Final Project Report

# AlectraDrive @HOME

## Managed Charging Program for Single & Multi Family Homes

**GROUP 1: Smart Charging- Time-variant pricing and load control**

Project Partners

alectra GRE&T Centre

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Natural Resources Canada

*Disclaimer: This project is supported by the financial contribution of the Independent Electricity System Operator (IESO), through its Grid Innovation Fund. However, the views, opinions and learnings expressed in this report are solely those of Alectra Utilities Corporation.*

# Public Report – AlectraDrive @Home (Smart Charging)

***Group 1: Smart Charging:*** *Time-variant pricing and load control (30 customers)*

## Executive Summary

The AlectraDrive @Home project targeted the need for affordable and effective EV charging solutions in both multi-residential and single-family homes. By evaluating both passive (pricing) and active (utility-managed charging) models, the AlectraDrive @Home program aimed to provide access to affordable EV charging options while also optimizing charging behaviours that would mitigate potential strain on the electrical grid caused by unmanaged charging and give insights into future program design. Customer feedback indicated strong satisfaction with this project, with 82% of participants expressing being content with the program and finding value for their money. Moreover, 80% of charging was shifted to off-peak times when compared to baseline data. These stats indicated the project's efficacy in providing grid management solutions as well as understanding customer needs. Additional key findings indicated high price elasticity of electric vehicle (EV) charging behaviours, and that demand response (DR) events are an effective method to reduce EV charging demand during peak hours.

Challenges exist in managing EV charging in both multi-unit residential buildings (MURBs) and single-family homes (SFHs) due to technical complexities. Consistent with other studies, MURBs encountered more complex technical issues related to installation and management of EV charging equipment, where SFHs were simpler due to a less complex installation, billing and communications needs. The pilot demonstrated that current and prospective EV drivers require more support from their electrical utilities. This work should include support for customers in the form of guides for acquiring an EVSE, communication of best practices for EV charging, and additional programs that reward customers for shifting their charging to off-peak times.

Future initiatives stemming from the findings of this project include highlighting opportunities for regulatory changes, enhancing community engagement, and streamlining enrollment processes for future programs. Overall, AlectraDrive @Home laid the groundwork for customer-facing EV support programs, while showcasing that managed charging of EVs works and is a viable method for electrical utilities to reduce demand across their service territories.

The project was set up with 3 customer groups: Group 1 (managed charging group), Group 2 (rewards groups) and Group 3 (control group). This program has been made possible through the provision of funds by Ontario's Independent Electricity System Operator (IESO) and the Government of Canada, through Natural Resources Canada (NRCan).  The IESO's financial contributions relate to Group 1, whereas NRCan's contributions relate to both program treatment groups (Group 1 and 2/3).

Note that some content for this public report was sourced from Guidehouse's process and impact evaluation reports.

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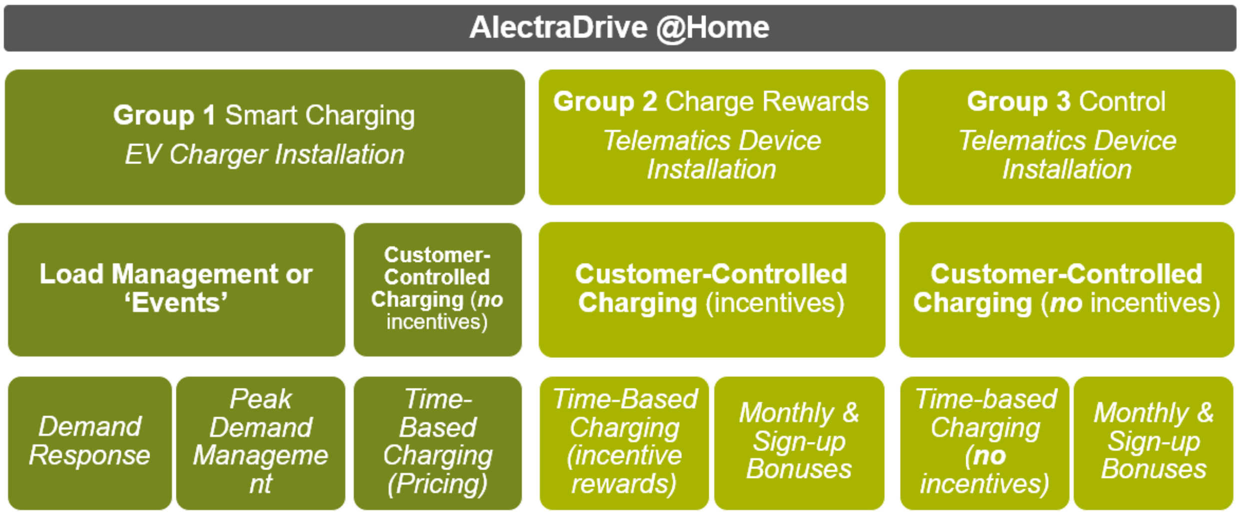


*Figure 1 - High-level pilot program group architecture.*

## Project Objectives & Pilot Architecture

In 2020, Alectra initiated the AlectraDrive @Home project which was designed to explore a variety of strategies to ensure that consumer EV charging was timed to maximize the cost-effectiveness of EVs and complement an increasingly distributed electricity system. The program targeted solutions that met these criteria for residential consumers, including both multi-unit residential buildings (MURBs) and single-family homes (SFHs).

There were two goals for Group 1 in this pilot:

1. The first goal of this the project was to test the effectiveness of automatic technological electric vehicle supply equipment (EVSE) control for drivers charging at home.
2. The second goal of the impact evaluation was to test the effectiveness of the time-varied pricing treatment at reducing EV demand during the project on-peak periods.

Note that for the purpose of the pilot, on-peak time was considered all hours outside of 1 to 9 pm on non-holiday weekdays.

### *Group 1 – Detailed Architecture & Description*

All Group 1 participants, part of the smart charging group, were provided access to subsidized FLO CoRe+ Level 2 EVSE at their residence, including the installation, in return for paying a monthly fee for the duration of the project (see Figure 2 below). There were 9 installations of EVSE in 4 MURBs, and 17 EVSE installed in 17 single-family homes, for a total of 26 participant EV chargers. There were 12 drivers in the MURB portion of the pilot, and 18 drivers in SFHs. Note that no analysis was completed on non-participant chargers installed at MURB buildings. These chargers were installed to provide access to EV charging at buildings that had EV drivers not enrolled in the pilot.

