage of existing fleet vehicles due to the pandemic's impacts on business operations. One participant expressed concerns about

moving forward with vehicle conversions until fleet vehicle activity resumes to pre-COVID-19 levels.

Finding #8: Fleet Conversions. The Fleet Advisory Services Program studies are nearing completion, but the program is not achieving direct vehicle conversions within the program time period. Participants reported high satisfaction with the program and final reports, but face barriers for fleet conversions. The primary barrier cited by participants was their requirement to work within their existing vehicle replacement cycles, which typically don't enable changes until the lease terms of their existing vehicles expire. Other barriers included observed utilization decreases from the COVID-19 pandemic and concerns about rapidly changing technologies and high replacement costs for EVs.

- **Consideration:** The program staff and implementation contractor should consider a long-term engagement approach to help support participants through their vehicle lifecycles to ensure that fleet electrification continues to be a priority. Staff currently re-engage participants 6 months after study completion, and they should continue this engagement to help participants develop a long-term electrification approach. Interviewees requested updates on new technologies and advances in EV options beyond the fleet study cycle to stay up-to-date as the market continues to evolve.

1.3 Future Program Considerations

While ERS did not formally evaluate or consider future EV program designs or ideas, we identified the following considerations for future iterations of these programs that arose organically during the evaluation.

Finding #9: Future Time-of-Use (TOU) Rate Design. For the Off-Peak Charging Rebate Pilot, a majority of the control group charging activity already takes place in the off-peak period. Across all vehicle types and months, the control group initiated 53.4% of their charging sessions off-peak. However, it is important to note that the coincident peak demand (kW) is a focal point of the program in testing feasibility of future rate designs and peak demand impacts may still present challenges even if the majority of charging sessions are initiated off-peak. Additionally, ERS did not observe a statistically significant increase in off-peak charging during the summer months when higher rebates were available for the treatment group, relative to non-summer months. Note that the result reported in this finding differed from the survey respondents' reported value (per Finding #4, 35% of control respondents reported charging off-peak) but reflects the actual charging data for the full suite of program participants.

- **Consideration:** When designing TOU rates for EV owners, National Grid should consider the baseline level of off-peak charging behavior, as well as the potential for creating new peaks by concentrating charging load at a single hour. National Grid

will need to investigate technologies and incentives to mitigate and manage any timer or rebound peaks induced from TOU rates. Staggering several off-peak windows throughout the off-peak period could help distribute EV charging activity, mitigating potential additional peaks from EV charging.

Finding #10: Supplier Diversity. One EVSE provider continues to provide the overwhelming majority of Charging Station Demonstration Program charging stations and utilization. The EVSE vendor's equipment is used at 91% of all activated ports and supplies 97% of all kWh charged in the program.

- **Recommendation:** Continue to provide resources to participating and potential site hosts about eligible EVSE providers to encourage EVSE supplier diversity. National Grid and participating vendors are already actively providing site hosts with resources on EVs and EVSE, but additional information on all available EVSE technologies for all customers can help promote further participation and encourage use of other vendors. Some interviewed site hosts in the public sector indicated that they can only buy from the Rhode Island master price agreement[4] and currently there is only one EVSE provider on that list. Expansion of that list to other providers could encourage more diversity in EVSE providers.

Finding #11: National Grid Ownership. National Grid ownership and operation of charging stations is a complex issue with diverse implications that need to be carefully explored before moving forward. During the Charging Station Demonstration Program interviews, the team asked site hosts for their opinion on potential National Grid ownership and operation of charging stations on site host property. The responses varied from positive to negative. Several site hosts were interested in learning more details and suggested that benefits could include reduced staff time in the initial stages and for station management along with reduced upfront and maintenance costs. Other site hosts expressed reservations with concerns about the utility using their property for revenue generation, the complexity of involving multiple parties, and a more challenging approval process.

The remainder of this report presents a summary of the Electric Transportation Initiative, ERS's evaluation methodology, and program-specific details regarding results, findings, and recommendations.

[4] https://www.ridop.ri.gov/contract-board/

2 INTRODUCTION

This section describes National Grid's Electric Transportation Initiative in Rhode Island and the evaluation objectives for Rate Year (RY2), spanning September 1, 2019, through August 31, 2020. ERS was contracted to conduct an independent evaluation of the Electric Transportation Initiative for each of the three rate years.

2.1 Electric Transportation Initiative

National Grid's Electric Transportation Initiative consists of several programs designed to encourage charging infrastructure development and EV deployment throughout Rhode Island. The initiative includes the following programs:

- **Off-Peak Charging Rebate Pilot**, marketed by National Grid as the "SmartCharge Rhode Island" (SCRI) program,[5] which aims to understand EV charging patterns and the effect of rebates in shifting EV charging from on-peak to off-peak hours. Participants' charging activity is measured by a Geotab monitoring device ("C2 device"), which plugs into a vehicle's onboard diagnostics port and records data while the vehicle is actively charging. The peak period is defined as the hours of 1 p.m. to 9 p.m. on all days, including weekends.
  - To evaluate this program and determine the effects of rebates on participant charging behavior, ERS, National Grid, and Geotab are conducting an experiment modeled after a randomized controlled trial (RCT). An RCT is a highly structured and rigorous experimental approach commonly used in the medical and social science fields to test the effect of a treatment on a group of participants, minimizing bias by randomly allocating participants across treatment and control groups. The two groups receive different treatments during the experimental period, enabling assessment of the treatment on the outcome being measured. The team's experimental design of the Off-Peak Charging Rebate Pilot is summarized in Table 2-1 and explained below.

[5] For more information, visit https://www.fleetcarma.com/smartchargerhodeisland/

Table 2-1. Experimental Design for Off-Peak Charging Rebate Pilot

Participant Group	RY1 (6/19/19 – 8/31/19)	RY2 (9/1/19 – 8/31/20)	RY3 (9/1/20 – 8/31/21)
Control Group	Recruitment period: participants enroll and are activated in the program and receive incentive for installing device.[6]	Receives access to online dashboard showing on- and off-peak charging behavior (serves as baseline behavior)	All participants receive access to dashboard and the additional incentives
Treatment Group		Receives access to online dashboard **plus additional incentives per kWh charged during off-peak periods**	

- During RY2 – from September 1, 2019, to August 31, 2020 – National Grid, ERS and Geotab randomly assigned participating vehicles to either a control or treatment group. The first random allocation occurred in late August 2019, and additional allocations continued through March 2020 as more vehicles enrolled in this program.[7] As part of this allocation process, ERS ensured that the two groups were appropriately representative of the participating vehicles in the study (see Table 4-15 for the group breakdown). During RY2, the control group received access to an online dashboard showing their charging behavior, while the treatment group received access to the same dashboard as well as rebates for off-peak charging. These rebates are 6 cents per kWh charged off-peak in the summer months and 4 cents per kWh charged off-peak during the non-summer months[8]. All participants also received $50 for installing their C2 device and recording their first charge, as well as an additional $50 for each year they keep the device plugged in, for a maximum participation incentive of $150.
- In RY3, all participants were placed in the treatment group, receiving not only access to the dashboard but also the charging incentives. This will enable comparisons between RY2 and RY3 charging behavior to further identify impacts of the incentives.

[6] Note that while charging data was collected for participants who enrolled in the program and activated their C2 devices prior to the start of RY2, this data was of insufficient quality and volume to be used in a difference-in-differences analysis assessing the impact of the online dashboard on the control group's off-peak charging performance. Any impact the dashboard alone may have on charging behavior has not been measured through this analysis.

[7] For more details on the allocation process, please see Appendix 1 of the RY1 Annual Report, http://www.ripuc.ri.gov/eventsactions/docket/4770-NGrid-ElectricTransportation%20RY1%20Annual%20Report%20(10-31-19).pdf.

[8] "Summer" months are defined as June through September and "non-summer" months as October through May.

- **Charging Station Demonstration Program**, commonly referred to as the "Infrastructure Program," which incentivizes Level 2[9] and DCFC[10] charging station and port deployment throughout Rhode Island. National Grid has targets for both Level 2 (320 ports) and DCFC stations (46 ports) by market segment, and the program engages both internal marketing staff and third-party vendors to recruit potential host sites and facilitate EVSE installation. Table 2-2 presents the charging port targets and incentives by segment for both Level 2 and DCFC stations.

Table 2-2. Charging Station Demonstration Program Targets and Rebate Levels

Charging Level	Segment	Target Number of Ports	EVSE Equipment Rebate Level
Level 2	Corporate light-duty fleet	24	50%
Level 2	Government light-duty fleet	24	50%
Level 2	Public transit stations	60	50%
Level 2	Environmental justice communities	36	100%
Level 2	Apartment buildings (MUD)	36	75%
Level 2	Workplaces	140	50%
DCFC	Municipal school buses	3	75%
DCFC	Other heavy-duty (port, airport)	8	50%
DCFC	Rideshare company hub	5	25%
DCFC	Public transit buses	10	50%
DCFC	Public DCFC	20	0%

- **Discount Pilot for DCFC Stations** to help mitigate the impacts of demand charges on DCFC sites which may have low initial utilization by providing an electric rate discount equal to 100% of the DCFC's distribution demand charges for a three-year period. This program is available to both existing and new DCFC stations in Rhode Island.
- **Fleet Advisory Services Program** to conduct fleet electrification and other studies for up to 12 Rhode Island fleet operators aimed at promoting vehicle electrification. These services are managed by a National Grid Program Manager, and a third-party implementation contractor has been retained to conduct these studies and present results to participating fleet operators.

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

2.2 Evaluation Objectives

The RY2 evaluation objectives are as follows:

1. Characterize and describe the implementation of the Electric Transportation Initiative, assessing results and progress for each individual program component.
2. Report incremental CO_2 reductions resulting from incremental vehicle adoption.
3. Develop recommendations to enhance the Electric Transportation Initiative.

For the RY2 evaluation, the ERS Team completed research activities for each of the Electric Transportation Initiative's four programs. Primary data collection methods included analysis of charging data from owners and site hosts, as well as in-depth-interviews with site hosts and surveys with SCRI participants.

3 METHODOLOGY

The ERS Team completed the following activities during RY2 of this evaluation:

- **Project Manager (PM) follow-up interviews** – ERS conducted follow-up interviews with the National Grid program management team to help ERS understand how program objectives and delivery methods have evolved since RY1 to refine our survey and interview guides and analyses.
- **Participant interviews** – ERS conducted interviews with participants in the Charging Station Demonstration and Fleet Advisory Services Programs. These interviews gathered participants' experiences within the program, addressing program processes, successes and barriers, and satisfaction with their participation.
- **Data analysis** – The team conducted data analysis across the suite of Electric Transportation Initiative programs to understand progress against program goals and to analyze EV charging behavior at deployed stations and vehicles. This included:
  - **Off-Peak Charging Rebate Pilot** – ERS analyzed the program's RY2 performance, described in detail in Section 3.1.
  - **Charging Station Demonstration Program** – ERS assessed program progress against stated goals, reviewed and analyzed program data and tracking spreadsheets, and calculated charging station utilization based on charging data provided by four EVSE vendors from a total of 211 actively reporting charging ports.
  - **Discount Pilot for DCFC Stations** – ERS summarized program discounts provided to the two participants in this program during RY2.

Table 3-1 summarizes the evaluation activities across the four RI programs; Table 3-2, below, summarizes the primary interviews conducted by the ERS Team.

Table 3-1. Summary of RY2 Evaluation Activities

Research Area	Data Analysis	Primary Research
Off-Peak Charging Rebate Pilot Evaluation	Geotab charging data analysis for initial period	Survey program participants (n=123)
Charging Station Demonstration Evaluation	Review of program tracking data, program scorecards, and initial site-host charging data	Interviews with site host participants (n=10)
Discount Pilot for DCFC Station Evaluation	Summary of DCFC discounts provided during RY2	No primary research completed in RY2 per discussions with National Grid, as there were no new participants in the program.
Fleet Advisory Services	Review of study timelines, final reports, and program scorecards	Interviews with program participants (n=2)

Table 3-2. Program Interview Summary

Interviewee	RY1 Completed	RY2 Completed	Total
National Grid RI program managers	3	2	5
National Grid sales staff	1	0	1
National Grid marketing staff	1	0	1
Charging Station Demonstration program participants	3	10	13
Charging Station Demonstration program vendors	3	0	3
DCFC Pilot participants	1	0	1
Fleet Advisory Services implementation vendors	1	0	1
Fleet Advisory Services participants	2	2	4
Total Interviews	**15**	**14**	**29**

3.1 Off-Peak Charging Rebate Pilot Analysis Methodology

The ERS Team analyzed the charging data collected through the Off-Peak Charging Rebate Pilot to determine the extent to which charging behavior was affected by the program. The scope of this analysis includes charging data recorded from September 2019 through August 2020.[11] ERS completed the following activities:

- **Data cleaning and quality control,** consisting of:
  - **Tracking vehicle group assignments.** ERS worked with National Grid and Geotab to finalize the list of vehicle group assignments. Data was provided for a total of 397 vehicles during the analysis period; of those, 20 vehicles were never assigned to a group because they either swapped out their vehicle or withdrew from the program prior to assignment.[12] ERS removed an additional 23 vehicles from the analysis because all of their data failed quality control (QC) or they did not record any post-

[11] Note that while charging data was collected for participants who enrolled in the program and activated their C2 devices prior to the start of RY2, this data was of insufficient quality and volume to be used in a difference-in-differences analysis assessing the impact of the online dashboard on the control group's off-peak charging performance. Any impact the dashboard alone may have on charging behavior has not been measured through this analysis.

[12] Over the course of RY2, several vehicles either withdrew from the program or were swapped out for a newer EV with the owner continuing to participate in the program with their new vehicle; data from these vehicles that was recorded during RY2 and passed QC was included in the analysis.

assignment data,[13] leaving a total of 354 vehicles whose data was included in this analysis.

- **Quality control.** ERS performed QC checks to ensure that blank, invalid, and inaccurate data was flagged for removal from the analysis. Examples of data the team omitted from the analysis include negative kWh or kW data, charge rates that exceeded a given EV model's maximum charge acceptance rate (kW), and vehicles belonging to National Grid employees who might have knowledge of the program and could introduce bias into the results. Of the over 1.5 million charging intervals analyzed across over 125,000 charging sessions, 90.5% of data points passed QC.[14]
- **Filtering for eligible data**. As stated above, ERS filtered the data to remove all charging intervals that failed QC, were recorded prior to the RY2 analysis period, or were recorded prior to a vehicle's group assignment date. Of the 377 vehicles that were assigned to a group, 354 remained after the filtering operation. The 23 assigned vehicles that were filtered out did not record any data meeting the above criteria.

- **Initial analysis.** ERS conducted an initial analysis to quantify high-level program statistics and develop charging load profiles with 15-minute resolution. Only data that met the above criteria was included in this analysis, which included the following steps:
  - ERS calculated vehicle-level and program-level statistics, including total kWh charged and number of charging sessions by month, group, and vehicle type. In addition, the team used the program-level data to identify the aggregate impacts of the COVID-19 pandemic.
  - We constructed per-vehicle average charging load profiles with 15-minute resolution, based on post-assignment RY2 data, and aggregated them by vehicle type and group (treatment vs. control); we further segmented load profiles by month and day type (weekday vs. weekend).
  - To assess the program's effectiveness, we calculated the percentage of kWh charged off-peak by month for each vehicle. We also calculated a similar metric representing the percentage of charging sessions initiated off-peak by month for each vehicle to identify potential differences in observed behavior with that metric.

[13] ERS tracked the date of each vehicle's assignment and excluded "pre-assignment" data from the analysis, since charging activity recorded prior to a vehicle's assignment to a group is not representative of the behavior this analysis seeks to understand.

[14] Some amount of out-of-bounds or blank data is typically expected with remote data collection equipment such as Geotab's C2 device; the QC process is designed to remove suspect data so as not to bias the analysis results.

- **Regression analysis.** ERS developed two separate econometric regression models to assess the impact of several independent variables on two metrics representing participant charging behavior. The following bullets describe the approach and model at a high level; the results of the modeling are outlined in Results and Findings (Section 4).
  - ERS used the SPSS statistical software package to run two multivariate linear regression models, each assessing a different dependent variable.
  - We iteratively tested the effects of different combinations of independent variables, with the goal of identifying a statistically significant set of estimators that explained the observed behavior with an adequate "goodness of fit" (R^2 $value$).
  - The two dependent variables were 1) the per-vehicle monthly percentage of kWh charged off-peak (y_{kWh}) and 2) the per-vehicle monthly percentage of charging sessions initiated off-peak (y_{start}). These metrics were chosen because they reflect different aspects of charging behavior. While the goal of the program is to shift EV charging load (kWh), it would be possible for a driver to consistently plug their EV in and start charging on-peak (e.g., 8:00 p.m.) but still charge their vehicle mostly off-peak if the charging session lasted more than two hours. This measure of off-peak performance is a function of differences in battery size, charger type (Level 1, Level 2, or DCFC), and driving patterns. On the other hand, the act of delaying charging until off-peak hours – whether by setting a schedule on a home charger or simply waiting to plug a vehicle in – represents a conscious behavior that can be assessed by analyzing the session start hour.
  - Table 3-3 presents the full set of independent variables that ERS tested for the full RY2 analysis. As part of our iterative modeling process, we introduced independent variables representing the vehicle-specific electric range (miles) and charge acceptance rate (kW) to determine whether they had a statistically significant impact on off-peak performance; we found that they did not and excluded them from the final regression model. Similarly, we did not assess interactivity between the treatment group and month dummy variables due to the relatively high correlation between the introduction of the higher summer rebate and lingering COVID-19 impacts on charging behavior.
  - The resulting models have the following form:

$$y = \beta_0 + \beta_1 T + \beta_2 S + \beta_3 L + \beta_4 (S \times T) + \beta_5 (L \times T) + \beta_6 (Oct) + \beta_7 (Nov) + \beta_8 (Dec) + \beta_9 (Jan) + \beta_{10} (Feb) + \beta_{11} (Mar) + \beta_{12} (Apr) + \beta_{13} (May) + \beta_{14} (Jun) + \beta_{15} (Jul) + \beta_{16} (Aug) + \beta_{17} \mathrm{K}$$

Table 3-3. Independent Variables Summary

Independent Variable	Symbol(s)	Variable Type	Potential Values	Properties
Off-peak charging price signal	T	Dummy, main effect	Control: T = 0 Treatment: T = 1	Tests the effect of a vehicle's group on off-peak charging performance.
Vehicle type	S, L	Dummy, main effect	PHEV: S=0, L=0 Non-Tesla BEV: S=1, L=0 Tesla BEV: S=0, L=1	Tests the effect of vehicle type on off-peak charging performance.
Price signal: vehicle type interaction	S x T, L x T	Dummy, interactive effect	Multiplication of (S x T) and (L x T)	Measures the incremental off-peak performance of a *treatment group* non-PHEV vs. a control group vehicle
Program activity	K	Continuous, main effect	Represents hundreds of kWh charged per month or tens of charging sessions per month (model dependent).	Tests the effect of a participant's level of charging activity on off-peak charging performance, with the intent of measuring whether more charging activity translates into greater program engagement or an improved understanding of the off-peak price signal.
Month	Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug	Dummy, main effect	For each month variable, the variable is equal to "1" if the data was recorded in that month and "0" if not; September 2019 is the base case and is not assigned a variable	Tests for non-linear effects of time on the observed behavior - specifically, is there a statistically significant behavior change in response to a higher rebate or the COVID-19 pandemic?

4 Results and Findings

This section contains the RY2 results and findings for each of the Rhode Island Electric Transportation Initiative programs evaluated.

4.1 Off-Peak Charging Rebate Pilot (SmartCharge Rhode Island, or SCRI)

In RY2, ERS conducted two rounds of evaluation of the Off-Peak Charging Rebate Pilot. The team conducted an interim analysis in May 2020, based on data through March 2020, to develop initial findings to inform program design changes in RY3 and assess the immediate impact of the COVID-19 pandemic. We then conducted a full analysis covering all RY2 data in September 2020 to evaluate the effectiveness of the off-peak price signal in shifting EV charging load to off-peak hours. As part of these efforts, ERS cleaned and analyzed the charging data to characterize the vehicles participating in the program, developed average charging load profiles across multiple time horizons, and assessed the prevalence and timing of both on-peak and off-peak charging to determine the impact of the off-peak charging rebate.

In summer 2020, ERS also developed, fielded, and analyzed results from a web-based survey to collect additional data from program participants and assess program satisfaction. This survey collected information on home charging access and equipment, self-reported plug-in times, awareness and use of smart charging tools, prevalence of "away" (i.e., not home) charging, and perspectives on how future driving and charging behavior may be impacted by COVID-19.

4.1.1 Program Implementation Approach

National Grid conducted a multi-faceted marketing campaign leveraging digital, email, print, paid search, and paid social media channels to encourage EV drivers to enroll in the program and to promote the financial and environmental benefits of participation. National Grid worked closely with Geotab on the implementation of this program to enroll participants and ensure that they install the C2 devices and meet all eligibility criteria. Geotab collected charging data and reported it regularly to National Grid.

ERS supported National Grid in the design and implementation of the experiment by randomly allocating participating vehicles to the control and treatment groups as well as advising on program rollout and continued enrollment. In RY2, ERS continued to provide program design and implementation support ahead of RY3 and participated in discussions regarding a potential program extension into RY4.

4.1.2 Off-Peak Charging Rebate Pilot Participant Survey Results

This section contains the results of the Off-Peak Charging Rebate Pilot (SCRI) participant survey. ERS attempted to survey a census of SCRI participants across both the control and

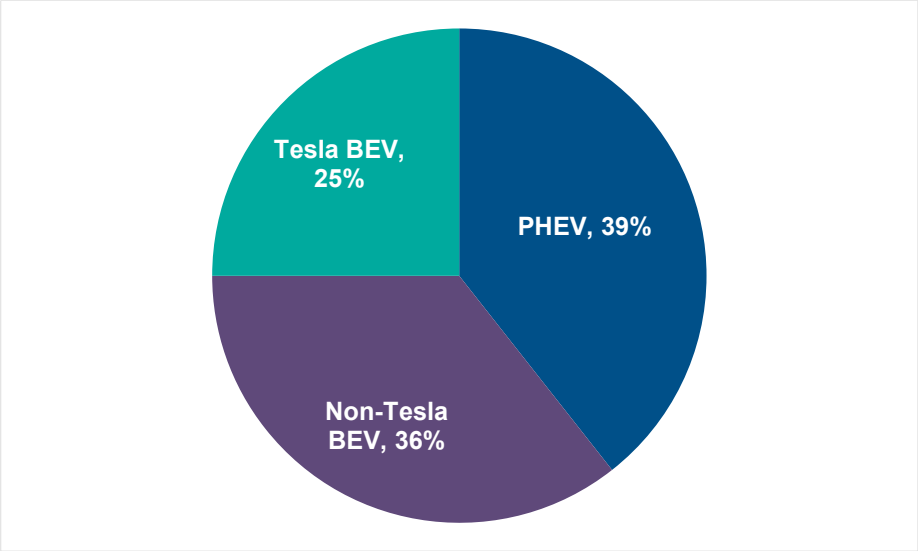
treatment groups. The survey was open from August 17 through September 8, 2020. Survey respondents were directed to answer questions based on their pre-COVID 19 charging and driving behavior; at the end of the survey they were asked a series of open-ended questions about COVID-19 impacts on their current and anticipated future driving and charging behavior.

Survey Respondent Summary and Demographics

A total of 123 SCRI participants completed the survey, out of a population of 354 SCRI total participants (35% response rate). An overwhelming number of survey participants are homeowners (95%) as opposed to renters. Participants primarily live in detached single-family homes (93%) and have a private driveway or garage in which to park their vehicle (96%). Among the survey participants, 39% indicated that solar panels are installed at their residence.

There is an approximate even split in number of respondents in the control (47%) and treatment groups (53%). This is representative of the entire participant population, which is comprised of 50% control group and 50% treatment group participants. Among the 123 participants who responded to the survey, an overwhelming majority of participants indicated owning a single EV (93%) as opposed to multiple EVs (7%). The most common vehicle type among participants was PHEV, followed by Non-Tesla BEV and then Tesla BEV (see Figure 4-1).

Figure 4-1. Distribution of Vehicle Types Among Owners (n=123)



EV Charging at Home

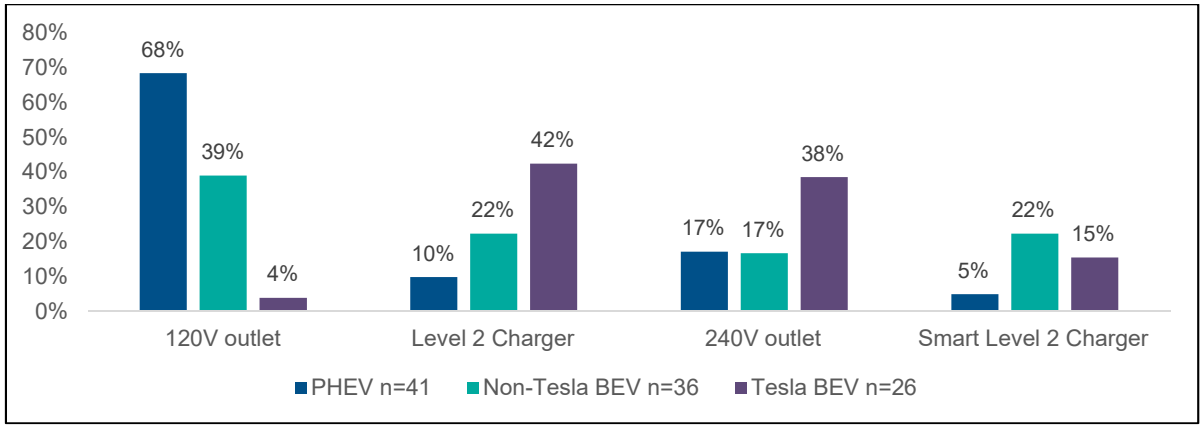
A large portion of the survey participants (94%) have access to EV charging at home. The majority of participants (58%) use a higher-powered charger (i.e., Level 2 or 240 V outlet charger) to charge at home as opposed to a 120 V outlet to charge their vehicles; the distribution of home charging equipment across control and treatment groups is included in Table 4-1 and

the distribution by vehicle type is shown in Figure 4-2. There are no significant differences detected in charger types at participant homes between the control and treatment groups. Similarly, both control (73%) and treatment (74%) group participants indicated that approximately three quarters of all their charging occurs at home as opposed to away from home. The majority of participants (59%) use a home vehicle charger manufactured by their car manufacturer, including Tesla vehicles and chargers.

Table 4-1. Distribution of Charger Types Among Participant Groups

Charger Type	Control n=49	Treatment n=54
I plug my EV/PHEV into a 120 V outlet ("standard" wall socket)	43%	41%
I have a Level 2 charger installed in my home	22%	22%
I plug my EV/PHEV into a 240 V outlet ("dryer" socket)	22%	22%
I have a smart Level 2 charger installed in my home (has the ability to connect to Wi-Fi and allows the owner to monitor their charging)	12%	15%

Figure 4-2. Distribution of Charger Types Among Vehicle Groups†



† ERS compared responses between the three vehicle groups using a Chi Square Test and found a statistically significant difference (p-value < 0.05) in the distribution of responses between the three groups. We did not include respondents with multiple EVs in this analysis, as they could not be classified into one of the vehicle groups.

Table 4-2 shows the participants' reported typical charging start times. Participants in the treatment group reported a significant increase in charging during the overnight hours from 9 p.m. to 8 a.m. compared to the control group. Additionally, participants in the control group indicated that they are significantly more likely to vary their charging times day to day.

Table 4-2. Distribution of Participants Charging Times at Home†

Charging Start Times	Control n=55	Treatment n=66
Morning (8 a.m. – 1 p.m.)	2%	2%
Afternoon (1 p.m. – 5 p.m.)	0%	2%
Evening (5 p.m. – 9 p.m.)	29%	21%
Night (9 p.m. – 8 a.m.)	35%	69%
When I start charging varies from day to day	35%	7%

† ERS compared responses between the two groups using a Chi Square Test and found a statistically significant difference (p-value < 0.05) in the distribution of responses between the two groups.

When participants were asked for reasons and motivations why they charge at their indicated times at home, the control group participants stated they are significantly more likely to not consider the time of day when they charge and plug the vehicle when they arrive home. The treatment group was significantly more likely to indicate reduced charging costs as a reason to charge at their indicated times. It is worth noting that the primary reason reported by treatment group participants for charging at their indicated times was because they perceived it is better for the environment or grid. The same motivation to charge when it is better for the environment or grid was echoed in the control group as the second highest response.

Table 4-3. Reasons Participants Start Charging at Their Selected Times†

Reason	Control n=55	Treatment n=61
It is better for the environment or the electric grid	22%	36%
I just plug my vehicle in when I get home and don't think about the time of day	51%	20%
It is less expensive	2%	23%
It is convenient for my schedule	22%	13%
To coincide with Smart Charge Program hours or incentive	0%	7%
Other	4%	2%

† ERS compared responses between the two groups using a Chi Square Test and found a statistically significant difference (p-value < 0.05) in the distribution of responses between the two groups.

Managed or Scheduled Charging

The survey asked participants about their awareness and use of tools and technologies to manage and/or schedule their EV charging. Most of the control (71%) and treatment (62%) groups were aware of a feature or tool that they can use to control charging. There were not statistical differences detected between the two groups on their awareness. Looking at participant awareness of control features by vehicle type, a majority of each of the three vehicle

group types were aware of a feature/tool to control charging. No statistical difference was detected between the three vehicle group types on their awareness; however, after combining both Non-Tesla and Tesla BEVs into one category, there is a statistically significant difference detected on the BEV owners' awareness of control charging features compared to PHEVs.

Table 4-4. Participant Awareness of Control Features for Charging

Awareness	Control n=58	Treatment n=65
Yes	71%	62%
No	28%	35%
N/A – I do not have a home charger	2%	3%

Table 4-5. Participant Awareness of Control Features for Charging by Vehicle Type†

Awareness	PHEV n=45	Non-Tesla BEV n=39	Tesla BEV n=27	Total BEV (Non-Tesla + Tesla BEV) n=66
Yes	58%	72%	81%	76%
No	42%	28%	19%	24%

† ERS compared responses between the two vehicle groups (PHEV and Total BEV) using a Chi Square Test and found a statistically significant difference (p-value < 0.05) between the distribution of responses between the two vehicle groups. When the team compared responses across three vehicle groups (PHEV, Non-Tesla BEV, and Tesla BEV) no statistically significant difference was detected. We did not include respondents with multiple EVs in this analysis as they could not be classified into one of the vehicle groups.

The majority of participants who manage charging do so remotely through a phone or web app provided by their car manufacturer or charging station. There were not statistical differences detected between the control and treatment groups on the applications used to manage charging. Participants with Tesla BEVs were significantly more likely than the PHEV or Non-Tesla BEV groups to manage their charging using a phone or web app provided by their car manufacturer. Participants in the PHEV and Non-Tesla BEV groups were more likely to manage their charging through a phone or web app from the charging station manufacturer. Participants with PHEVs were also more likely to use the scheduler in their vehicle to control charging compared to the other two vehicle groups.

Table 4-6. Applications that Participants Use to Manage Charging (Multiple response)

Application Type	Control n=30	Treatment n=36
Phone or web app provided by car manufacturer	80%	67%
Phone or web app provided by charging station manufacturer	20%	25%
Scheduler on vehicle	10%	19%
Third-party tool, app, or software	10%	3%

Table 4-7: Applications that Participants Use to Manage Charging by Vehicle Type (Multiple response)

Application Type	PHEV n=18	Non-Tesla BEV n=22	Tesla BEV n=22
Phone or web app provided by car manufacturer†	56%	64%	95%
Phone or web app provided by charging station manufacturer†	33%	36%	5%
Scheduler on vehicle†	39%	5%	5%
Third-party tool, app, or software	6%	9%	5%

† ERS ran a Chi Square Test for each response across the three vehicle groups. Responses denoted with an asterisk indicate a statistically significant difference (p-value < 0.05) in the distribution of responses between the three vehicle groups was found. We did not include respondents with multiple EVs from this figure as they could not be classified into one of the vehicle groups.

Participants reported three main behaviors regarding the frequency at which they override their charging schedule. The first group is aware of a scheduling capability but they do not use it, the second group sets their charging schedule once and does not override the schedule, and the third group overrides their schedule on a recurring basis, ranging from daily to monthly to less frequent overrides. Overall, a majority of both control and treatment group participants who use scheduling features rarely or never override their schedule. There was no statistical difference detected between how frequent the two groups override their schedule

Table 4-8. Frequency at Which Participants Override Their Charging Schedule

Frequency	Control n=37	Treatment n=39
I am aware of, but do not use, any scheduling features	59%	28%
I scheduled my charging once and do not override it	14%	31%
I override the schedule monthly	8%	21%
I override the schedule weekly	11%	10%
I override the schedule less frequently than every month	8%	5%
I override the schedule daily	0%	3%
Other	0%	3%

The survey asked those participants who reported awareness of scheduling tools about the most influential factor that motivates them to control charging. Table 4-9 presents these results; the primary factors included the ability to control charging remotely, the environmental impact of charging, smart charging features, and the cost of charging.

Table 4-9. Most Influential Factor when Controlling Charging

Factor	Control n=17	Treatment n=29
Ability to control my charging remotely (e.g., using a phone app)	35%	17%
Environmental impact	24%	24%
Smart charging features (e.g., the charger automatically manages charging to ensure a full battery by a certain time)	29%	21%
Cost of charging†	N/A	34%
Other	12%	0%
I don't expect that I would use these features if they were available to me	0%	3%

† The "cost of charging" option was only shown to the treatment group.

EV Charging Away from Home

The survey also asked participants about their charging habits away from home. Participants who charge away from home most frequently charge their vehicles at retail locations, their workplace, and in municipal parking lots. Among the locations listed, participants indicated they spend the most time charging at their workplace .

Table 4-10. Frequent Charging Locations Away from Home (Multiple response)

Location	Proportion n=83
Retail location (including restaurants, convenience stores, pharmacies, malls)	43%
Your workplace	36%
The municipal or government parking (e.g., town hall, library, or municipal parking lot)	31%
The travel plaza or highway rest stop	22%
The park or recreation area	22%
Paid public parking (e.g., garage or surface lot)	19%
The school, college, or university	16%
The car dealership	14%
The hotel	14%
The grocery store	14%
The airport	12%
The hospital or healthcare facility	12%
Tesla supercharger stations	12%
Street parking	4%
The community center	1%
Train station	1%
Movie theater	1%
Parking lot	1%
Other	2%

Among participants who charge at stations away from their residence, 48% indicated that the away charger they typically use is a Level 2 charger, while 19% reported typically using DCFC charging stations. The majority of away charging participants (67%) indicated that they do not pay for charging when away from home. If the away station did not offer complimentary charging, the most common method was to pay per kWh charged (27%) compared to pay per hour of charge or a recurring subscription fee.

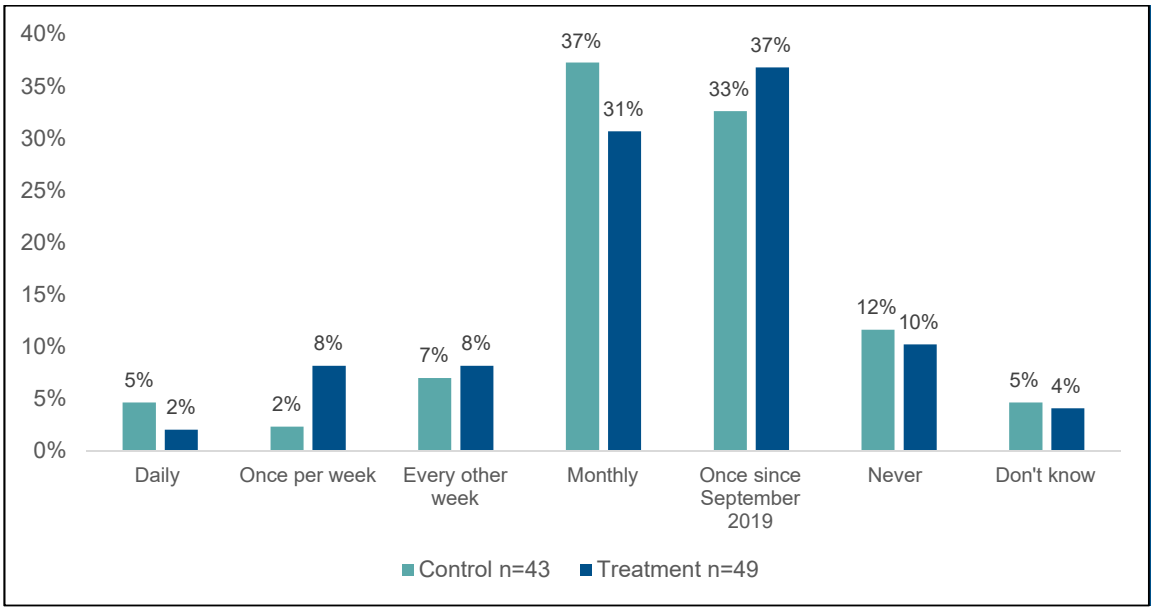
Away charging participants were asked at what times of day they charge at their away stations. These participants most commonly indicated that their away charging varies day to day (32%) followed by charging in the morning hours of 8 a.m. to 1 p.m. (28%); this aligns with the participants' indication that they conduct the highest percentage of charging at workplace and retail locations.