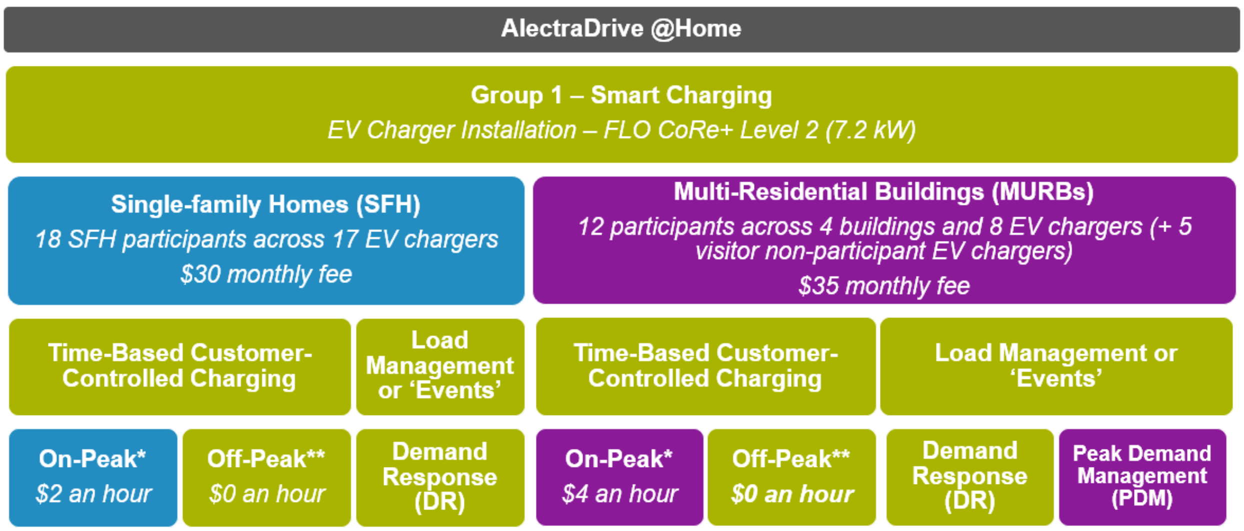


*Figure 2 - Group 1 pilot architecture.*

## Active and Passive Controls – Description & Findings

The AlectraDrive @Home pilot program had two components core to the managed charging process:

- **Pricing signals or *passive control***: Participants were subjected to daily peak period charges intended to reduce average demand during the project on-peak period (1pm – 9pm on non-holiday weekdays). This charge was applied as a $/hour surcharge to use the EVSE during this peak period. MURBs paid $4 an hour for any charging done during on-peak hours, whereas SFH drivers paid $2 an hour. The reasoning behind the difference in costs was to account for the fact that SFH drivers paid for their electrical usage on their own utility bills, while MURB drivers only paid the on-peak costs. All energy commodity costs used by the MURB drivers were remitted to the condo corporation or building owner.

- **Automatic EVSE managed charging or *technological Control***: Demand Response (DR), which for the purpose of this project is the reduction of power to the charging station during a pre-determined time, was completed across the project to test the effectiveness of the technology and how customers react to reduce power to their charging station during peak hours. Peak Demand Management was also tested across the 4 MURBs, showcasing how demand can be reduced based on historical demand profiles to avoid increasing demand charges caused by concurrent EV charging during peak times.

As described above, passive control was performed through a pre-established per hour price when charging during on-peak times (1 pm to 9 pm on non-holiday weekdays) to test whether pricing was a strong enough driver to move charging to off peak times (9 pm to 1 pm on holidays and weekends).

Technological or active control was completed automatically using a custom API connection from FLO's EV chargers to Generac's (formerly Enbala) Concerto platform acting as a DERMS. Through the FLO API integration, the project team was able to customize the degree to which the EV charger should be curtailed as well as the frequency and timing. During each DR event, power to the station was throttled to 80% of the original 7 kW output. In simpler terms, a typical 7 kW station will charge an EV in 4 to 8 hours, whereas the 80% reduction increases this to about 9 to 15 hours. Note that DR events were not ran for the entire overnight period, so the time to charge will vary depending on the DR length and the type of EV being charged. Impacts were estimated for a series of pre-planned DR events covering a range of day-types, and the most appropriate estimated event impact (or aggregation of impacts) was considered to provide an ex-ante estimate of the equipment's DR capability.

Each participant was given two free opt-out opportunities to remove themselves from the DR event, and each opt-out above that cost them $10. DR events were scheduled every other week across 9 months, on predetermined days. Participants became aware of the DR event on the day-of, at 7 am via a text message and/or an email describing the event timing and instructions regarding opting out. Each participant was expected to plan accordingly to ensure they had enough charge for any trips required following the DR event. The project team saw only a single instance of opting out during the pilot across both SFH and MURB drivers.

Initially, the DR window was from 5 pm to 9 pm every other week on a predetermined day. The project team saw very minimal charging during this initial DR period due to the strength of pricing signals (passive control). To ensure the team had access to DR data, the DR window was changed to occur between 10 pm to 12 am based on the same schedule as the previous window timing. This resulted in proper testing availability and collection of data needed for the impact evaluation.

This pilot also tested the efficacy of a DERMS deployed in MURBs which worked to reduce building distribution demand charges through the deployment of a form of automated DR: Peak Demand Management (PDM). As with the DR events, participants could opt out of PDM events for a fee, with both DR and PDM opt-outs counting towards the same allotment of freebies. The goal of the pilot for PDM was to quantify to which degree PDM can mitigate increases in the monthly non-coincident peak demands of MURBs. This relates but also expands on DR's goal of quantifying to what degree EVSE curtailment DR events could reduce the IESO-coincident summer peak demand when applied to residential L2 EVSE in single and multi-family buildings.

## Project Partners

The table below outlines the project partners involved with AlectraDrive @Home along with their roles and responsibilities.

*Table 1 - Project Partners.*

| Partner | Role | Responsibilities |
|---|---|---|
| Alectra | Project Lead | Overall project design, management, execution, and reporting; vendor and budget management; overall customer experience and reporting to funders |
| Geotab (formerly known as FleetCarma) | Telematics device provider; data acquisition and analysis | Equipment deployment (C2); customer recruitment, data collection, analysis, and reporting on findings from incentive models and control groups; customer support and engagement related to C2 device; program administration; participation in rewards structure and access to web portal; note that Group 2/3 received C2 devices, not Group 1. |
| Flo | EVSE provider and operations manager | Integration with Generac DERMS platform; development of Time of Use (TOU) pricing and DR software features for Flo CoRe+ EVSE; sales support with MURBs (condos) and residential customer support; site plans and technical designs for EVSE installations, overseeing site deployment process with RBI and/or other contractors as required by Alectra; managing pricing/customer billing interface for end-user and support for Alectra admin portal for TOU/CPP pricing/scheduling; overall EVSE technology solution and project management as per Alectra-Flo SOW. |
| Generac (formerly known as Enbala) | DERMS provider | Installation and operation of DERMS at participating sites; integration of pricing signals and real-time usage data with demand curtailment to manage EVSE loads; use-case testing, analysis and reporting as per UAT and Alectra-Generac SOW. |
| Smith & Long/Robertson Bright (RBI) + Bracer EV | Electrical contractors | Virtual and physical MURB + SFH site assessments, EVSE installations, including additional equipment as required, required electrical upgrades, and related electrical work at participating sites. |
| Alectra Energy Solutions/Services. | Key account management /MURB recruitment | Key account management, customer care, and support recruitment of MURB participants |

| | | |
|---|---|---|
| Plug'n Drive | Customer engagement and insights | Marketing and customer engagement support through design of messaging, materials, and engagements for participants; webinars and info sessions (Ride & Drives as required/circumstances allow) |
| Guidehouse | Pilot design and evaluation | Pilot design and evaluation consultant; pricing model development, evaluation, data analysis and reporting. |
| Laszlo Energy Services | Project management | Project budgeting, reporting, customer management, and evaluation support. |

## Impact Evaluation Approach & Results

As per the final evaluation report for Group 1 completed by Guidehouse, both impact and process evaluations were undertaken for the managed charging (Group 1) pilot. Impacts were evaluated using a regression analysis, applied to the quarter hourly individual EVSE data. Guidehouse estimated a separate regression model for each EVSE, controlling for the month, day of the week, and hour of day. Additional variables were included to capture the impact of pricing treatment and events (DR and PDM).

For event period impacts, Guidehouse used interval data from participant EVSE during the pilot period. The week-on-week-off approach provided a nearly contemporaneous baseline period for evaluating the impacts of the use-cases; the regression-based approach compares each EVSE's demand during the "on" weeks with the same EVSE's demand during the "off" weeks. The on/off design applies only to the automatic interventions (the "use-cases"). Impacts for pricing were estimated through a regression-based comparison of individual EVSE charging profiles before and after the application of prices. Each EVSE's profile in the initial baseline period (i.e., before prices or use-cases were deployed) was compared to the same EVSE's charging profile in the "off" weeks in the period in which the on/off design is deployed.

Guidehouse applied a seasonal charging profile and charging consumption adjustment factor to demand in the baseline period to account for seasonal differences between the baseline and pilot periods. Seasonal adjustments were estimated using data from the Group 2 (Rewards) pilot evaluation, which includes a control group (known as Group 3) of EV drivers whose vehicles' charging was logged from November of 2020 through the end of December 2022. Group 3 drivers were not subject to any pilot treatment.

### *Impact Evaluation Results (Demand Response)*

The original event schedule included a series of DR events from 5 pm – 9 pm, coinciding with the on-peak pricing period from 1 pm – 9 pm. Based on preliminary results estimated approximately halfway through the pilot period, Guidehouse determined that given the response to pricing, little to no demand remained during the 5 pm – 9 pm window to curtail with DR. This is illustrated by Figure 3, which shows total demand across the SFH participants (green line) and MURB participants (blue line) for the DR event from 5 pm – 9 pm on May 25th. Demand was close to zero for both MURB and SFH participants leading up to the event and remained at the same level during the event. Demand increased at 9 pm, once the event and on-peak pricing period had both ended.

Following a recommendation from Guidehouse, Alectra worked with the vendor to shift remaining DR events to the 2-hour period from 10 pm to midnight. This illustrated an important challenge in planning EVSE DR events: for on-demand capacity to be achieved, there must be existing load to curtail.

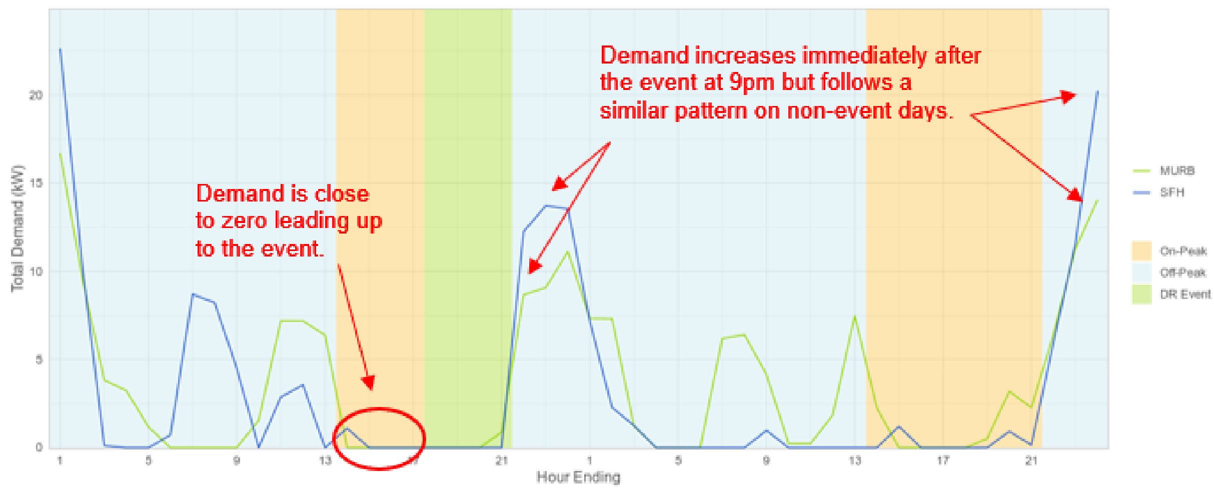


*Figure 3 - Total Demand by Building Type, 5 pm to 9 pm DR on May 25, 2023. (Source: Generac data, Guidehouse analysis.)*

Like the previous figure, Figure 4 shows the event from 10 pm – midnight on July 17th, 2023, with total demand across the SFH participants (green line) and MURB participants (blue line). In contrast to the May 25th, 2023, event, the on-peak pricing period had already ended at the time of the event start (10pm), so demand was non-zero leading up to the event. Demand fell to near zero for MURBs and SFHs during the event, then rose immediately after.

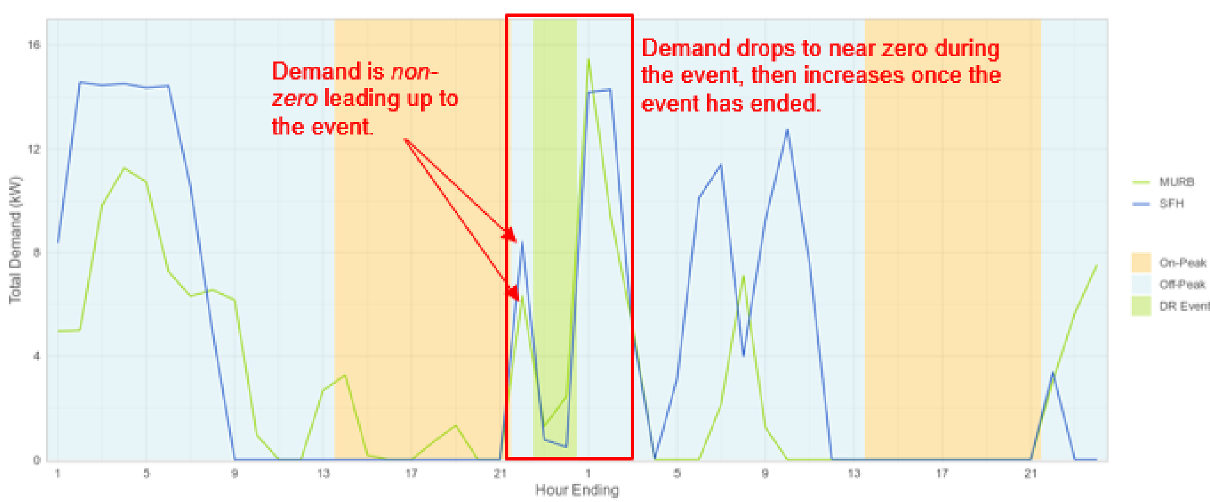


*Figure 4 - Total Demand by Building Type, 10 pm to 12 am DR on July 17, 2023. (Source: Generac data, Guidehouse analysis.)*