Geotab Dashboard

The majority of the control group (74%) and treatment group (75%) survey participants were aware of the Geotab Dashboard.

Among participants aware of a dashboard, the participants' usage pattern can be divided into two behavior groups over the six-month period between September 2019 and February 2020 (prior to COVID-19). The first group checks and uses the dashboard on a recurring basis, whether daily, weekly, or monthly. The second group either has never used the dashboard or logged in once over six months. These two behavior groups are approximately evenly split as a portion of the population. Note that there were no statistical differences in dashboard engagement between the control and treatment group participants. Treatment group participants also receive monthly emails about their rewards; this may affect dashboard engagement. This data is presented in Figure 4-3, below.

Figure 4-3. How Often Participants Used Dashboard between September 2019 and February 2020



Common themes and reasons why participants are not using the dashboard on a recurring basis included the following survey answers: participants felt that the dashboard does not provide useful or actionable information, the dashboard is unnecessary and inconvenient to access, and that the information provided on the dashboard does not affect their usage of the vehicle. Another respondent suggested emailing a link every week to participants to encourage more frequent dashboard usage.

For participants who have logged into the dashboard, the primary reasons for doing so are to understand how much their vehicle is charging, their environmental impact of charging in GHG emissions, and to review trip logs.

Table 4-11. Reasons Participants Are Using the Dashboard (Multiple response)

Choice	Control n=43	Treatment n=49
To understand how much I am charging my EV/PHEV	35%	61%
To learn about my environmental impact (GHG emissions)	30%	31%
To view my trip log	35%	20%
To understand when I am charging my EV/PHEV	23%	22%
To understand the battery state of health	16%	29%
To view the amount of incentive I have earned†	N/A	47%

Choice	Control n=43	Treatment n=49
Don't know	9%	12%
None	7%	4%
Efficiency metrics	5%	2%
Curiosity / See what it offers	5%	0%
Download data for further analysis	2%	0%
Other	7%	0%

† The "To view the amount of incentive I have earned" option was only available to treatment group participants.

Program Satisfaction

Participants were asked to rate their overall program experience on a scale of 0 (not at all satisfied) to 10 (extremely satisfied). Treatment group participants significantly rated their overall program experience higher than the control group, as shown in Table 4-12. One participant of the treatment group indicated that, although there are no off-peak charging rates yet, the program's incentives help drive their charging at low demand hours. Some control group participants indicated that they feel they are providing a lot of data to the program with insufficient benefit.

Table 4-12. Program Satisfaction Mean Ratings and Influence Ratings of Rebates

Category	Group	n	Mean Rating
Overall program experience	Control	50	6.8†
	Treatment	62	8.7†
Influence of rebate to charge during off-peak hours	Control	Not asked	Not asked
	Treatment	61	7.2

† ERS compared responses between the two groups using a t-test. An asterisk denotes statistically significant difference (p-value < 0.05) in responses between the two groups.

Treatment group participants were asked to rate the influence of the rebate to charge during off-peak hours on a scale of 0 (not at all influential) to 10 (extremely influential). The mean rating was 7.2. For participants who indicated a low rebate influence, common themes reported included drivers seeing themselves as environmentally cautious and concerned with the grid and the low incentive level provided by the program. Some participants suggested that more education explaining the benefit of charging off peak would help motivate them.

COVID-19 Impacts

The survey asked participants about how their driving and charging behavior has changed due to COVID-19 and their anticipated future behavior. The majority of participants reported driving and charging their vehicles less than they did before COVID-19, as shown in Table 4-13.

Table 4-13. Impact of COVID-19 on Participants' Driving and Charging Behavior

COVID-19 Impact	n	Choice	Proportion
On Driving Behavior	123	I am driving less	74%
		I am driving the same amount	24%
		I am driving more	2%
On Charging Behavior	122	I am charging my EV/PHEV(s) less.	66%
		I am charging my EV/PHEV(s) the same amount.	32%
		I am charging my EV/PHEV(s) more.	2%

Looking into their future anticipated driving behavior, participants indicated a lot of uncertainty regarding whether they will drive more, the same, or less. We see the same uncertainty play out in participant's future charging behavior. Some respondents indicated that they expect less driving if they are allowed to continue to work from home. Other respondents noted that they have returned to working away from home and don't anticipate any changes. Among respondents who anticipate driving more, one common expectation is that they will be taking more road trips in the future.

Table 4-14. Impact of COVID-19 to Participants' Future Driving and Charging Behavior

Future Behavior	n	Choice	Proportion
On Driving	122	I anticipate driving my EV/PHEV(s) the same	46%
		I anticipate driving my EV/PHEV(s) less	27%
		I anticipate driving my EV/PHEV(s) more	23%
		Don't know	4%
On Charging	119	I anticipate charging my EV/PHEV(s) the same	51%
		I anticipate charging my EV/PHEV(s) less	20%
		I anticipate charging my EV/PHEV(s) more	23%
		Don't know	6%

4.1.3 Off-Peak Charging Rebate Pilot Data Analysis

This section presents the results of the Off-Peak Charging Rebate Pilot analyses, which includes program summary statistics, charging load profile analysis, and statistical regression results.

Program Statistics

ERS analyzed the overall program charging activity recorded during RY2, summarized in Table 4-15, below. The vehicle strata presented in this analysis reflect the allocation of participating vehicles into the control and treatment groups as individuals enrolled in the program. Tesla BEVs are defined as any Tesla vehicle – Model S, Model 3, or Model X – while non-Tesla BEVs are defined as any non-Tesla all-electric vehicle. This distinction was made for this study to capture the fact that Tesla has the highest market share among EV manufacturers and its vehicles have access to its proprietary Supercharger network of DC fast chargers. PHEVs are those that have both an electric battery and an internal combustion engine.

Table 4-15. RY2 Program Summary Statistics

		Vehicle Count*		kWh Charged**		Charge Sessions‡	
Group	Vehicle Stratum	Total	Percent of Group	Overall	Per Vehicle	Overall	Per Vehicle
Control	PHEV	79	44%	107,842	1,365	27,498	348
	Non-Tesla BEV	56	31%	113,592	2,028	11,490	205
	Tesla BEV	43	24%	163,426	3,801	19,567	455
Total	**All**	**178**	**100%**	**384,860**	**2,162**	**58,555**	**329**
Treatment	PHEV	67	38%	84,148	1,256	21,043	314
	Non-Tesla BEV	62	35%	116,338	1,876	14,088	227
	Tesla BEV	47	27%	187,681	3,993	15,256	325
Total	**All**	**176**	**100%**	**388,168**	**2,205**	**50,387**	**286**
Overall Total		**354**		**773,027**	**2,184**	**108,942**	**308**

* ERS ran a Chi Square Test to test the equivalency of the control and treatment groups. With a p-value of 0.482, the test indicates there is no statistically significant difference in the groups' composition.

** ERS ran an independent samples t-test to assess the statistical significance of differences in the amount of kWh charged per vehicle. Across all vehicle types, the differences observed between the control and treatment group were not found to be statistically significant, which indicates that the drivers in each group behave similarly in terms of the overall volume of charging they do (though, as will be discussed later, the timing of that charging differs significantly between the two groups).

‡ ERS ran an independent samples t-test to assess the statistical significance of differences in the number of charge sessions per vehicle. Across all vehicle types, the differences observed between the control and treatment group were not found to be statistically significant, which indicates that the drivers in each group behave similarly in terms of how often they plug in (though, as will be discussed later, the timing of those charging sessions differs significantly between the two groups).

Several observations can be drawn by examining the high-level program charging data.

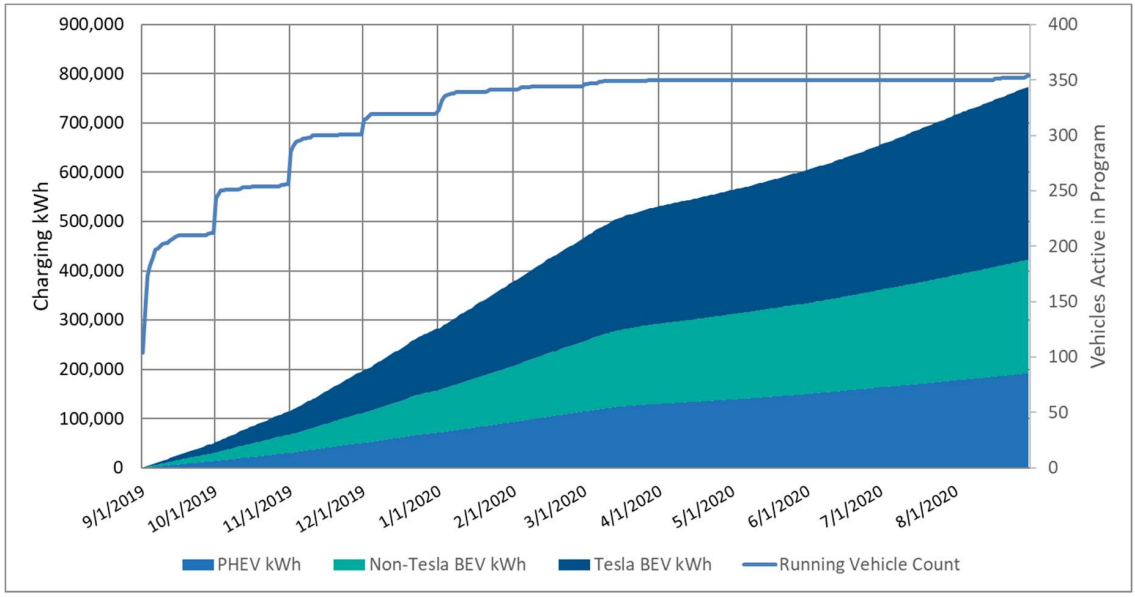
- Charging volume and frequency reflect differences in vehicle strata composition.
  - Across vehicle types, PHEVs recorded the most charging sessions and charged the least kWh across both groups, suggesting that these vehicles need to charge more frequently as a result of their small battery size (kWh).

  - Tesla BEV drivers charged the most kWh of any vehicle type across both groups, a result of their larger battery sizes and likely use of their EV as their primary vehicle.
  - In both groups, non-Tesla BEVs fell between the other two types in terms of kWh charged, reflecting the broad range of vehicles, battery sizes, and technologies in this group.
- The overall amount of charging (kWh) is statistically equivalent between the control and treatment groups when normalized by the count of vehicles in each group; the control group charged 2,162 kWh/vehicle and the treatment group charged 2,205 kWh/vehicle (a delta of just under 2%). This observation is consistent with the program goal of shifting when charging occurs, rather than the amount of charging taking place.

The off-peak charging rebate resulted in a shift of 49,848 kWh away from the on-peak period. By vehicle type, 12,419 kWh were shifted away from the on-peak period for PHEVs, 12,582 kWh were shifted for Non-Tesla BEVs, and 24,847 kWh were shifted for Tesla BEVs. Over the course of RY2, $12,865 in off-peak charging rebates were earned by the treatment group, based on a total of 199,256 kWh charged off-peak during non-summer months and 81,576 kWh charged off-peak during the summer months.

Figure 4-4, below, provides another view of the program activity over the course of RY2; it highlights the simultaneous growth of the charging load and the number of assigned program participants. Note that, because group assignments were conducted monthly, the participant count does not increase smoothly. Note also that the growth rate of the aggregate charging load slowed significantly in mid-March 2020 as the COVID-19 pandemic emerged. We will discuss more granular program trends, including COVID-19 impacts, in the next subsection.

Figure 4-4. Charging Activity and Enrollment Throughout RY2



Granular Trend Analysis and COVID-19 Impacts

In addition to calculating high-level program statistics, ERS developed higher resolution statistics to evaluate time-varying EV charging behavior, including seasonal and COVID-19 impacts. COVID-19 introduced an unanticipated variable into the equation for this analysis and makes it difficult to detect seasonal trends.

For this analysis, we treated March 2020 as the first month in which COVID-19 effects could be observed. In Rhode Island, the first confirmed positive cases were identified on March 1; a state of emergency was declared on March 9[15]; and crowds of 25 or more were banned starting on March 17. A stay-at-home order was enacted on March 28 and lifted on May 9. Rhode Island entered Phase 1 of reopening on May 9, Phase 2 on June 1, and Phase 3 on June 30. The fourth phase was delayed on July 29 following an uptick in COVID-19 cases, indicating that the state has not yet "returned to normal" at the time of writing and suggesting that lingering effects on charging behavior will be observable into RY3. Since the full impacts of COVID-19 took effect mid-March, it should be noted that part of that month represents "normal" charging behavior, before State efforts directly impacted people's daily lives and driving patterns. The full impacts emerge in April 2020 and continue to reverberate until the end of RY2.

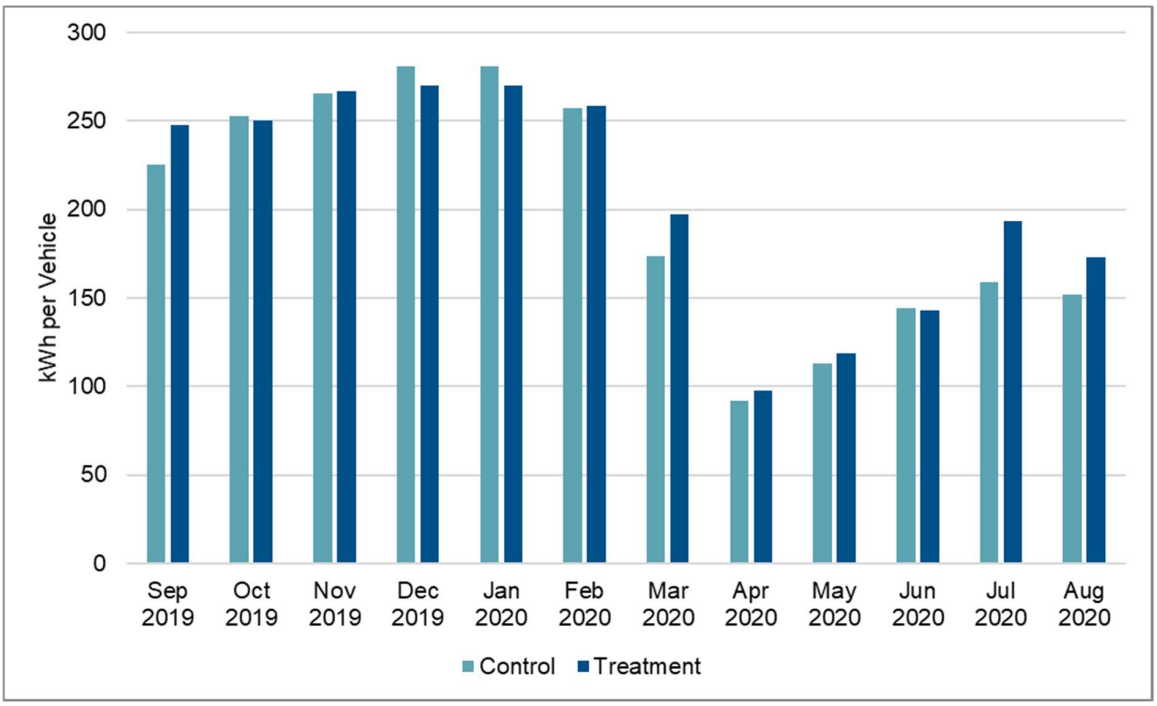
We hypothesized that overall charging activity would fall initially due to the pandemic before increasing again, as social distancing measures, bans or limitations on group gatherings, and

[15] Andrade, K. "Rhode Island Governor Declares State of Emergency as Coronavirus Concerns Intensify." WGBH, March 9, 2020. https://www.wgbh.org/news/local-news/2020/03/09/ri-governor-declares-state-of-emergency.

disrupted school and work schedules led to reduced demand for travel and changes in many EV drivers' business-as-usual charging behavior. Analysis of month-over-month data (Figure 4-5, below) shows a 63% decline in per-vehicle charging load in April relative to February, highlighting how deeply travel and charging demand were impacted. (March, which was partially impacted by COVID-19, showed a 28% reduction in per-vehicle charging load relative to February.) Charging then increased, relative to April, each month from May to July before falling again slightly in August; this suggests that participants are resuming some, but not all, of their pre-COVID activities. Even now, 6 months removed from the initial emergence of COVID-19, the average per-vehicle charging load is 37% lower than it was in January and February 2020. All of the above comparisons of the average monthly per-vehicle charging load (kWh) were found to be statistically significant (p-value < 0.05); in each case, data from a post-COVID-19 month was compared to February 2020 (pre-COVID-19).

This analysis validates the hypothesis that the COVID-19 pandemic had a significant impact on the overall amount of charging (kWh), particularly in March, April, and May. As seen in the data from April through August 2020, charging activity has not yet returned to pre-pandemic levels; as such, the full impacts on charging behavior cannot be assessed until data through the end of RY3 is available.