Guidehouse estimated average event impacts for each building type and event time, as well as individually for each event. DR delivered consistent and meaningful load reductions in periods which EVSE are normally in use. During events overlapping with the on-peak pricing period (5 pm – 9 pm events), DR delivered low or zero savings, as most pilot participants had already shifted charging at this window in response to pilot pricing. For events from 10 pm to midnight, MURB and SFH participants reduced demand by an average of 0.92 kW and 0.65 kW per EVSE, respectively. DR impacts were higher in hours in which baseline demand is higher; dispatching DR events outside of the on-peak pricing period for testing purposes did yield much higher impacts than DR events dispatched during hours in which drivers are already responding to prices.

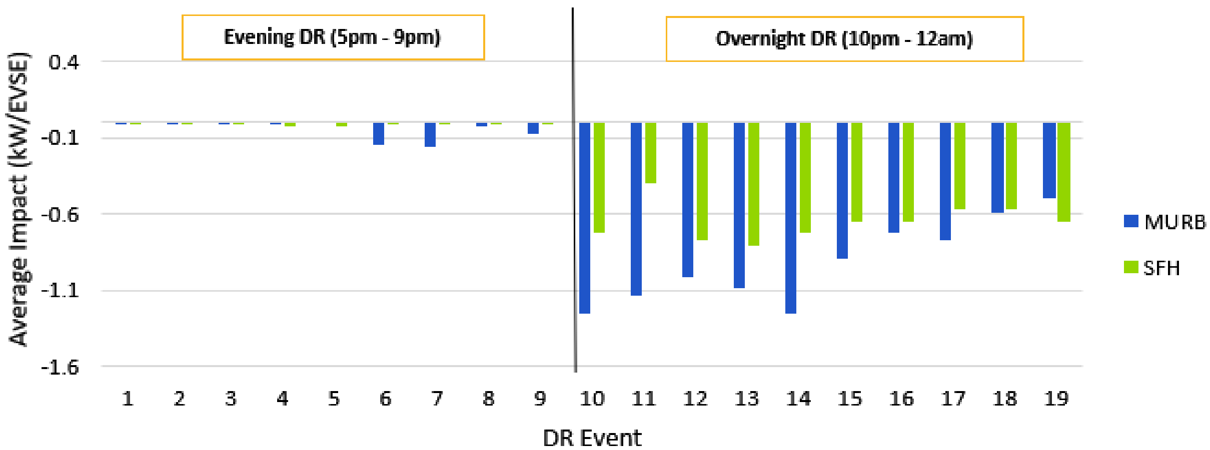


*Figure 5 – Avg. impacts per DR event by building type. (Source: Generac data, Guidehouse analysis.)*

Figure 5 shows average impact per EVSE by building type for each of the 19 DR events. Impacts for the first nine events (5 pm – 9 pm) were low, but in almost all cases, were directionally in alignment with expectations. For the first 9 events, impacts for MURBs ranged from 0 to -0.16 kW per EVSE, compared to 0 to -0.03 kW per EVSE for SFH participants. For events 10 – 18 (10 pm – midnight), impacts were larger, ranging from -0.5 to -1.25 kW per EVSE for MURBs and -0.4 to -0.81 kW per EVSE for SFH participants.

Clear demand reductions were estimated for events from 10 pm – midnight for both SFH and MURB participants. Average impacts were -0.92 kW per EVSE for MURBs and -0.65 kW per EVSE for SFHs, representing demand reductions of 86% and 89% of baseline demand for MURBs and SFHs, respectively. While none of the impacts represented statistically significant estimates, impacts for the later event time (10 pm – midnight) were less uncertain and may provide a more accurate estimate of on-demand capacity. The statistical uncertainty in these cases appeared to be driven by the highly binary nature of EV loads, which are typically either on or off, and the small number of events and participating EVSE.

For SFH participants, almost no charging occurred from 8 am – 5 pm on weekdays, coinciding both with a standard workday but also with the highest-priced periods in the Regulated Price Plan (RPP) time of use (TOU) price schedule. Charging is most concentrated after 9 pm. For MURB participants, demand is slightly higher during the day (MURB drivers are not subject to the default RPP TOU price) and increases from midday through midnight.

In planning future EVSE DR events, Alectra will consider the type of participants and their existing charging patterns when developing expectations around the potential for demand reductions. If EVSE are normally in use during a given period, DR dispatched at this time can be expected to deliver meaningful load reductions.

### *Impact Evaluation Results (Pricing)*

A simple comparison of baseline period and pilot period average charging profiles was sufficient to identify that the program had an impact in shifting vehicle charging later into the evening, reducing demand from 1 pm – 9 pm to nearly zero on weekdays. This shift was expected given the existing RPP TOU incentive for status quo charging to begin after 7 pm, and the pilot treatment pricing further disincentivizing charging between 1 pm and 9 pm.

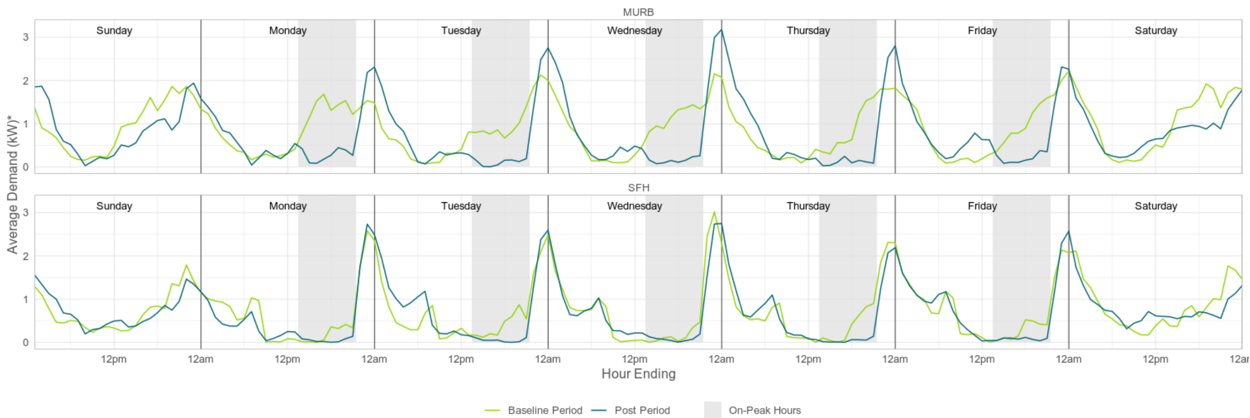


*Figure 6 - Weekly Avg. Charging Profiles. (Source: Generac interval data, Guidehouse analysis.)*

Figure 6 captured average charging demand per vehicle by day of week during the pilot period and in the baseline period. During the pilot on peak periods from 1 pm to 9 pm (shaded grey), post-period demand in blue was consistently below baseline period demand in green.

The top panel shows the average profile for MURB drivers, the bottom panel shows the average profile for SFH drivers. The key difference in the baseline profiles (green) between MURB and SFH can likely be attributed to the fact that the SFH drivers were already subject to RPP TOU, whereas the MURB drivers are not.

This was evidence of a consistent shift in participant charging patterns. The regression-estimated parameters yielded a contemporaneous baseline (very similar to, but not identical to, average demand in the pre-pilot period). This too clearly illustrated the impact of the program, as may be seen in Figure 7, which contrasts the average estimated participant baseline (dashed green line) with the average observed charging demand (solid orange line) for MURBs.

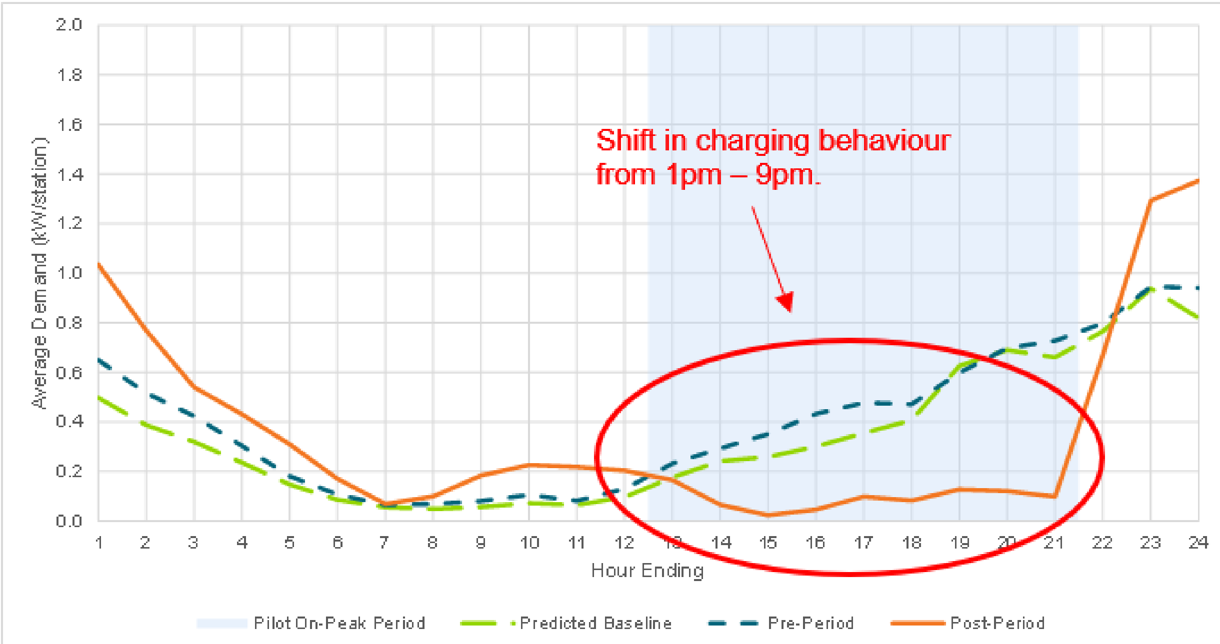


*Figure 7 - Avg. Non-Holiday Weekday Observed & Baseline Demand for MURBs. (Source: Generac interval data, Guidehouse analysis.)*

An equivalent figure for SFHs is included in Figure 8. Prior to the pilot, charging activity at MURBs was more concentrated during the 1 pm to 9 pm period than at SFHs, as illustrated by the dashed blue lines in Figure 7 and Figure 8. MURB participants were not subject to RPP TOU electricity pricing, whereas SFH participants were. This difference in initial charging patterns contributed to a more dramatic shift in charging behaviour observed for MURB participants.

In reviewing this, and all other figures showing estimated charging profiles, the reader must remember that average profiles are averages across all vehicles, including those charging and those not charging in any given interval. Put another way, although the estimation sample included approximately 25 EVSE across the two building types, there were at most 10 vehicles charging at any one time. Load profiles were therefore averages across a few vehicles with high demand (charging) and many with no demand (not charging).

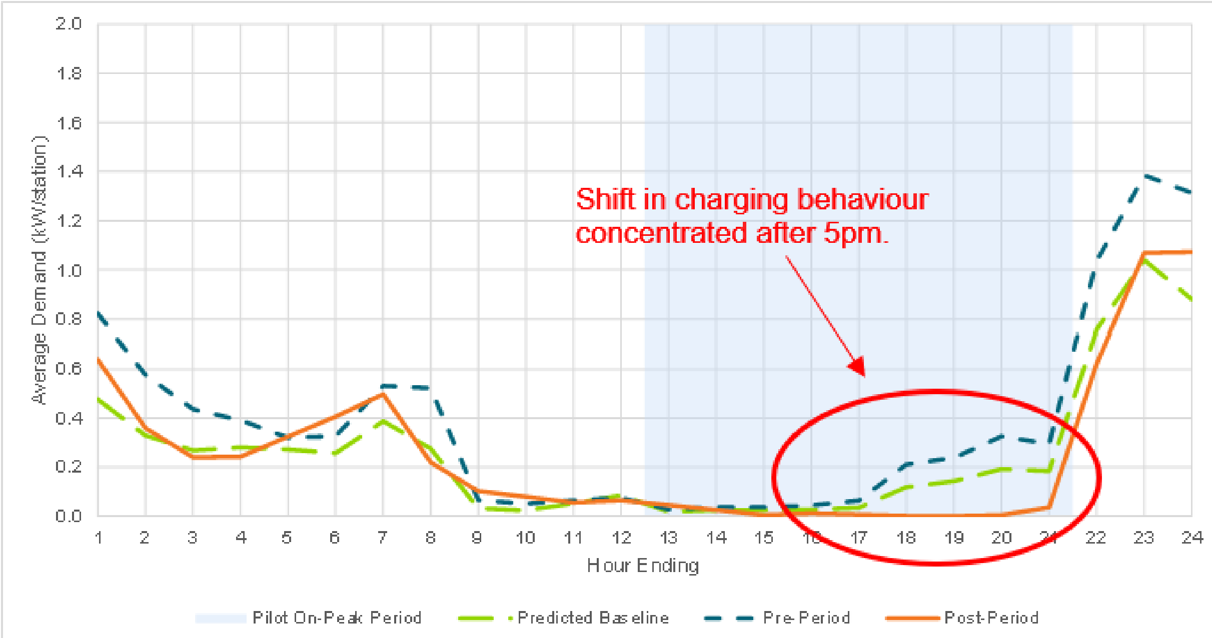


*Figure 8 - Avg. Non-Holiday Weekday Observed & Baseline Demand for SFHs. (Source: Generac interval data, Guidehouse analysis.)*

During on-peak periods, MURB participants delivered an average of 0.37 kW in savings per EVSE, compared to 0.08 kW per EVSE for SFH participants. For both participant types, this represented close to 85% of estimated baseline demand, indicating that participants shifted almost all charging activity outside of the 1pm – 9pm window.