Figure 4-5. Monthly kWh Per Vehicle – RY2



Though it is not possible to identify seasonal trends in charging behavior across all of RY2, the data recorded from September 2019 through February 2020 is available for this analysis. As temperatures dropped in winter 2019-2020, we hypothesized that the overall observed charging load (kWh) would increase due to greater energy requirements for both interior air conditioning (heating) and maintaining battery health. The figure above shows that the per-vehicle monthly charging load increased steadily from September 2019 through January 2020 before falling slightly in February; the normalized load was 10% higher in the winter (November 2019–February 2020) than in the fall (September and October 2019). No summer load trends can be discerned due to COVID-19. In RY3, ERS will seek to evaluate similar trends if possible.

ERS also assessed participant charging behavior across days of the week to determine how much EV charging varied throughout the week. The results are shown in Table 4-16, which shows the percent of an average EV's weekly charging load that occurs on each weekday by month; this analysis is based on data from all vehicles, regardless of group (treatment vs. control) or vehicle type. Days with darker shading represent a higher proportion of weekly charging than unshaded days.

Table 4-16. Percent Weekly Per-Vehicle Charging Energy by Month and Weekday – RY2

Month	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Sep 2019	13%	15%	14%	15%	15%	15%	13%
Oct 2019	13%	14%	14%	14%	16%	15%	14%
Nov 2019	14%	15%	15%	15%	14%	13%	14%
Dec 2019	13%	13%	14%	16%	17%	15%	13%
Jan 2020	13%	15%	13%	16%	17%	15%	12%
Feb 2020	12%	14%	14%	16%	16%	15%	12%
Mar 2020	13%	13%	15%	16%	15%	14%	13%
Apr 2020	13%	15%	14%	14%	15%	16%	14%
May 2020	12%	13%	14%	15%	15%	17%	15%
Jun 2020	12%	15%	15%	14%	16%	16%	13%
Jul 2020	14%	15%	15%	14%	14%	14%	14%
Aug 2020	14%	14%	14%	15%	16%	14%	14%

As evidenced in the table above, the charging load across weekdays is relatively consistent month-to-month, though there are several identifiable trends. The proportion of charging tends to peak between Thursday, Friday, and Saturday before dropping off significantly on Sunday and Monday; this trend is generally observable across all months of the year. The portion of charging occurring between Tuesday and Saturday is most consistent in September, June, and July, suggesting that summer schedules drive changes in travel and charging patterns relative to the rest of the year. Because participants' schedules have been altered significantly in RY2, it

may not be possible to draw concrete conclusions from this analysis until more data is available in RY3.

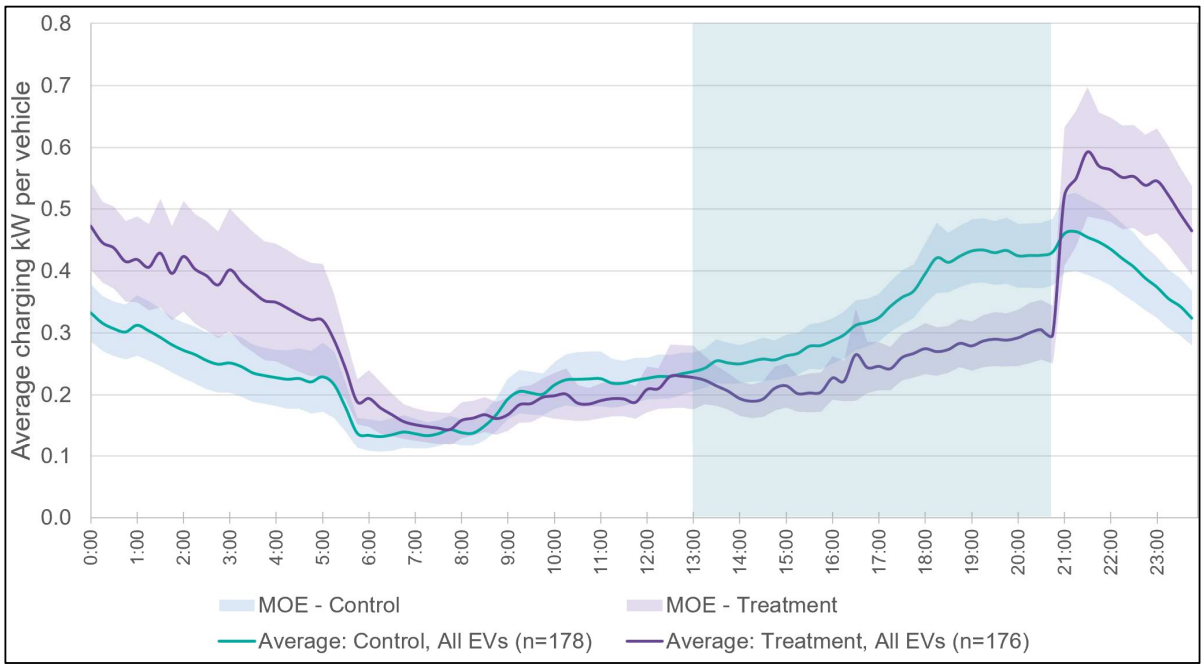
Charging Load Profile Analysis

ERS developed 24-hour charging load profiles with 15-minute resolution for the control and treatment groups using the following method:

- For each vehicle included in the analysis, we calculated a full charging load profile (kW) spanning the vehicle's group assignment date through the end of RY2; for participants who withdrew or vehicles that were swapped out mid-RY2, the last day they provided data was used as their endpoint. This approach considers periods during which data was not available because the vehicle was not charging (as having 0 kW of charging load) and ensures that the average load profile is not diluted for vehicles that were assigned to a group after the RY2 start date of September 1, 2019.
- We then calculated an average hourly charging load profile (kW) for each vehicle, weighting every hour and day in the analysis period equally.
- We constructed average charging load profiles by vehicle type and group, weighting every vehicle equally, to identify differences in charging behavior driven by the availability of the off-peak pricing signal as well as vehicle type.

Figure 4-6 shows a comparison between the control and treatment group load profiles across all vehicle types, including the margin of error (MOE) at the 90% confidence level. Note that the shaded box in the following figures represents the on-peak window of 1:00 p.m. to 9:00 p.m., ending slightly before the 9:00 p.m. interval to indicate that charging occurring at and after 9:00 p.m. is classified as off-peak.

Figure 4-6. Charging Load Profile Comparing Control and Treatment – All



Figures 4-7 through 4-9 show comparisons between the control and treatment group load profiles broken out by vehicle type. In each figure, the shaded box represents the on-peak window of 1:00 p.m. to 9:00 p.m., ending slightly before the 9:00 p.m. interval to indicate that charging occurring at and after 9:00 p.m. is classified as off-peak. The shaded bars in these figures also represent the margin of error (MOE) at the 90% confidence level.

Figure 4-7. Charging Load Profile Comparing Control and Treatment – Tesla BEV

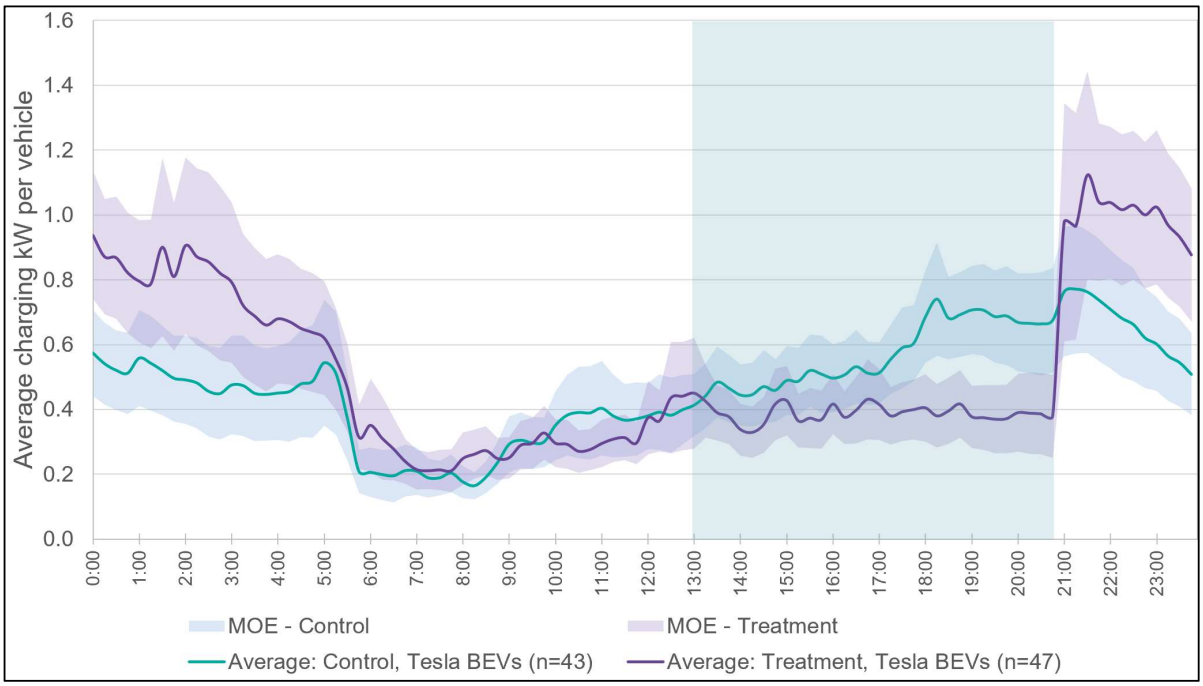


Figure 4-8. Charging Load Profile Comparing Control and Treatment – Non-Tesla BEV

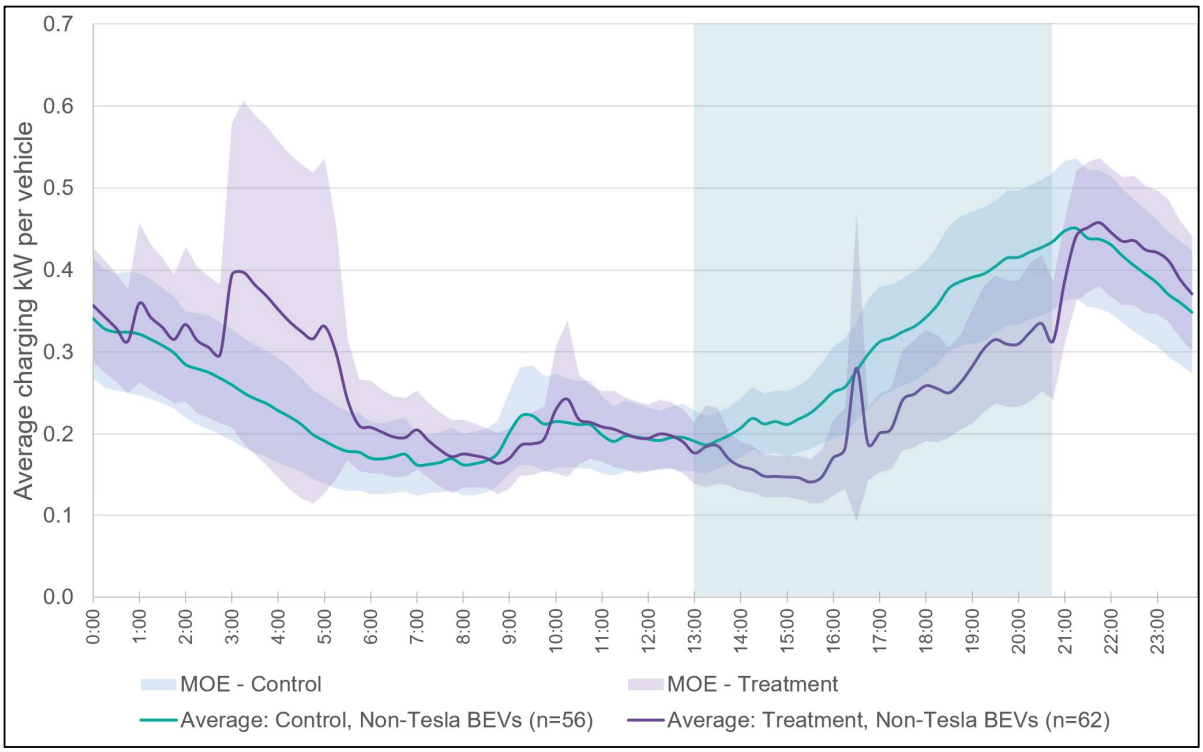
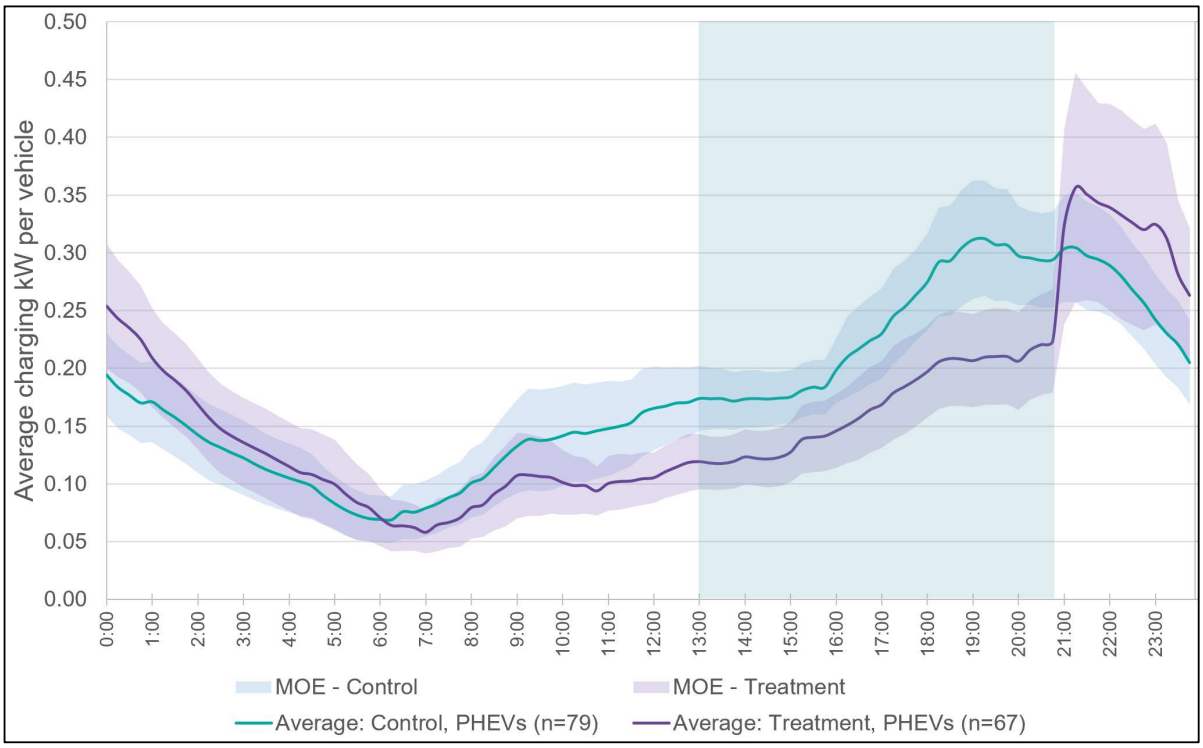


Figure 4-9. Charging Load Profile Comparing Control and Treatment – PHEV



In each of the figures above, there is a visible difference between the control and treatment group load profiles. For each vehicle type, the control group's charging ramps up slowly throughout the day, starting around 1:00 p.m. and peaking roughly between the hours of 6:00 p.m. and 9:00 p.m., after which it declines rapidly. As more vehicles reach a full charge around 9:00 p.m. and the following morning, the charging load bottoms out between approximately 6:00 and 8:30 a.m., when EV drivers likely leave for work. There is a slight uptick in charging load for both the control and treatment groups starting around 9:00 a.m., suggesting that some drivers have access to workplace charging; survey respondents reported that away from home, they charge at their workplaces the most.

In these load profiles, differences can be observed in the treatment group's response to the off-peak pricing signal, with notable variations by vehicle type. In all of the descriptions below, the average demand reduction is calculated by taking the average of the difference in per-vehicle charging load between the control and treatment groups over the hours in question. These differences are highlighted below:

- PHEVs in the treatment group charge less on-peak than their control group counterparts. Their charging ramps up between 1 p.m. and 6 p.m. and plateaus until 9 p.m. The average power draw increases by nearly 60%, from 0.21 kW to 0.34 kW, from the 8 p.m. hour to the 9 p.m. hour. The power draw then tapers off consistently until about 7 a.m. the next day.

The average demand reduction over the entire peak is .068 kW/vehicle; over the 5 p.m. – 9 p.m. window, it is 0.083 kW/vehicle.

- There is a persistent amount of on-peak charging. It does appear that commuters may have responded to the off-peak price signal, since the ramp-up in charging begins around the time commuters would typically get home and plug in.

- Non-Tesla BEVs in the treatment group also charge less on-peak than their control group counterparts. Their charging ramps up consistently between 4 p.m. and 9 p.m. before spiking from 0.32 to 0.44 kW/vehicle between the 8 p.m. and 9 p.m. hours (a 35% increase). Unlike the treatment group PHEVs, the power draw does not taper off smoothly overnight, as it appears that one or more drivers have programmed their charger to power on at 3 a.m. during the week. The average demand reduction over the entire peak is .078 kW/vehicle; over the 5 p.m. – 9 p.m. window, it is 0.102 kW/vehicle.
  - Similar to the treatment group PHEVs, a certain amount of on-peak charging persists for this group.
- Tesla BEVs in the treatment group charge less on-peak than their control group counterparts. Unlike PHEVs and Non-Tesla BEVs, they exhibit nearly constant charging throughout the entire peak period, with no observable mid-peak ramp. Between the 8 p.m. hour (on-peak) and 9 p.m. hour (off-peak), the Tesla BEVs' per-vehicle charging load increases from 0.39 kW/vehicle to 1.03 kW/vehicle, a roughly 265% increase in load that eclipses the control group's 9 p.m. load of 0.76 kW/vehicle by 35%. Following this nighttime peak, the charging load tapers off consistently overnight. The average demand reduction over the entire peak is .179 kW/vehicle; over the 5 p.m. – 9 p.m. window, it is 0.269 kW/vehicle.
  - It is worth noting that, like the other vehicle types, there is a consistent portion of on-peak Tesla BEV charging that remains on-peak. While this "stubborn" load does not ramp up during the peak period, it represents, at an average of 0.39 kW, a higher load than the 9 p.m. PHEV peak and is just shy of the 9 p.m. Non-Tesla BEV peak.