On-peak impacts were relatively consistent throughout the pilot period. Both MURB and SFH participants showed the greatest response relative to baseline demand in April, reducing over 95% of load during the on-peak period. Off-peak impacts were smaller, with an estimated increase of 0.18 kW and 0.03 kW of demand per EVSE for MURB and SFH participants, respectively. The smaller off-peak impact was likely a reflection of the pricing structure – on a non-holiday weekday, there are 8 on-peak hours and 16 off-peak hours, so load shifted outside of the on-peak window can be spread more evenly throughout the day. For example, some participants may have shifted charging to start at 9 pm, while others may have charged in the morning of the following day.

Average impacts by building type, season, and pilot period are presented in Table 2, below. All impacts were directionally consistent with expectations (increases in demand during off-peak periods, reductions in demand during on-peak periods). However, MURB participants showed a much greater response to pricing during off-peak weekdays, with an average increase in demand of 0.18 kW (62% of baseline demand) compared to just 0.03 kW for SFH participants in the same period (10% of baseline demand).

*Table 2 - Average Pilot Period Impacts. (Source: Generac interval data, Guidehouse analysis.)*

| Building Type | Day Type | Pilot Period | Average Impact (kW / EVSE) | Baseline | Percent Savings | Standard Error | Relative Precision |
|---|---|---|---|---|---|---|---|
| MURB | Weekday | On-Peak | -0.37 | 0.44 | 83% | 0.09 | 39% |
| | | Off-Peak | 0.18 | 0.30 | -62% | 0.09 | 78% |
| | Weekend/ Holiday | Off-Peak | 0.05 | 0.44 | -11% | 0.13 | 451% |
| SFH | Weekday | On-Peak | -0.08 | 0.09 | 88% | 0.06 | 122% |
| | | Off-Peak | 0.03 | 0.34 | -10% | 0.06 | 304% |
| | Weekend/ Holiday | Off-Peak | 0.05 | 0.33 | -15% | 0.09 | 300% |

In general, the evaluation team was inclined for this evaluation to interpret most statistically non-significant results as indicating that the result is present, but highly uncertain. As mentioned in the evaluation plan, uncertain estimates are an expected outcome of this evaluation given the small sample size (<15 EVSE in each group), nature of the estimation approach, and granularity of the baseline. Moreover, survey results corroborated the finding that results were present for both MURB and SFH participants – participants at both building types reported shifting charging behaviour in response to the pilot.

Regardless of statistical significance. as anticipated, the pilot did significantly impact vehicle charging, shifting almost all demand from the on-peak period to other times of day.

## *Impact Evaluation Results (Peak Demand Management)*

Average kW impacts were estimated for PDM events to which MURB Group 1 participants were subject, by pilot period (on-peak, off-peak). As with DR events, these impacts were derived from an event-specific baseline derived from each EVSE's charging behaviour during the pilot period, i.e., these impacts were incremental to existing vehicle response to the pilot on-peak pricing. Given the large number of PDM events that occurred, results were not reported on a per event basis.

During on-peak periods, there was virtually no impact at Building A and Building B, driven by low EVSE usage during on-peak periods. Estimated impacts at Building C were larger, 0.16 kW per EVSE. This impact is relatively uncertain given only a single event took place during the on-peak period at Building C. During off-peak periods, average impacts were highest magnitude at Building B and Building D, representing savings of 0.7 kW and 0.88 KW per EVSE, respectively.

At Building A, Guidehouse estimated demand savings of 0.12 kW per EVSE, slightly higher than the 0.09 kW in savings estimated for the EVSE at Building C.

Figure 9 presents the average PDM impacts. Given the low frequency of events at the Building C and Building D sites, impacts are highly uncertain and should be interpreted with caution. Events were more frequent at Building A and Building B, but no estimates are statistically significant at the 90% confidence level.

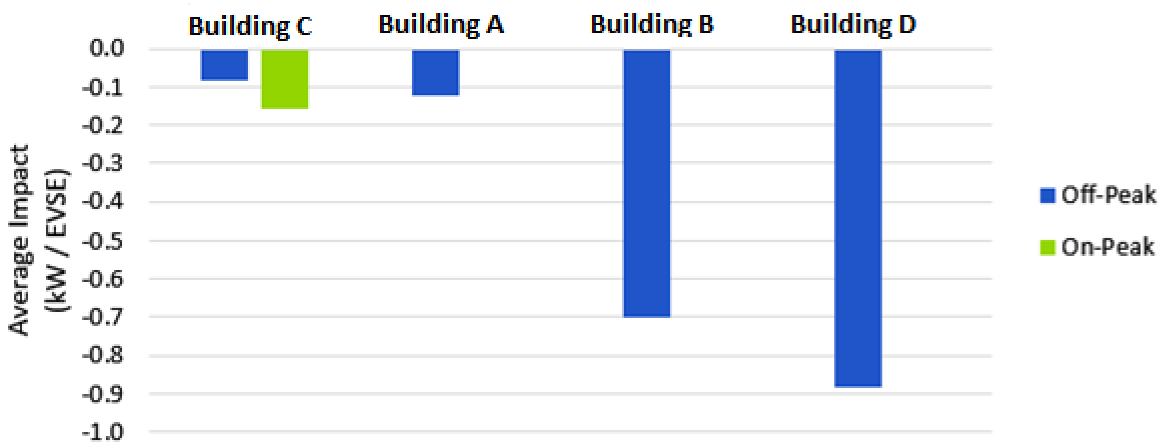


*Figure 9 – Avg. PDM impacts by pilot period and building. (Source: Generac data, Guidehouse analysis.)*

Despite relatively uncertain point estimates, the consistency of results across sites suggests estimated impacts represented real demand savings achieved by PDM. On average, PDM delivered modest but clear demand reductions during off-peak periods. PDM also appeared to have delivered on-peak demand reductions, but impacts were low and highly uncertain. Low impacts during the on-peak period were likely a result of the response to pricing treatment. Since EVSE were rarely in use during the on-peak periods, this reduced the ability of PDM to deliver savings in that window.