Table 4-17 shows the average demand reduction by vehicle type across the entire peak period (1 p.m.– 9 p.m.) as well as the second half of the peak (5 p.m.–9 p.m.); also included is the size of the demand reduction over the given hours relative to the control group's average charging demand over the same hours (akin to a percent demand reduction).

Table 4-17. Average Demand (kW) Reduction per Vehicle by Vehicle Type – RY2

Vehicle Type	Peak Period Demand (kW/vehicle) Reduction (1 - 9 p.m.)	Peak Period Demand Reduction Relative to Control Group Load	Average Demand (kW/vehicle) Reduction (5 - 9 p.m.)	Demand Reduction Relative to Control Group Load
PHEV	0.068	28.7%	0.083	29.1%
Non-Tesla BEV	0.078	25.8%	0.102	26.9%
Tesla BEV	0.179	31.6%	0.269	40.9%

ERS conducted a series of tests to determine the statistical significance of the above tables. For both PHEVs and Tesla BEVs, the difference between the average control group peak period demand and the average treatment group peak period demand **was** statistically significant (p-value < 0.05) over both the 1 p.m.–9 p.m. window and the 5 p.m.–9 p.m. window. The difference for Non-Tesla BEVs was not found to be statistically significant (p-value > 0.05 for both peak windows).

Overall, this data clearly indicates the following:

- Treatment group participants are delaying charging as a result of the off-peak price signal, with Tesla BEV vehicles exhibiting a particularly strong response and ability to manage charging.
- Both the charging behavior and the magnitude of charging load vary widely across vehicle types in both groups.
- For all vehicle types, there is a persistent amount of on-peak charging that has not been shifted off-peak, including in the treatment group. This may be workplace or away charging, though it may also come from participants who misunderstood the program or are not motivated by the off-peak price signal as currently designed.

It is promising to see the off-peak price signal shift behavior in this way, as it shows that EV drivers as a population are receptive to altering their behavior if provided with the right incentives to do so. There is, however, a risk to designing an off-peak pricing signal that incentivizes all EV drivers to act in tandem. Since many drivers have opted to schedule their charging for 9 p.m. or just after, there is a risk of creating a new peak after 9 p.m. as a large amount of EV charging load hits the grid simultaneously. In a future high-EV adoption scenario, this concentration of new load could create grid reliability concerns, particularly on networks or feeders with a high concentration of long-range EVs. We expect that a similar effect would be observed with customers on EV or whole-house time-of-use rates; the effect could potentially be mitigated by staggering several off-peak windows starting between 9:00 p.m. and midnight, for example, to avoid concentrating all EV charging load at a single hour.

Statistical Regression Results

ERS developed two linear regression models[16] to test the effect of several independent variables on two separate dependent variables representing off-peak charging performance: 1) the per-vehicle monthly percentage of kWh charged off-peak (y_{kWh}, charging load approach), and 2) the per-vehicle monthly percentage of charging sessions initiated off-peak (y_{start}, session start time approach). Both metrics provide valuable insight into how Rhode Island EV drivers charge their vehicles.

- The charging load approach reflects the program design of rewarding drivers who shift charging off-peak; however, the timing of when a vehicle consumes kWh is a function of several factors, including the plug-in time, the state of charge at plug-in, the battery size, and the level of the charger.
- The session start time approach focuses on the behavior behind initiating a charging session and more directly captures how participants have internalized the intent of the off-peak charging rebate.

For each model, ERS iteratively introduced variables to determine the impact they had on the estimator values, the statistical significance of each estimator, and the goodness of fit of each model. The final results for each model are presented below, along with high-level statistics on the off-peak performance observed during this analysis period.

Charging Load (kWh) Approach Model

The final model developed for estimating the percentage of kWh charged off-peak takes the following form:

$$y = \beta_0 + \beta_1 T + \beta_2 S + \beta_3 L + \beta_4 (S \times T) + \beta_5 (L \times T) + \beta_6 (Oct) + \beta_7 (Nov) + \beta_8 (Dec) + \beta_9 (Jan) + \beta_{10} (Feb) + \beta_{11} (Mar) + \beta_{12} (Apr) + \beta_{13} (May) + \beta_{14} (Jun) + \beta_{15} (Jul) + \beta_{16} (Aug) + \beta_{17} \mathrm{K}$$

where the variable meanings and properties are provided in Table 3-3 (Independent Variables Summary) in Section 3, and the coefficient values and statistical significance are as shown in Table 4-18, below. All of the unstandardized coefficients (except for the base case) represent the incremental per-vehicle percentage of off-peak charging introduced by turning on the respective variable – e.g., the model estimates that 53.4% of control group PHEV kWh charging

[16] ERS selected a linear model over other types of models (e.g., the logit model) because the behavior being modeled could take any value between 0% and 100%. Had the observed behavior gravitated toward either end of that spectrum, suggesting that most drivers tended to charge either all on-peak or all off-peak, the logit model would have been more appropriate, as it is designed to model such pass/fail events.

occurred off-peak (β_0 in Table 4-18, below) and that control group Tesla BEVs charge an additional 4.6% off-peak (β_3 in Table 4-18, below).

Table 4-18. Model Parameters – Regression Model for Off-Peak kWh Metric

Coefficient Symbol	Variable	Unstandardized Coefficient	Standard Error	Standardized Coefficient	P-value (statistical significance)
β_0	Base case; control group PHEVs	53.4%	1.8%	n/a	0.000
β_1	Treatment	9.6%	1.2%	0.198	0.000
β_2	Non-Tesla BEV	7.2%	1.3%	0.139	0.000
β_3	Tesla BEV	4.6%	1.4%	0.084	0.001
β_4	Non-Tesla BEV-treatment	2.0%	1.8%	0.031	0.284
β_5	Tesla BEV-treatment	10.1%	1.9%	0.145	0.000
β_6	October 2019	0.0%	2.1%	0	0.989
β_7	November 2019	-0.1%	2.1%	-0.001	0.696
β_8	December 2019	0.8%	2.0%	0.009	0.707
β_9	January 2020	-1.1%	2.0%	-0.013	0.588
β_{10}	February 2020	0.1%	5.0%	0.001	0.963
β_{11}	March 2020	0.5%	2.0%	0.005	0.819
β_{12}	April 2020	-3.1%	2.1%	-0.035	0.137
β_{13}	May 2020	-4.1%	2.1%	-0.047	0.046
β_{14}	June 2020	-1.8%	2.1%	-0.021	0.382
β_{15}	July 2020	-0.4%	2.0%	-0.004	0.862
β_{16}	August 2020	-0.4%	2.0%	-0.004	0.854
β_{17}	Hundreds of kWh charged per month	0.4%	0.2%	0.032	0.090
					R^2 = 0.127

[1] Unstandardized coefficients represent the amount of change in the dependent variable due to a unit change in the independent variable; in this model, the unstandardized coefficients represent a per-vehicle percentage of kWh charged off-peak.

[2] Standardized coefficients compare the relative strength of the effect of an independent variable on the dependent variable, with a higher absolute value representing a stronger effect.

[3] The p-value represents the statistical significance of a measured effect, with a value of less than 0.05 meaning that it is not likely the observed difference/effect is the result of randomness or chance.

This model leads us to several initial findings regarding the off-peak kWh charging performance:

- Participants in the treatment group charge more of their kWh off-peak, indicating that the off-peak price signal is having the desired effect. This effect is statistically significant.
- The effect of receiving the off-peak price signal is not uniform across all vehicles.

- Tesla BEVs in the treatment group charge 10.1% (β_5 in Table 4-18, above) more of their kWh off-peak than PHEVs in the treatment group (statistically significant). Survey responses show that Tesla BEV drivers have a high level of awareness of tools for managing their charging, which would support the observed higher rate of off-peak charging.
- Non-Tesla BEVs in the treatment group charge 2.0% (β_4 in Table 4-18, above) more of their kWh off-peak than PHEVs in the treatment group. This relationship is not statistically significant, however, as both vehicle types respond at roughly similar rates to the off-peak charging signal.

- There is a statistically significant relationship between a participant's vehicle type and their off-peak charging behavior, with both non-Tesla BEV (7.2%, β_2 in Table 4-18, above) and Tesla BEV (4.6%, β_3 in Table 4-18, above) owners being more likely to charge off-peak than a PHEV owner, even before the introduction of the off-peak pricing signal.
  - On average across all months and vehicle types, 60% of the control group's charging (kWh) occurred off-peak, suggesting that most drivers already often charge off-peak in the absence of a pricing signal. It is, however, important to note that the coincident peak demand (kW) is the program's focus and may still present an issue even if the majority of charging (kWh) occurs off-peak. The program is also affecting an on-peak demand reduction; these findings are discussed in the preceding section and encapsulated in Table 4-17.
  - On average across all months and vehicles types, 72% of the treatment group's kWh occurred off-peak, suggesting that these drivers are responding to the price signal but there may be a limit to how much of the charging load can be shifted off-peak.
- During May 2020, ERS observed a statistically significant change in off-peak charging performance. The percent of kWh charged off-peak dropped 4.1% (β_{13} in Table 4-18, above) in this month relative to September 2019 (the first month of RY2 data collection and the model's reference month), meaning more charging took place on-peak. It is possible that this behavior is related to changes in schedules and charging patterns due to COVID-19.

Table 4-19, below, consolidates the results of the regression analysis described above; it shows the percentage of kWh charged off-peak by vehicle type and group in the reference month (September 2019)[17].

[17] Note that the prevalence of off-peak charging in other months can be calculated by adding each month's off-peak performance coefficient to the values contained in Table 4-19. That is, to calculate the off-peak charging (kWh) percentage by vehicle type and group for June 2020, -1.8% should be added to each value in Table 4-19 (or, subtract 1.8%).

Table 4-19. Percentage of kWh Charged Off-Peak (Regression Outputs)

Vehicle Type	Control	Treatment
PHEV	53.4%	63.0%
Non-Tesla BEV	60.6%	72.2%
Tesla BEV	58.0%	77.7%

ERS also analyzed the total percentage of kWh charged off-peak in RY2 by month, vehicle type, and group, which provides a visual representation of off-peak charging performance. This data is presented in Figures 4-10 and 4-11 (split to accommodate the amount of information presented); note that these figures are based on actual data, not regression outputs.

Figure 4-10. Observed Off-Peak Charging Performance (kWh), September – February

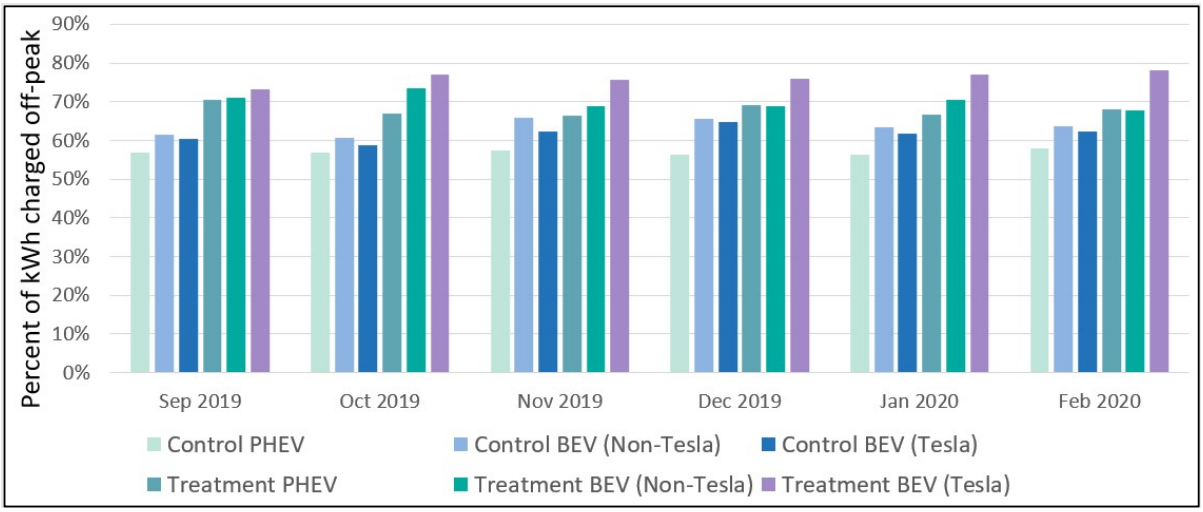
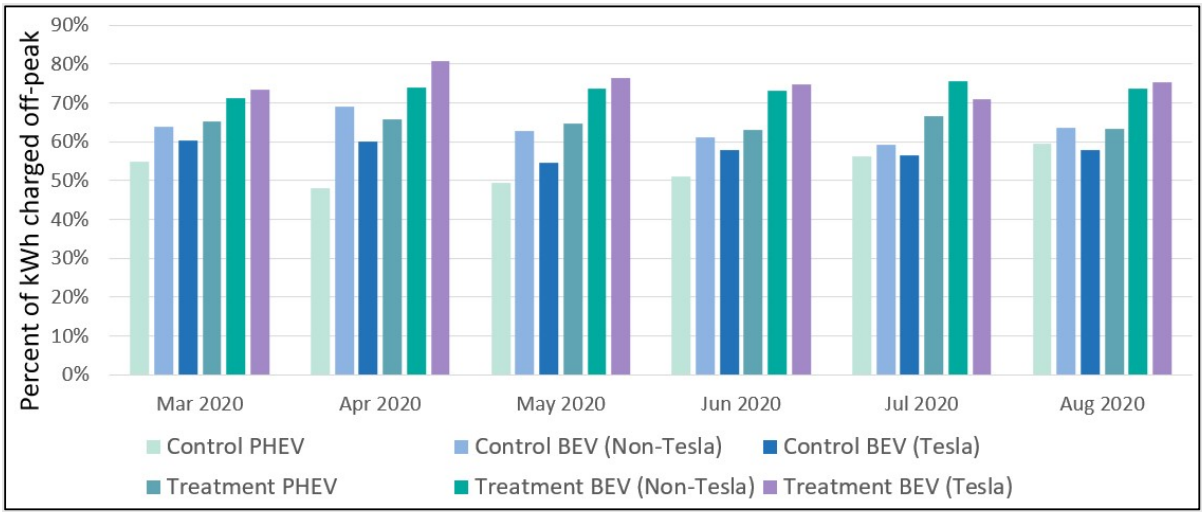


Figure 4-11. Observed Off-Peak Charging Performance (kWh), March – August



Session Start Time Approach Model

The final model developed for estimating the percentage of charging sessions initiated off-peak takes the following form:

$$y = \beta_0 + \beta_1 T + \beta_2 S + \beta_3 L + \beta_4 (S \times T) + \beta_5 (L \times T) + \beta_6 (Oct) + \beta_7 (Nov) + \beta_8 (Dec) + \beta_9 (Jan) + \beta_{10} (Feb) + \beta_{11} (Mar) + \beta_{12} (Apr) + \beta_{13} (May) + \beta_{14} (Jun) + \beta_{15} (Jul) + \beta_{16} (Aug) + \beta_{17} \mathrm{K}$$

where the variable meanings and properties are provided in Table 3-3 (Independent Variables Summary) in Section 3, and the coefficient values and statistical significance are as shown in Table 4-20, below. All of the unstandardized coefficients (except for the base case) represent the incremental per-vehicle percentage of off-peak charging introduced by turning on the respective variable – e.g., the model estimates that 41% (β_0 in Table 4-20, below) of control group PHEV charging sessions started off-peak and that control group Tesla BEVs start an additional 8.8% (β_3 in Table 4-20, below) of charging sessions off-peak.

Table 4-20. Model Parameters – Regression Model for Off-Peak Session Start Metric

Coefficient Symbol	Variable	Unstandardized Coefficient	Standard Error	Standardized Coefficient	P-Value (Statistical significance)
β_0	Base case; control group PHEVs	41.0%	1.9%	n/a	0.000
β_1	Treatment	7.0%	1.3%	0.129	0.000
β_2	Non-Tesla BEV	-3.4%	1.4%	-0.058	0.019
β_3	Tesla BEV	8.8%	1.5%	0.144	0.000
β_4	Non-Tesla BEV-treatment	12.7%	2.0%	0.176	0.000
β_5	Tesla BEV-treatment	11.5%	2.1%	0.148	0.000

Coefficient Symbol	Variable	Unstandardized Coefficient	Standard Error	Standardized Coefficient	P-Value (Statistical significance)
β_6	October 2019	1.7%	2.4%	0.016	0.459
β_7	November 2019	5.2%	2.3%	0.053	0.021
β_8	December 2019	6.8%	2.3%	0.07	0.003
β_9	January 2020	4.8%	2.2%	0.051	0.032
β_{10}	February 2020	5.4%	2.2%	0.057	0.015
β_{11}	March 2020	7.5%	2.2%	0.078	0.001
β_{12}	April 2020	8.5%	2.3%	0.086	0.000
β_{13}	May 2020	2.3%	2.3%	0.023	0.311
β_{14}	June 2020	0.5%	2.3%	0.006	0.813
β_{15}	July 2020	-0.4%	2.3%	-0.004	0.852
β_{16}	August 2020	1.2%	2.3%	0.012	0.603
β_{17}	Tens of charging sessions per month	0.7%	0.1%	0.095	0.000
					R^2 = 0.153

[1] Unstandardized coefficients represent the amount of change in the dependent variable due to a unit change in the independent variable; in this model, the unstandardized coefficients represent a per-vehicle percentage of charging sessions initiated off-peak.

[2] Standardized coefficients compare the relative strength of the effect of an independent variable on the dependent variable, with a higher absolute value representing a stronger effect.

[3] The p-value represents the statistical significance of a measured effect, with a value of less than 0.05 meaning that it is not likely the observed difference/effect is the result of randomness or chance.

This model leads us to several findings regarding the off-peak session start performance:

- Participants belonging to the treatment group, on average, initiate more of their charging sessions off-peak, indicating that the off-peak price signal is having the desired effect. This effect is statistically significant.
- The impact of the off-peak price signal is not uniform across all vehicles.
  - Non-Tesla BEV owners in the treatment group charge 12.7% (β_4 in Table 4-20, above) more off-peak than PHEV owners in the treatment group. Notably, this relationship is statistically significant, which was not the case in the kWh model.
  - Tesla BEV owners in the treatment group charge 11.5% (β_5 in Table 4-20, above) more off-peak than PHEV owners in the treatment group, which is also statistically significant.
  - We hypothesized that greater access to scheduled charging could account for some of this difference. The participant survey found that 76% of BEV (Tesla + Non-Tesla) drivers were aware of tools and features for controlling their EV charging vs. 58% for PHEV drivers; this difference was statistically significant.