### *Impacts by IESO Cost-Effectiveness Period and Avoided Cost Benefits of EV Charging Response*

In Ontario, the provincial benefits of energy efficiency (also known as conservation and demand management, or CDM) are measured using the estimated value of avoided generation costs. Unit values of avoided costs are published by the Independent Electricity System Operator (IESO) as part of that organization's Cost-Effectiveness Tool. Avoided energy costs are provided by year, for eight different time periods. These are identified in the table below, drawn directly from the IESO's Cost Effectiveness Guide (see reference below in Figure 10).

| TOU Period | Winter | Summer | Shoulder |
|---|---|---|---|
| On-Peak | 0700 – 1100 and<br>1700 – 2000<br>weekdays<br>(602 Hours) | 1100 – 1700<br>weekdays<br>(522<br>hours) | None |
| Mid-Peak | 1100 – 1700 and<br>2000 – 2200<br>weekdays<br>(688 hours) | 0700 – 1100 and<br>1700 – 2200<br>weekdays<br>(783<br>hours) | 0700 – 2200<br>weekdays<br>(1,305 hours) |
| Off-Peak | 0000 – 0700 and<br>2200 – 2400<br>weekdays;<br>All hours weekends<br>and holidays<br>(1,614 hours) | 0000 – 0700 and<br>2200 – 2400<br>weekdays;<br>All hours weekends<br>and holidays<br>(1,623<br>hours) | 0000 – 0700 and<br>2200 – 2400<br>weekdays;<br>All hours weekends<br>and holidays<br>(1,623 hours) |

*Figure 10 – IESO avoided cost TOU periods. (Source: IESO).*

The estimated impacts of pricing by IESO TOU period were presented in Table 3 below. As previously, impacts were presented as average kW and average percent of baseline impacts and are accompanied by an estimate of the relative precision. Estimated energy impacts were applied to the average number of hours per TOU period in a calendar year to calculate average annual energy savings by TOU period.

*Table 3 – Avg. impacts by IESO avoided cost TOU period. (Source: Generac interval data, Guidehouse analysis.)*

| Season | Day Type | Cost Period | Average kW Impact | Relative Precision (+/- % at 90% Confidence) | Average % Savings | Energy Impact (kWh/EVSE/year) |
|---|---|---|---|---|---|---|
| Summer | Non-Holiday Weekday | On-Peak | -0.06 | 185% | 60% | -34 |
| | | Mid-Peak | -0.02 | 500% | 17% | -19 |
| | | Off-Peak | 0.05 | 289% | -14% | 86 |
| | Weekend/Holiday | Off-Peak | -0.06 | 176% | 51% | -84 |
| Shoulder | Non-Holiday Weekday | Mid-Peak | 0.05 | 285% | -14% | 87 |
| | | Off-Peak | -0.08 | 154% | 46% | -45 |
| | Weekend/Holiday | Off-Peak | -0.07 | 163% | 65% | -49 |
| Winter | Non-Holiday Weekday | On-Peak | 0.02 | 792% | -5% | 33 |
| | | Mid-Peak | -0.06 | 185% | 60% | -34 |
| | | Off-Peak | -0.02 | 500% | 17% | -19 |
| | Weekend/Holiday | Off-Peak | 0.05 | 289% | -14% | 86 |

Avoided generation capacity costs were also provided. The IESO cost-effectiveness tool assumed some value for avoided transmission and distribution capacity costs through 2018 but assigns these benefits a $0 value in subsequent years. Guidehouse applied these costs to the average combined impact of pricing and DR, weighted based on the number of historical 5CP occurring in each hour. The IESO cost effectiveness guide defined the peak demand reduction period as 1 pm to 7 pm during June, July, and August. Guidehouse used the IESO defined costs because they provided the best publicly available estimate of benefits but included all hours in which pricing and DR were in effect.

*Table 4 - Avg. peak demand impact. (Source: Generac interval data, Guidehouse analysis.)*

| Hour Ending | Percent of 5CP in Hour | Average DR Impact (kW / EVSE) | Average Pricing Impact (kW / EVSE) | Weighted Average (kW / EVSE) |
|---|---|---|---|---|
| 14 | 0% | - | -0.07 | 0.00 |
| 15 | 10% | - | -0.10 | -0.01 |
| 16 | 5% | - | -0.11 | -0.01 |
| 17 | 5% | - | -0.11 | -0.01 |
| 18 | 52% | -0.02 | -0.20 | -0.11 |
| 19 | 19% | -0.03 | -0.28 | -0.06 |
| 20 | 0% | -0.02 | -0.33 | 0.00 |
| 21 | 5% | -0.03 | -0.30 | -0.02 |
| 23 | 0% | -0.70 | - | 0.00 |
| 24 | 0% | -0.78 | - | 0.00 |
| **Total:** | | | | **-0.21** |

The average demand savings from DR and pricing may be applied to the annual avoided capacity costs to deliver an estimate of generation capacity benefits. The product of the energy benefits in Table 4 and the IESO avoided cost in each period delivered generation energy benefits. Guidehouse combined these benefits and calculated the net present value. For the purposes of this analysis, Guidehouse has assumed a “measure lifetime” of 7 years, a social discount rate of 4%, and that the first year of savings was 2023. Applying these estimated impacts and other assumed values **delivered a lifetime avoided cost benefit of EV charging behaviour changes from the program of approximately $113 ($2021) per EV**. This value did not include any estimated value associated with deferred distribution or transmission capacity upgrades, and, as noted above substantially understated its likely value as a resource for providing provincial coincident peak capacity.

## *EVSE Utilization & Curtailment Capability*

Pricing was effective at shifting EV loads in a block. Simple TOU-style pricing and the availability of vehicle charging scheduling options to drivers resulted in convergent migration of charging profiles to periods of lowest cost (typically periods in which demand imposes the lowest system costs). As EV adoption grows, event-based solutions such as DR may be required to manage load if EV adoption is sufficiently pronounced that the rate-driven load migration defines a new local or system peak that cannot be easily addressed through an appropriate adjustment of the price signal.

It is highly uncertain, however, at what point simply allowing pricing to push EV loads off-peak is insufficient and managed charging is required. Assuming that all EVSE are being exercised at their maximum delivery capacity simultaneously delivers very large estimates of EV-driven peak demand. Such estimates are often used in strategic discussions of energy transition concerns. The reality is that EV loads are temporally diverse, even within their least expensive pricing windows. Planning exercises based on projected EV (and especially level 2 EVSE) adoption must de-rate peak EVSE delivery capability values or risk over-investing in infrastructure.

## Process Evaluation Methods & Findings

The Guidehouse team employed a comprehensive process evaluation methodology, analyzing different facets of the program to gauge its effectiveness and impact. This approach ensured a holistic understanding of the program's operations, participant engagement, and overall outcomes.

- **Program Materials Review.** Guidehouse conducted a document review, reviewing a range of materials utilized by the pilot. This included educational content, email outreach communications, and promotional materials. This step was crucial in understanding the informational context and outreach strategies employed, providing insights into how participants perceived and interacted with the program.

- **Program Staff Interviews.** Guidehouse interviewed four staff members involved in the pilot, including program implementers, between August and September 2023. These interactions helped delineate the program’s internal workings and staff perspectives on its execution.