- Vehicle type has a statistically significant effect on the observed off-peak charging behavior absent an off-peak pricing signal; the direction of this impact differs between non-Tesla BEVs and Tesla BEVs.
  - Tesla BEV drivers start 8.8% (β_3 in Table 4-20, above) **more** of their charging sessions off-peak than PHEVs even without an off-peak price signal, suggesting they may have a technology edge over PHEVs or potentially receive outside marketing regarding off-peak charging.
  - Control group Non-Tesla BEV owners initiate 3.4% (β_2 in Table 4-20, above) **fewer** of their charging sessions off-peak than control group PHEVs.
  - It is noteworthy that control group Non-Tesla BEV owners charged significantly more of their kWh **off-peak** than control group PHEV owners but initiate their charging sessions **on-peak**. This demonstrates that non-Tesla BEV owners in the control group start charging on-peak, though more of their charging kWh occurs off-peak.
- Time had a statistically significant impact on the off-peak session start performance for November and December (in 2019) and January, February, March, and April (in 2020). We believe there are several factors driving this observed behavior, described below.
  - On average from November to February, 5.5% (the average of β_7, β_8, β_9, β_{10} in Table 4-20, above) more charging sessions than in September 2019 were initiated off-peak across all vehicles. We were expecting the opposite to be true, as greater in-car heater use in winter months would increase charging overall and could push session start times earlier. ERS will investigate additional seasonality trends in RY3.
  - In March and April, the two months in which Rhode Island was most deeply impacted by COVID-19, charging sessions were initiated off-peak 7.5% and 8.5% (β_{11} and β_{12}, respectively, in Table 4-20, above) more frequently than in September 2019, respectively, across all vehicles. This shift off-peak is likely driven by a significant decrease in charging outside the home, such as at a workplace or retail location; this charging is more likely to occur on-peak and its absence would skew the percentage of off-peak at-home charging proportionally higher.

Notably, the COVID-19 pandemic, which emerged in March 2020, did not have a dampening effect on off-peak charging performance. As charging overall decreased significantly (and remains low relative to pre-COVID levels), on-peak charging has dropped off more than off-peak.

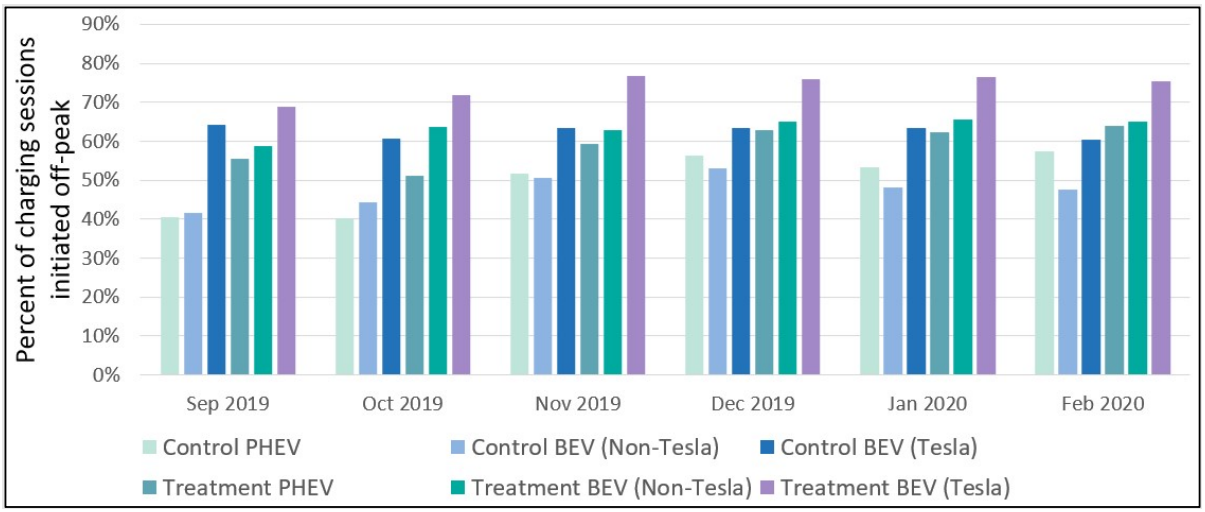
Table 4-21, below, consolidates the results of the regression analysis described above; it shows the percentage of charging sessions initiated off-peak by vehicle type and group in the reference month (September 2019)[18].

Table 4-21. Percent of Charging Sessions Started Off-Peak (Regression Outputs)

Vehicle Type	Control	Treatment
PHEV	41.0%	48.0%
Non-Tesla BEV	37.6%	57.3%
Tesla BEV	49.8%	68.3%

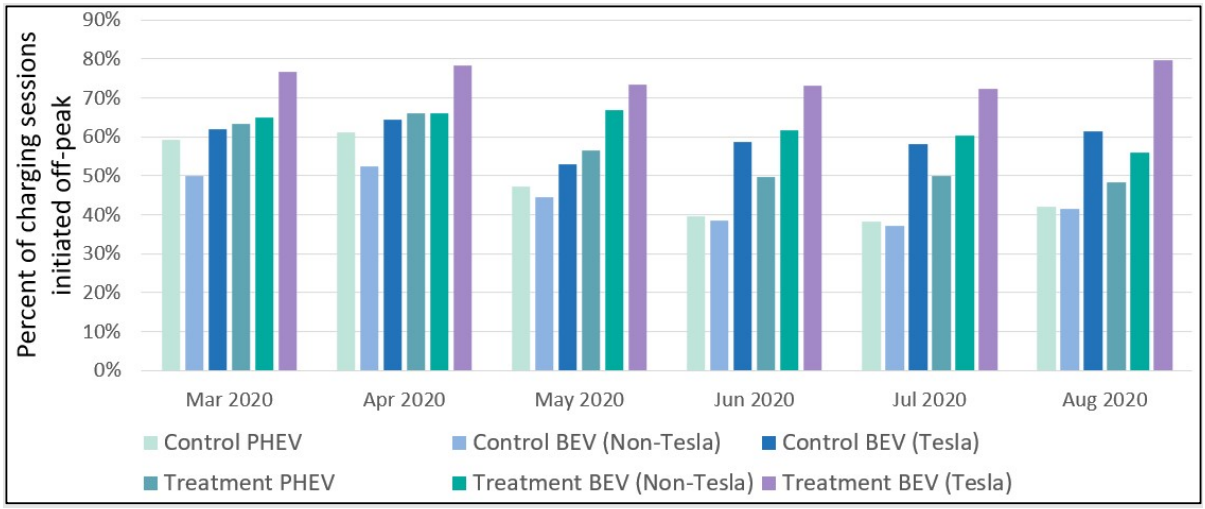
ERS also analyzed the total percentage of charging sessions that were initiated off-peak in RY2 by month, vehicle type, and group, which provides a visual representation of the data analyzed using the regression model. This data is presented in Figures 4-12 and 4-13 (split to accommodate the amount of information presented); note that these figures are based on actual data, not regression outputs.

Figure 4-12. Observed Off-Peak Charging Performance (kWh), September – February



[18] Note that the prevalence of off-peak charging in other months can be calculated by adding each month's off-peak performance coefficient to the values contained in Table 4-19. That is, to calculate the off-peak session start percentage by vehicle type and group for June 2020, 0.5% should be added to each value in Table 4-19.

Figure 4-13. Observed Off-Peak Charging Performance (kWh), March – August



4.1.4 Upcoming Activities for RY3

ERS will work with National Grid to support evaluation activities for RY3 and RY4 (as approved) which includes distribution of educational materials. ERS will perform an additional analysis in RY3 to assess the impacts of the program's change to provide the rebate to all participants and provide evaluation support through RY4.

4.2 Charging Station Demonstration Program

National Grid's Charging Infrastructure Program seeks to increase the deployment of Level 2 and DCFC stations throughout Rhode Island. The program covers 100% of the cost of electric service upgrades and distribution equipment needed to power and install the charging stations and also provides a rebate for the cost of the EVSE equipment. This rebate varies by target charging segment (see Table 2-2) and covers station hardware. The program requires network and station monitoring for a minimum of five years after installation.

4.2.1 Program Implementation Approach

The Charging Station Demonstration Program leverages National Grid's existing sales staff and vendor networks to assist program staff in implementation. Sales staff solicit initial customer interest and provide leads to program staff, who provide program details and engage the vendor network as appropriate. Typically, the vendors navigate customers through the application and installation activities. National Grid is actively expanding this network, qualifying additional vendors to deliver this program.

4.2.2 Program Results

The following sections outline program results for the Charging Station Demonstration Program in RY2.

Charging Station Development

National Grid has made great progress in RY2 across several Level 2 segments, most notably in workplaces, and also in environmental justice communities and multi-unit dwellings (MUD). In RY2, the program has also seen progress in activating public DCFC ports. Customers in RY2 activated 230 Level 2 ports and 3 DCFC ports at 62 locations, consisting of 233 ports in total across 122 stations. Based on the program tracking spreadsheet, the program has a pipeline of an additional 47 approved Level 2 ports with 99 under development and more still in the preliminary stages of the program. Of the activated and approved ports, 13% are located within environmental justice communities, defined as host sites within environmental justice areas (as defined by the RI Department of Environmental Management) and located at MUD or public parking lots.

Progress has still been slower for corporate light-duty fleets, public transit stations, and for DCFC stations, though activity has increased significantly since RY1 for both Level 2 stations in most segments and for DCFC stations. National Grid program staff expect that continued outreach and the ongoing Fleet Advisory Studies Program will assist in future infrastructure development for both fleet and DCFC stations, and that Electrify RI funding will also enable development of additional DCFC stations in RY3.

Tables 4-22 and 4-23 present the program goals and progress through RY2 for both Level 2 and DCFC infrastructure development, measured in the total number of charging ports.

Table 4-22. Charging Infrastructure Program Level 2 Progress to Date – Charging Ports

Level 2 Segment	Target Port Count	Activated	Approved	Under Development*	Waitlisted	Total
Corporate Fleet	24	2	6	0	0	8
Environmental Justice	36	36	0	6	0	42
Government Fleet	24	20	4	4	0	28
MUD	36	32	4	20	8	64
Public Transit	60	14	19	8	0	41
Workplace	140	126	14	32	88	260
Total Level 2	**320**	**230**	**47**	**70**	**96**	**443**

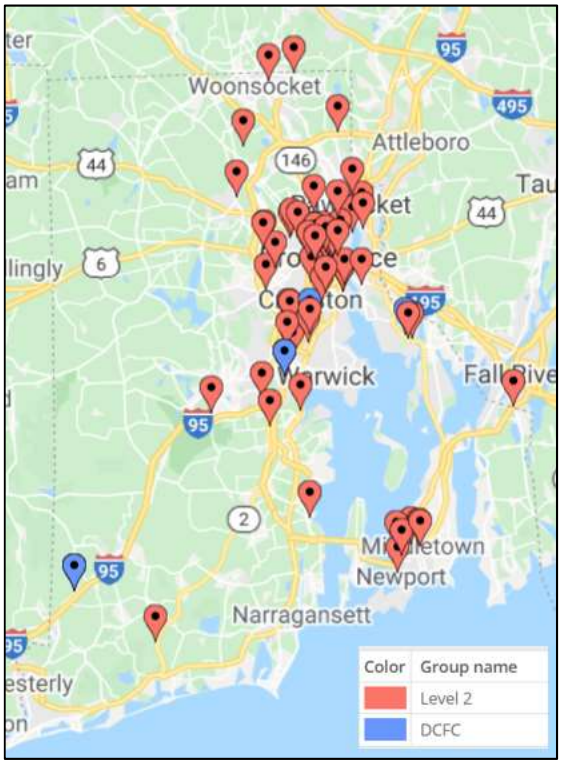
* "Under Development" includes ports with the following statuses in National Grid's tracking data: application submitted, project opportunity, and submitted.

Table 4-23. Charging Infrastructure Program DCFC Progress to Date – Charging Ports

DCFC Segment	Target Port Count	Activated	Approved	Under Development	Waitlisted	Total
Municipal school buses	3	0	0	0	0	0
Other heavy-duty (port, airport)	8	0	0	0	0	0
Rideshare company hub	5	0	0	0	0	0
Public Transit Buses	10	0	0	10	0	10
Public DCFC	20	3	4	19	0	26
Total DCFC	**46**	**3**	**4**	**29**	**0**	**36**

Figure 4-14, below, shows the distribution of the active and approved Level 2 and DCFC stations throughout Rhode Island as of August 31, 2020.

Figure 4-14. Activated and Approved Level 2 and DCFC Stations in Rhode Island



Charging Station Utilization

The Charging Station Demonstration Program requires a minimum of 5 years of network monitoring for each station installed through the program. Charging data is reported to National Grid by the EVSE suppliers. The ERS Team analyzed charging data from 208 Level 2

ports and 3 DCFC ports (211 ports in total) in RY2 to help National Grid understand station utilization in Rhode Island. Of the actively reporting ports, 20 were activated prior to September 2019 and the remainder were activated in RY2; charging data was available from September 2019 through August 2020.

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

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

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

ERS conducted an early EVSE data review in August 2020 to verify whether the vendors were providing data according to National Grid's EV charging data standards. We made several recommendations to improve data quality ahead of the full RY2 analysis. ERS observed that the quality and amount of data varied across vendors, though all vendors that delivered data provided all of the fields listed above. One vendor provided additional data, including a unique Driver ID for each charging session and the zip code in which the charging vehicle was registered. While not required for the purposes of this evaluation effort, these additional fields could enable ERS to further assess station utilization for that vendor's stations to gain an understanding of how many drivers and localities are impacted by a given charging station.

Utilization Analysis Results. Table 4-24, below, provides an overview of the charging data analyzed in RY2. Overall, 99.6% of charging sessions and 99.4% of the total charged energy (kWh) came from Level 2 stations. Note that this utilization analysis does not include all stations in the Project Tracking spreadsheet that have an "activated" status; charging data was only provided for 211 of the 249 "activated" ports in RY2, and the analysis is therefore limited to only those stations for which data sets were available. Further, all of the analysis results in

this section are based on charging data from chargers that could be matched to a project in the tracker and that passed quality control checks designed to flag invalid or inaccurate data.

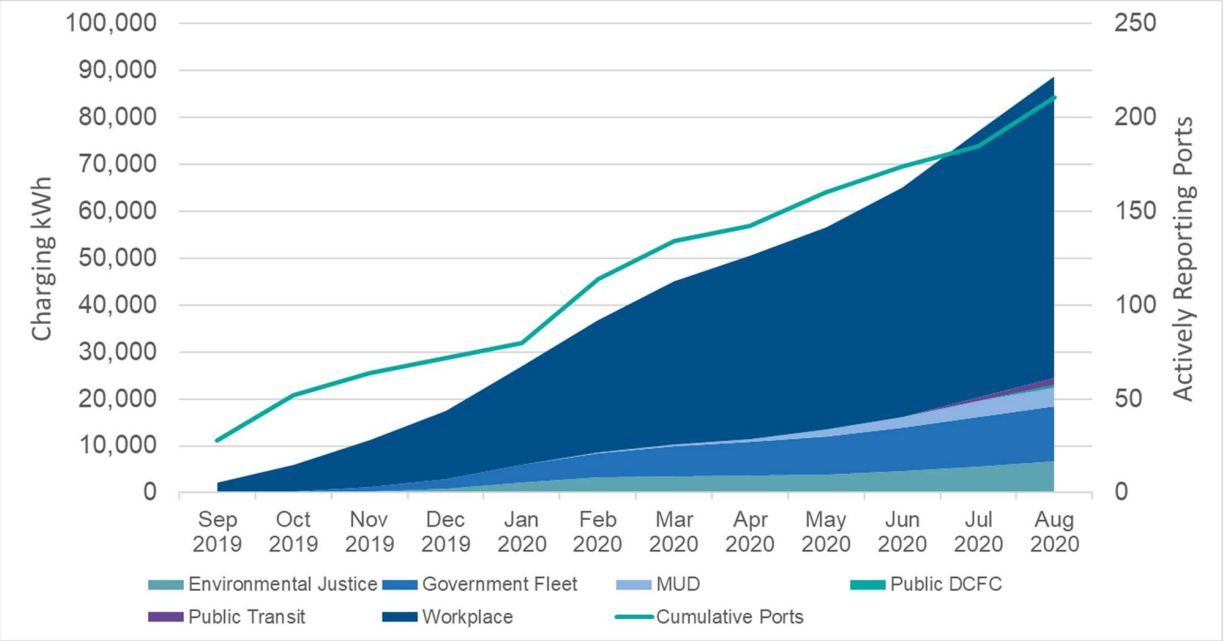
Table 4-24. RY2 Charging Station Utilization Data Overview

Metric	Level 2	DCFC	Total
Number of ports	208	3	211
Number of charging sessions	6,120	27	6,147
Charging energy consumed (kWh)	88,203	514	88,718
Average charging energy per port (kWh)	424	171	596
Average charging energy per session (kWh)	14	19	33

The 211 charging stations that reported data in RY2 are located at a total of 52 facilities, with several facilities containing multiple stations and ports. Because drivers tend to choose whichever port or station is available when they arrive at a charging location with multiple options, we have considered co-located stations as a single station-location; this approach also streamlines the utilization analysis. Table A-1, in Appendix A, summarizes the utilization of the co-located chargers for RY2 across multiple metrics; the anonymized stations are ordered based on the RIEVSE ID they were assigned in the program tracking spreadsheet.

Station Development and Charging kWh. As noted above, the program is making steady progress toward its goals, as described in Tables 4-22 and 4-23. In RY2, of the 249 activated ports, there were 211 ports that reported charging data. While the amount of charging (kWh) initially lagged the growth in the number of active charging stations, it began to increase rapidly starting in early 2020 before slowing in March, April, and May 2020, as shutdowns and schedule disruptions due to COVID-19 reduced the amount of workplace charging being done in Rhode Island. As of June 2020, as evidenced by accelerated growth in charging kWh, it appears that EV drivers are returning to the stations funded by the program.

Figure 4-15. Growth in Reporting Station Count and Charging Activity Over RY2



Station Utilization by Station Use and Segment. In RY2, 99% of the 211 ports reporting charging data were classified as Level 2 in the Project Tracking spreadsheet and 55% of the Level 2 stations were classified as "workplace" charging ports. Approximately 72% (64,204 kWh) of all charging has occurred at workplace ports; of this total, 67% (43,148 kWh) comes from just 20 highly utilized ports at 5 sites. Similarly, 82% of the government fleet charging (9,582 kWh) comes from a single project comprised of two charge ports. Table 4-25 provides an overview of the utilization data by segment and charging type.

Table 4-25. Charging Station Utilization Breakdown by Segment (Level 2 and DCFC)

Charging Level	Segment	Port Count	Charge Session Count	Sessions per Port	Total kWh	kWh per Session	kWh per Port
Level 2	Environmental Justice	30	640	21	6,739	11	225
	Government Fleet	16	801	50	11,699	15	731
	MUD	22	212	10	3,927	19	178
	Public Transit	26	148	6	1,635	11	63
	Workplace	114	4,319	38	64,204	15	563
Total Level 2		**208**	**6,120**	**29**	**88,203**	**14**	**424**
DCFC	Public DCFC	3	27	9	514	19	171
Total		**211**	**6,147**	**29**	**88,718**	**14**	**420**

Figure 4-16 shows the overall breakdown of charging energy consumed by segment in RY2; it is clear that workplace charging represents the largest share of charging, followed by charging at government fleet facilities.

Figure 4-16. Charging Station Utilization Breakdown by Segment (kWh)

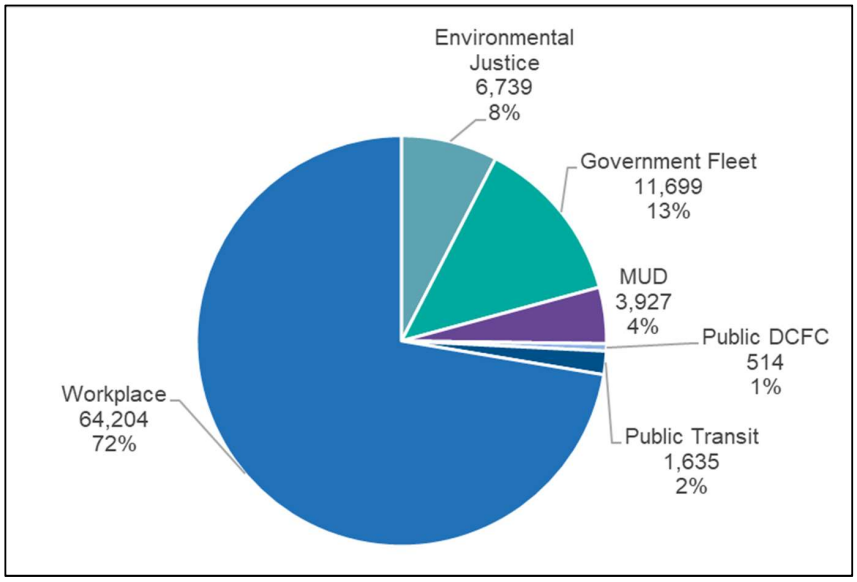
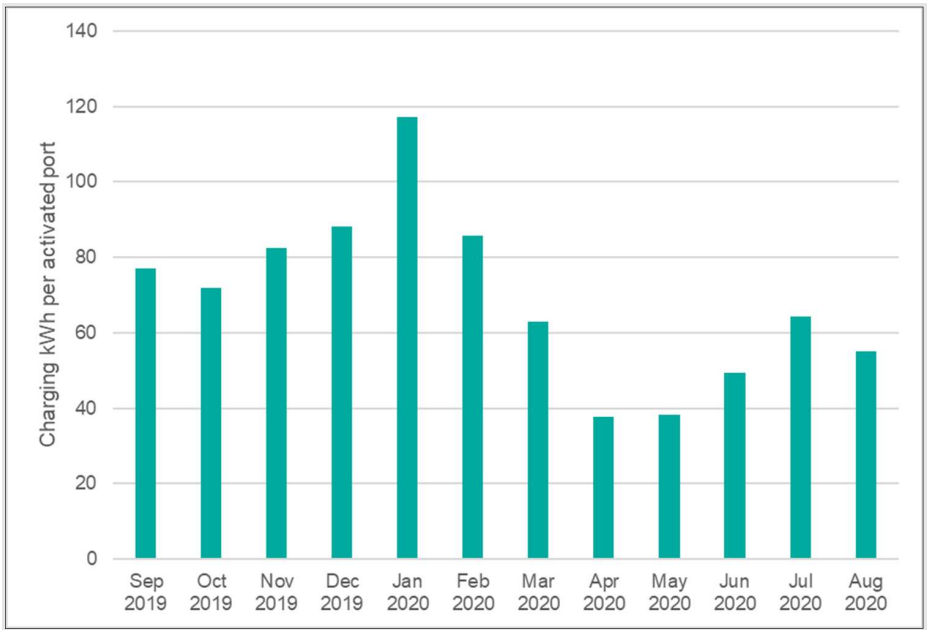


Figure 4-17, below, shows the monthly per-port utilization of the activated charging ports. Note the drop-off in charging at the start of the COVID-19 pandemic in March and April 2020, which is followed by a bounce back, starting in June, as EV drivers return to work. The March per-port charging total across all segments equals 73% of the per-port charging load in February, while the April per-port charging load represents just 44% of the charging load recorded in February 2020. While there has been some bounce back, workplace charging remains lower than pre-pandemic levels on a per-port basis.

Figure 4-17. Charging Station Utilization Breakdown by Month



Incremental EV Adoption above National Grid Forecasts

National Grid's Amended Settlement Agreement, Docket Nos. 4770 and 4780, filed in August 2018, established annual company forecasts for incremental EV registrations in Rhode Island and set company targets for CO_2 reductions resulting from incremental EV adoption beyond these forecasts. ERS compared the annual company forecasts to data provided by National Grid from IHS Markit, an organization that tracks EV registrations in Rhode Island and other states on a quarterly basis. Note that the Electric Transportation Initiative Rate Year runs from September through August and this does not align with the IHS Markit calendar year quarters, but we can report on available data at the time of this report.

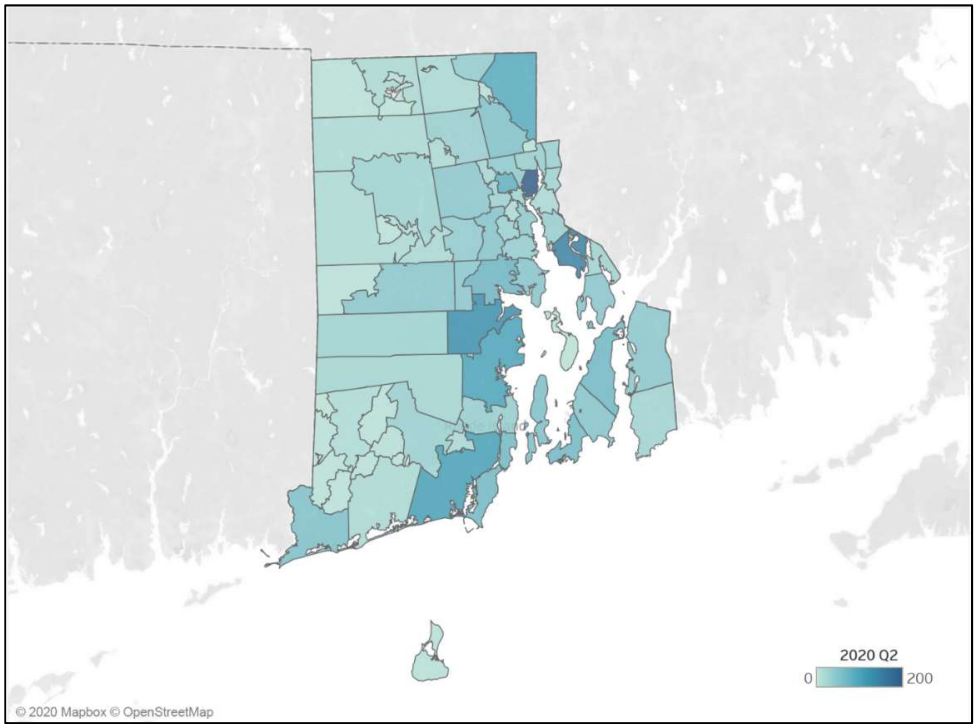
The National Grid forecast for 2019 was 857 vehicles, and for 2020 was 1,180 vehicles. In 2019, the IHS Market data included 326 incremental BEV registrations and 187 incremental PHEV registrations, for a total of 513 incremental EV registrations. In 2020, data is available through Q2, and it shows 198 incremental BEV registrations and 115 incremental PHEV registrations, for a total of 313 incremental EV registrations over the first two quarters. Table 4-26 provides the total Rhode Island EV registrations and the incremental increases for 2019 and through Q2 2020.

Table 4-26. Rhode Island EV Total and Incremental Registrations, 2019 and 2020 To Date

Time Period	BEV (Non-Tesla)	BEV (Tesla)	PHEV	Total
Total RI Registrations as of Q4 2018	318	275	1,140	1,733
Total RI Registrations as of Q4 2019	404	515	1,327	2,246
2019 Incremental Change	**86**	**240**	**187**	**513**
Total RI Registrations as of Q2 2020	444	673	1,442	2,559
2020 Incremental Change To Date	**40**	**158**	**115**	**313**

In 2019, incremental EV registrations fell short of the National Grid forecast. While Q3 and Q4 2020 data is not yet available from IHS, the initial results suggest that actual EV registrations likely will fall short of National Grid forecasts. As a result, there are no emissions reductions resulting from incremental EV registrations beyond the forecast. ERS will plan to revisit this analysis in RY3 to provide full 2020 data and all available 2021 data. Figure 4-18 shows the spatial distribution of Rhode Island's EV population by ZIP code as of 2019 Q2, with darker colors indicating greater EV penetration; this information is also presented in tabular format in Appendix B.

Figure 4-18. Rhode Island EVs by ZIP Code – Through 2020 Q2



Environmental Justice (EJ) Communities

In addition to covering the cost of electric service upgrades and other installation costs, National Grid provides rebates to cover 100% of the equipment cost of EVSE located in EJ communities. EJ communities, as defined by the program, are locations that meet the following three criteria:

1. They must be located within an environmental justice area as defined by the Department of Environmental Management.[19]
2. The project(s) must be located at either a multi-unit dwelling (MUD) facility or a public parking location.
3. The project cannot be located at a workplace or a part of a college campus.

The ERS Team reviewed the tracking data and verified the EJ communities identified for activated, approved, and in-development charging stations by overlaying geospatial data for these stations with EJ map data downloaded from the RI Department of Environmental Management.

Based on the verification analysis performed by ERS, shown below in Table 4-27, 56 ports meet the program's EJ requirements as of August 31, 2020, which exceeds National Grid's program goal of 36 activated ports, 156% of their target. Since the EJ segment goal has been achieved, National Grid allocated the additional ports meeting EJ criteria to other program segments.

Table 4-27. Results of ERS Environmental Justice Community Status Verification

EJ Community Status	Project Tracking Spreadsheet Ports	ERS Team Verified Ports
Activated	36	56
Approved	0	4
In Development	6	38
Total	**42**	**98**

ERS also reviewed all activated ports in the program and identified 14 additional ports that are located within EJ communities but do not meet all three criteria, primarily because they are classified as workplaces and/or campus locations. While not officially designated as EJ community ports, they may also help serve those communities.

[19] Rhode Island Department of Environmental Management Resource Map, http://www.dem.ri.gov/maps/index.php

4.2.3 Charging Demonstration Program Evaluation Key Findings

In RY2, the ERS Team interviewed 10 site hosts with activated stations. The following are key takeaways from these interviews, interviews with the program managers and the analysis of program data:

- **The Infrastructure Program continues to make progress toward its goals.** Overall, the program has reached 76% of the target activated L2 ports and 15% of the target DCFC ports. One Level 2 segment, the Environmental Justice segment, has been fully subscribed, and additional outreach will be required in RY3 to hit the program's goals for the remaining segments, such as corporate fleet, public transit, and government fleet.
- **There is little evidence of free ridership in the Charging Demonstration program. Most** participants who were interviewed said that they would not have installed charging stations in the absence of the program.
- **The incentives provided by National Grid are essential to participation.** Almost all participants mentioned that the incentives and support provided by National Grid were key to install charging stations. Most site hosts said they do not have the budget to install charging stations, or that they would have installed stations in the future, but the funding from the program was the final push.
- **Funding of EVSE hardware can help bolster program participation.** Funding from the VW Settlement Agreement became available in RY2 through the Electrify Rhode Island program and has helped site hosts alleviate the costs of charging station equipment that is not covered by National Grid's program. Many participants who were interviewed said they would not have participated in National Grid's program if additional funding offered by the State had not been available to cover the entire cost of the equipment Government fleet, municipal buildings, and public transit segments specifically indicated in interviews that without the program, they would not have the budget to install any charging stations.
- **Site host familiarity with EV equipment and technology varies**. Interviewees reported varying levels of knowledge and familiarity with EV and EVSE systems. While many site hosts are aware of the charging station technology and even own EVs themselves, several site hosts mentioned a lack of knowledge on charging station equipment and available manufacturers and therefore defaulted to the recommendations provided by their installation vendors. One participant said: "[The vendor] treated me like an EV expert, but I am not."
- **Site hosts are very satisfied with program offerings.** ERS asked site hosts to rate their satisfaction with the program on a scale from 0 to 10, with 0 being not satisfied and 10 being extremely satisfied. Across all participants interviewed in RY1 and RY2, the average

rating was a 9.2. Many participants said the process was "seamless," and that the program offerings were able to alleviate most of the financial burden of purchasing charging stations.

- **Station utilization has been very limited since the COVID-19 pandemic began.** Many site hosts mentioned that the COVID-19 pandemic has resulted in very low station utilization. Many employees of site hosts are working remotely, and public stations lack utilization due to the lack of travel and tourism. The utilization data reflects this decline in charging reported by site hosts.
- **Most site hosts have long-term visions to support vehicle electrification and GHG emissions reductions.** When asked about their primary motivations for installing their charging stations, most site hosts mentioned a long-term vision of increasing penetration of vehicle electrification and a desire to prepare for the market to change. Common themes heard during interviews included reducing GHG emissions, encouraging EV ownership, and planning for the uptick in future EV adoption for personal and fleet vehicles. ERS recommends building on these themes of GHG reduction, greening of the workplace etc., in recruitment materials to encourage additional forward-thinking site hosts to participate in the program.

> "We are thought of as a 21st century city, and one that is threatened by sea level rise and climate change and depend greatly on tourism. We are looking to protect our historic asset that attracts tourists and protects emissions in the area."
>
> –Charging Station Demonstration Program Participant

- **Site host perspectives regarding National Grid ownership and operation of charging stations varied.** National Grid asked ERS to solicit site hosts' initial perspective regarding a potential future arrangement where National Grid would own and operate charging stations on site host property.[20] ERS received mixed feedback from site hosts, but several were interested in learning more about the details of what these arrangements would look like. Site hosts stated that the benefits of this opportunity included a reduction in staff time to manage their stations and reduced upfront and maintenance costs, while other site hosts raised potential challenges with having multiple parties involved and more difficult approval processes.

[20] The topic of utility ownership of EV stations has been discussed and debated regularly in the industry, with multiple reports published on the benefits and challenges of different ownership models. One such report identified by the ERS team can be found here: https://www.mjbradley.com/sites/default/files/MJBA_Accelerating_the_Electric_Vehicle_Market_FINAL.pdf.

4.2.4 Upcoming Activities for RY3

During RY3, ERS will continue to interview program participants and potentially additional program vendors. At the conclusion of RY3, we will again analyze charging station utilization and review program progress against metrics.

4.3 Discount Pilot for DCFC Station Accounts

The Discount Pilot for DCFC Station Accounts Program provides incentives to owners of existing and new DCFC charging stations to offset demand charges incurred from usage of these high-kW-drawing stations (typically 150 kW and up).

4.3.1 Program Implementation Approach

National Grid has established a process to identify and enroll eligible site hosts and works across its Marketing, Customer Solutions, Sales Processing, and Accounts Processing teams to calculate and process monthly credits. National Grid program staff manage the program, regularly monitoring and reporting program progress.

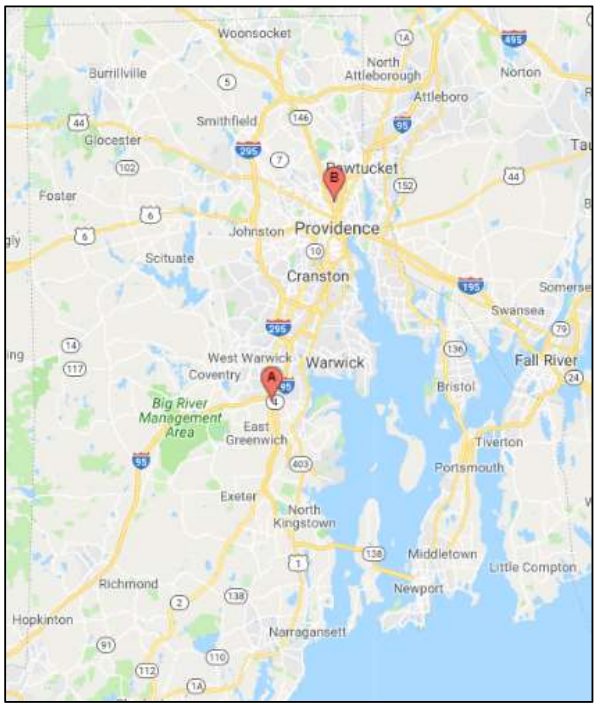
4.3.2 Program Results

While there were no DCFC chargers installed from the charging demonstration program, two sites were approved for the DCFC program in RY1 and received benefits during RY2. No additional sites were approved for this program in RY2 and, thus, ERS and National Grid agreed that it was not necessary to conduct participant interviews during RY2. Additionally, one participant elected to change their billing rate in May 2020, a change that made them ineligible for the Discount Pilot Program. . Table 4-28 shows the total charging kWh, peak site kW, and total discounts provided through RY2. The figure below shows the locations of both of the DCFC stations that received the DCFC discount rate pilot through RY2.

Table 4-28. DCFC Program Summary Metrics through RY2

Program Participant	In-Service Date	RY2 Charging kWh	RY2 Peak Site kW	Total Discount Received RY2	Total Program Charging kWh (RY1 and RY2)	Total Program Discount (RY1 and RY2)
DCFC A	Existing site	627,600	568	$18,742.30	1,177,000	$32,155.22
DCFC B	Existing site	21,000	170	$2,951.87	21,000	$2,951.87
Totals		**648,600**		**$21,694.17**	**1,198,000**	**$35,107.09**

Figure 4-19. Location of DCFC Pilot Program Participants



4.3.3 Upcoming Activities for RY3

During RY3, the ERS Team plans to interview any new DCFC discount rate pilot participants to learn more about program participation drivers as well as successes and barriers, including any potential free ridership and/or spillover effects. The team will also conduct a final review of program documentation and tracking information.

4.4 Fleet Advisory Services

National Grid's Fleet Advisory Services program offers fleet electrification studies and other services to qualifying fleet operators throughout RI, including corporate light-duty, government light/medium/heavy-duty, public transit, and municipal school buses.

4.4.1 Program Implementation Approach

National Grid program staff have retained an implementation contractor for this program to evaluate the current fleet inventory of a participating fleet operator and propose fleet electrification options for consideration. The implementation contractor works closely with National Grid during the selection of participants, and National Grid regularly monitors study progress. At the end of each study, the implementation contractor delivers final reports to participants and National Grid.

4.4.2 Program Results

The Fleet Advisory Services program has enrolled nine participants to-date. Fleet studies are complete for five of the participants, and the remaining four are expected to be completed in late 2020. Table 4-29 summarizes the program participants to date.

Table 4-29. Fleet Advisory Study Participants

RY1 Participants	Number of Participants
Corporate light-duty fleet	1
Corporate medium/heavy duty fleet/school bus	1
Government	3
Public transit	1
University/corporate light-duty fleet	2
Utility/corporate light-duty fleet	1
Total	**9**

Table 4-30 summarizes the metrics for this program in RY2.

Table 4-30. Fleet Advisory Study Metrics

Program Metric	Results through RY2
Total number of vehicles leased/purchased	Zero vehicles leased/purchased
Total number of fleet vehicles converted to EVs	Zero vehicles converted to EVs
Total number of EVs planned/pledged	13 vehicles
Total number of EVSE charging ports planned or installed	26-28 ports
Total number of vehicles recommended for replacement	135 vehicles
Estimated greenhouse gases avoided due to fleet vehicles converted to EVs	No vehicles converted, so no greenhouse gases avoided.

4.4.3 Fleet Advisory Services Program Interview Results

In RY2, the ERS Team interviewed two participants who completed fleet electrification studies, bringing the total number of completed interview to four participants to date. The following are key takeaways from these interviews:

> "We've never had a study in front of us like this before where we could compare all of the costs and current usage of our fleet. This was very compelling to the Admin."
>
> —Fleet Advisory Services Program Participant

- **Participants reported high satisfaction with the program and final reports.** All four program participants interviewed to date provided positive feedback about their program experience. Program participants commended the expertise and professionalism of the implementation contractor and complemented the very detailed final reports.
- **Participants would like ongoing program support**. Most interviewed participants indicated that they would likely take a phased approach to electrifying their fleet and installing charging stations, and they mentioned that while they plan to follow the electrification recommendations from their report, the timing of their fleet upgrades may not reflect the timing in the report and would likely span at least 3-5 years. Participants expressed interest in ongoing communication from National Grid and/or the implementation contractor, suggesting it would be useful to receive a brief annual update on market trends or new vehicles and/or technologies to help guide their future decision-making regarding vehicle electrification. To date, two participants have received 6-month follow-up calls from National Grid and stated they are helpful in keeping the dialogue open after the final report is complete. Implementing this recommendation could also assist in meeting the program's goals of installing Level 2 ports in corporate fleet and public transit sectors since, as fleets are converted, those fleet owners will also need charging infrastructure. As shown in Table 4-18, there are several Level 2 ports planned/installed for these segments already.
- **The program provides well-supported guidance and justification to support electrification.** Both participants interviewed during RY2 commented that their electrification study was a helpful resource in promoting vehicle electrification within their company, and the details regarding savings potential provided in the final reports provided opportunities to economically justify future EV purchases. These participants also reported that the studies were useful in synthesizing data regarding their existing fleets that they do not have the bandwidth to sift through or analyze on their own. Without this program, it is likely that the interviewed participants would not have begun any research to electrify their vehicles or they would have moved at a slower pace. One participant said that they "would have done a trial and error [if the program was not offered] and would have started to introduce some hybrid vehicles [before purchasing any EVs]."
- **The Fleet Advisory Services Program will continue to likely drive participation for other EV programs.** From the participant interviews, ERS learned that two participants are already involved in the Charging Station Demonstration Program. As additional fleet

electrification studies are completed, we expect participants who pursue electrification will take advantage of the infrastructure program for Level 2 and/or DCFC stations. As noted in Table 4-26, 3 participants plan to convert 13 vehicles and 5 participants plan to install a total of 26–28 charging ports.

- **Vehicle electrification barriers include both normal business planning cycles and COVID-19 impacts.** Participants expressed several barriers to pursuing the fleet electrification and charging station recommendations from their final reports. These barriers include a requirement to work within their existing vehicle replacement cycle, which often includes long-term vehicle leases that span beyond the duration of the three-year program cycle. Participants reported a plan to pursue EVs as their existing vehicle commitments end, but vehicle conversions may not occur until after the conclusion of the program. The COVID-19 pandemic has also affected electrification plans, as fleet operators reported reduced vehicle usage during shutdown or scaled back operations, resulting in a reluctance to pursue new vehicles amidst this uncertainty.

4.4.4 Upcoming Activities for RY3

During RY3, ERS will attempt to interview the remaining participants in this program. The team may also conduct follow-up interviews with program participants interviewed in RY1 and RY2 to inquire about actions taken for fleet electrification after study completion.

Appendix A. Project-Level Utilization Metrics

Table A-1 summarizes the utilization of the co-located chargers for RY2 across multiple metrics; the anonymized stations are ordered based on the RIEVSE ID they were assigned in the project tracking spreadsheet.

Table A-1. Charging Station Utilization by Station

Rhode Island Tracking ID	Charger Type	Activation Date (from tracking)	First Charge Date (in data)	Charge Session Count	Charged kWh	Charged kWh per charge session	Project Segment	Project Status	Port Count
RIEVSE-1	Level 2	05/14/19	09/03/19	516	6,942	13.5	Workplace	Activated	4
RIEVSE-2	Level 2	12/01/19	06/11/20	10	329	32.9	MUD	Activated	4
RIEVSE-4	Level 2	09/09/19	09/03/19	383	8,751	22.8	Workplace	Activated	2
RIEVSE-6	Level 2	11/27/19	01/10/20	63	778	12.4	Workplace	Activated	4
RIEVSE-7	Level 2	11/27/19	02/05/20	74	939	12.7	Workplace	Activated	4
RIEVSE-9	Level 2	01/02/20	02/20/20	647	16,460	25.4	Workplace	Activated	6
RIEVSE-13	Level 2	03/10/20	03/01/20	280	1,775	6.3	Workplace	Activated	4
RIEVSE-14	Level 2	03/10/20	03/02/20	283	2,400	8.5	Workplace	Activated	2
RIEVSE-16	Level 2	03/10/20	08/25/20	2	19	9.6	Workplace	Activated	4
RIEVSE-18	Level 2	12/01/19	02/04/20	82	422	5.1	Workplace	Activated	8
RIEVSE-20	Level 2	03/04/20	05/02/20	24	669	27.9	Workplace	Activated	2
RIEVSE-22	Level 2	11/18/19	11/16/19	670	9,582	14.3	Government Fleet	Activated	2
RIEVSE-23	Level 2	11/18/19	11/16/19	432	6,947	16.1	Workplace	Activated	4
RIEVSE-24	Level 2	06/01/20	05/05/20	23	319	13.9	Government Fleet	Activated	8
RIEVSE-27	Level 2	08/23/19	09/03/19	208	2,594	12.5	Workplace	Activated	4
RIEVSE-29	Level 2	11/18/19	10/30/19	78	1,488	19.1	Workplace	Activated	2
RIEVSE-30	Level 2	11/18/19	10/26/19	71	1,634	23.0	Government Fleet	Activated	2
RIEVSE-31	Level 2	11/18/19	10/10/19	186	1,338	7.2	Workplace	Activated	4
RIEVSE-35	Level 2	09/20/19	09/13/19	422	4,038	9.6	Workplace	Activated	4
RIEVSE-37	Level 2	10/14/19	10/14/19	223	2,131	9.6	Environmental Justice	Activated	4
RIEVSE-38	Level 2	02/05/20	02/19/20	10	134	13.4	Workplace	Activated	4
RIEVSE-39	Level 2	06/24/20	06/02/20	52	1,650	31.7	Workplace	Activated	6
RIEVSE-46	Level 2	08/20/19	09/05/19	10	63	6.3	Workplace	Activated	4
RIEVSE-47	Level 2	08/20/19	09/05/19	2	19	9.5	Workplace	Activated	4
RIEVSE-48	Level 2	08/28/19	10/11/19	22	181	8.2	Workplace	Activated	4
RIEVSE-49	Level 2	09/09/19	09/16/19	165	2,681	16.2	Workplace	Activated	2
RIEVSE-50	Level 2	02/26/20	02/11/20	17	274	16.1	MUD	Activated	4
RIEVSE-51	Level 2	12/18/19	11/28/19	217	2,692	12.4	Environmental Justice	Activated	6
RIEVSE-52	Level 2	04/09/20	03/29/20	125	2,164	17.3	MUD	Activated	4

Rhode Island Tracking ID	Charger Type	Activation Date (from tracking)	First Charge Date (in data)	Charge Session Count	Charged kWh	Charged kWh per charge session	Project Segment	Project Status	Port Count
RIEVSE-54	Level 2	10/25/19	10/30/19	15	207	13.8	Workplace	Activated	2
RIEVSE-55	Level 2	09/25/19	10/23/19	62	501	8.1	Environmental Justice	Activated	6
RIEVSE-57	Level 2	12/03/19	12/03/19	17	227	13.3	Workplace	Activated	2
RIEVSE-61	Level 2	12/13/19	09/13/20	184	2,257	12.3	Workplace	Activated	4
RIEVSE-73	Level 2	12/03/19	12/01/19	82	636	7.8	Environmental Justice	Activated	6
RIEVSE-75	Level 2	05/11/20	06/28/20	39	636	16.3	Environmental Justice	Activated	4
RIEVSE-76	Level 2	04/27/20	04/14/20	5	108	21.5	Workplace	Activated	4
RIEVSE-77	Level 2	05/15/20	04/30/20	13	83	6.4	Workplace	Activated	4
RIEVSE-80	Level 2	05/30/20	07/12/20	11	33	3.0	Workplace	Activated	4
RIEVSE-81	Level 2	03/10/20	03/10/20	54	1,130	20.9	MUD	Activated	6
RIEVSE-83	Level 2	02/15/20	02/25/20	83	805	9.7	Workplace	Activated	4
RIEVSE-88	Level 2	03/26/20	08/07/20	17	142	8.4	Environmental Justice	Activated	4
RIEVSE-93	**DCFC**	08/05/20	07/29/20	23	410	17.8	Public DCFC	Activated	1
RIEVSE-94	Level 2	01/23/20	01/21/20	40	182	4.6	Workplace	Activated	4
RIEVSE-101	Level 2	03/15/20	02/19/20	10	12	1.2	Workplace	Activated	4
RIEVSE-106	Level 2	09/02/20	08/27/20	4	30	7.5	Public Transit	Activated	6
RIEVSE-107	Level 2	09/02/20	08/26/20	10	188	18.8	Public Transit	Activated	6
RIEVSE-108	Level 2	03/10/20	03/15/20	37	165	4.4	Government Fleet	Activated	4
RIEVSE-109	Level 2	03/26/20	05/03/20	6	31	5.1	MUD	Activated	4
RIEVSE-114	Level 2	06/24/20	07/12/20	75	900	12.0	Public Transit	Activated	6
RIEVSE-117	Level 2	08/07/20	08/11/20	3	6	2.0	Public Transit	Activated	4
RIEVSE-121	**DCFC**	08/19/20	08/20/20	4	104	26.1	Public DCFC	Activated	2
RIEVSE-122	Level 2	05/20/20	05/15/20	56	511	9.1	Public Transit	Activated	4
				6,147	**88,718**				**211**

Appendix B. Electric Vehicle Population Breakdown by ZIP Code

Table B-1 provides the count of EVs by ZIP code and vehicle type for 2020 Q2.

Table B-1. Number of EVs by ZIP Code and Vehicle Type – 2020 Q2

ZIP Code	PHEV	BEV (Non-Tesla)	BEV (Tesla)	Total
02802	3	0	0	3
02804	1	1	0	2
02806	63	23	63	149
02807	3	1	1	5
02808	1	0	1	2
02809	20	10	17	47
02812	5	1	1	7
02813	10	5	1	16
02814	11	2	2	15
02815	0	0	1	1
02816	33	6	7	46
02817	17	3	7	27
02818	55	19	55	129
02822	13	5	3	21
02825	9	3	2	14
02826	3	0	0	3
02827	2	1	0	3
02828	8	2	6	16
02829	1	0	0	1
02830	9	1	5	15
02831	11	1	5	17
02832	10	2	1	13
02833	1	1	0	2
02835	31	12	13	56
02837	16	4	5	25
02838	4	1	0	5
02839	1	0	0	1
02840	34	15	19	68
02842	37	8	5	50
02852	50	18	33	101
02857	15	3	8	26
02859	2	0	2	4
02860	22	6	6	34
02861	18	7	6	31
02863	1	1	1	3
02864	47	14	30	91
02865	25	10	19	54
02871	35	19	15	69
02872	0	0	1	1
02873	0	0	0	0
02874	17	4	13	34
02875	0	0	0	0
02876	0	1	0	1
02877	3	0	0	3
02878	17	7	20	44
02879	55	29	22	106
02880	0	0	1	1
02881	11	2	4	17

ZIP Code	PHEV	BEV (Non-Tesla)	BEV (Tesla)	Total
02882	47	11	9	67
02885	16	5	4	25
02886	39	8	25	72
02888	22	6	7	35
02889	30	9	10	49
02891	33	12	11	56
02892	20	6	5	31
02893	28	6	11	45
02894	2	1	0	3
02895	25	5	9	39
02896	11	2	4	17
02898	3	0	0	3
02903	12	4	9	25
02904	27	3	12	42
02905	21	9	12	42
02906	101	35	64	200
02907	9	5	2	16
02908	60	16	7	83
02909	18	4	7	29
02910	19	8	4	31
02911	12	5	3	20
02912	1	0	0	1
02914	12	1	4	17
02915	23	6	4	33
02916	11	10	5	26
02917	23	3	6	32
02919	28	7	10	45
02920	36	6	9	51
02921	23	2	15	40
02940	0	1	3	4
	1,442	**444**	**672**	**2,558**

Appendix C. Daily EV Charging Load Distribution

Table C-1 shows the percent of daily EV charging broken down by hour across all vehicle types and groups (control vs. treatment).

Table C-1. Hourly Distribution of Daily EV Charging Load by Vehicle Type and Group

Time (hour starting)	Hour (hour starting)	Percent of Daily kWh Charged by Hour							
		PHEV		Non-Tesla BEV		Tesla BEV		All Vehicles	
		Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
0:00	0	4.2%	6.2%	5.1%	5.2%	4.7%	6.9%	4.7%	6.2%
1:00	1	3.7%	5.0%	4.8%	5.3%	4.6%	6.5%	4.4%	5.8%
2:00	2	3.1%	4.0%	4.2%	4.9%	4.1%	6.9%	3.9%	5.6%
3:00	3	2.7%	3.3%	3.8%	6.0%	4.0%	5.7%	3.6%	5.3%
4:00	4	2.3%	2.8%	3.3%	5.2%	4.1%	5.2%	3.3%	4.7%
5:00	5	1.8%	2.3%	2.8%	4.2%	3.6%	3.9%	2.8%	3.7%
6:00	6	1.7%	1.7%	2.6%	3.1%	1.8%	2.3%	2.0%	2.5%
7:00	7	2.0%	1.7%	2.5%	2.9%	1.7%	1.7%	2.0%	2.1%
8:00	8	2.6%	2.3%	2.6%	2.7%	1.7%	2.1%	2.2%	2.3%
9:00	9	3.2%	2.8%	3.3%	2.9%	2.6%	2.3%	3.0%	2.6%
10:00	10	3.3%	2.5%	3.3%	3.5%	3.3%	2.3%	3.3%	2.7%
11:00	11	3.5%	2.6%	3.0%	3.2%	3.3%	2.4%	3.3%	2.7%
12:00	12	3.9%	2.9%	3.0%	3.1%	3.4%	3.2%	3.4%	3.1%
13:00	13	4.0%	3.1%	2.9%	2.8%	3.9%	3.3%	3.7%	3.1%
14:00	14	4.0%	3.2%	3.3%	2.4%	4.0%	2.9%	3.8%	2.8%
15:00	15	4.2%	3.5%	3.4%	2.3%	4.4%	3.0%	4.0%	2.9%
16:00	16	4.9%	4.0%	4.2%	3.2%	4.5%	3.2%	4.5%	3.4%
17:00	17	5.7%	4.7%	4.9%	3.5%	4.9%	3.2%	5.2%	3.6%
18:00	18	6.7%	5.3%	5.6%	4.0%	6.1%	3.2%	6.1%	3.9%
19:00	19	7.2%	5.4%	6.2%	4.7%	6.1%	3.0%	6.4%	4.0%
20:00	20	6.8%	5.6%	6.5%	5.0%	5.8%	3.1%	6.3%	4.2%
21:00	21	6.9%	8.9%	6.8%	6.8%	6.6%	8.2%	6.8%	7.9%
22:00	22	6.3%	8.5%	6.3%	6.8%	5.8%	8.1%	6.1%	7.8%
23:00	23	5.2%	7.6%	5.6%	6.2%	4.8%	7.5%	5.2%	7.1%
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%