- **MURB Interview Analysis.** Alectra undertook a series of interviews with MURB participants in September and October 2023, which was analyzed by Guidehouse. The notes from these discussions provided nuanced, insight into participant experiences.

- **Participant Survey and Analysis.** Guidehouse reviewed surveys disseminated by Alectra to pilot participants at different stages of the pilot. These included a baseline survey (February 2023), an interim survey (June 2023), and a concluding survey (September 2023), encompassing feedback from 12 MURB and 16 SFH participants. These surveys captured the evolving perceptions and attitudes of participants throughout the pilot.

The process evaluation team compared its findings against the impact evaluation results, cross-verifying them with the qualitative data from the interviews and surveys. This approach ensured consistency and validity in our findings.

### *Effectiveness of Models (Process Evaluation)*

Across the surveys with MURBs and SFHs, there were a few key similarities and differences. Both MURB and SFH participants indicated high levels of satisfaction with the program's overall management, the reliability of the charging technology, and the clarity of communications they received. A notable difference lay in the complexity of installations and ongoing management of

EV charging in MURBs, requiring more robust communication strategies and coordination with property management.
In contrast, SFH participants enjoyed more straightforward experiences. Both groups shared concerns about the pricing structures and would prefer to avoid paying the premium during peak periods. However, there was a general openness to participating in future initiatives, especially those offering financial incentives.

There were four main differences between the groups.

*Table 5 – Key differences in EV installation between SFHs and MURBs. (Source: Guidehouse Analysis of Survey and Interview data.)*

| Topic | SFH | MURB |
| --- | --- | --- |
| **Installation Logistics** | **SFH installations were typically more straightforward** because they usually involve a single homeowner's decision and direct coordination with the installers. There was no need to negotiate with multiple stakeholders, making the process quicker and more efficient. Homeowners had greater freedom in choosing the location of the chargers, and there were fewer restrictions concerning electrical capacity and parking arrangements. | **MURBs faced more complex logistics**, requiring coordination with property management, condo boards, and potentially other residents. The installation must often accommodate multiple vehicles.<br><br>The process can be slower due to the need for approvals and potential electrical upgrades to support the additional load, especially in larger MURBs. Parking arrangements can also be more complex, requiring designated spaces for EV charging. |
| **Ongoing Management** | **Homeowners had direct control over their EV charging stations,** with little need for ongoing coordination with third parties. This autonomy can lead to higher satisfaction rates and less administrative overhead. However, the homeowner was solely responsible for maintenance and any required troubleshooting. | **MURBs required a more structured management approach** to ensure fair access to charging stations, handle maintenance, and resolve any user disputes. This may have involved scheduling systems, communication protocols, and designated personnel to manage the EV charging program. While more complex, this structured approach was necessary to maintain order and satisfaction among multiple residents. |

| Topic | SFH | MURB |
|---|---|---|
| **User Satisfaction** | **SFH participants often reported high satisfaction,** likely due to the ease of installation and autonomy over charging systems. They were able to manage their charging schedules, maintenance, and any upgrades directly, with no need to coordinate with neighbors or management entities. | **Satisfaction levels in MURBs did vary significantly**, influenced by factors like charging station availability, ease of access, and property management communication effectiveness. Successful MURB installations featured clear guidelines, robust support, and effective communication channels, enhancing resident satisfaction. |
| **Feasibility and Cost-Effectiveness** | **SFH participants reported a positive experience**, citing the ease of installation and management of charging times. They appreciated the reliability of the hardware and the clarity of program communications. Like MURB participants, the reaction to rate changes was mixed, with some participants expressing caution about increased costs during specific periods. | **Many MURB respondents appreciated the program but indicated a perceived need for more accessible charging solutions within their living arrangements.** While some MURB participants noted the program was “game-changer” for EV drivers in condos, others expressed desires for the program's extension or expansion. The introduction of new rates, especially the Ultra-Low Overnight (ULO) rate, was met with interest, though some participants were still evaluating its value for their specific situations |

### *Regulatory Barriers and Solutions*

The pilot highlighted several complex challenges in retrofitting EVSE into existing MURBs. This was primarily due to logistical hurdles such as the strategic placement near designated parking spaces, the augmentation of power supply in locations where existing infrastructure was insufficient, and the establishment of reliable Wi-Fi connectivity in subterranean garages, which was essential for the operation of the EVSE use-cases and pricing.

It was challenging for MURB managers to provide pilot participants charging station access near their allotted parking spot or provide reliable access to a shared spot to charge their EV. Navigating the regulatory landscape to address these challenges was nontrivial. While electrical codes serve as non-negotiable safety standards, there was latitude for policy innovation in other areas to help MURB managers mitigate these barriers.

For example, providing additional financial incentives would have helped MURBs afford the costs necessary to upgrade electrical systems when installing multiple EV charging stations. More proactive measures like advocating for building code policies that mandate the inclusion of EV charging facilities in new building designs would help reduce those expensive future retrofit costs in the longer term.

### *MURB Technical Issues*

While interview data shared generally positive feedback regarding the pilot, MURBs faced some unique challenges. Addressing these pain points may help to improve delivery for future scaled programs.

*Table 6 - Technical issues for MURB participants. (Source: Guidehouse Analysis of survey and interview data*

| Technical Challenge for Participation | Details |
| --- | --- |
| **Connectivity Issues** | Participants noted internet connectivity variations, especially in underground garages, as sometimes experiencing less consistent connections. This made it challenging for consumers to respond to price signals by program their EV remotely to avoid charging in the on-peak period. This influenced the ease of ongoing pilot participation. |
| **Hardware Challenges** | Participants encountered instances of device malfunctions or interactions with existing infrastructure that required additional troubleshooting. These occurrences were part of the pilot's technological adaptation phase and influenced various activities and engagement levels. |
| **Navigating New and Intricate Software** | Feedback included mentions of challenges navigating the software platforms, from encountering unexpected bugs to adapting to user interface (UI) designs. These learning opportunities were part of familiarizing with the digital tools provided and occasionally influenced the smoothness of user experience. |
| **Accessing Technical Support** | Access to technical support was a highlighted aspect, with suggestions for enhancing the responsiveness of this service. Timely assistance was identified as a key factor in maintaining steady program engagement and effectively addressing participant queries or concerns. |
| **Security Awareness** | Awareness of digital security within online platforms was evident, with participants mindful of data privacy and unauthorized access risks. Ensuring a secure digital experience was important for maintaining confidence in the program's technological aspects. |
| **Resource Utilization Guidance** | There was desire for more comprehensive guidance or training to fully leverage the program's technological resources and tools. Enhanced educational support could further empower participants to maximize the benefits and functionalities offered. |

Ensuring EVSE installations were compliant with building and electrical codes was costly and logistically challenging. Alectra should therefore focus on enhancing its "soft services" like outreach and communication to encourage more participation, or by being more proactive: advocating for policies that require installation of EV chargers during the development of

MURBs (rather than as an afterthought when it would have to be retrofitted, as was the case during this pilot).

Table 7 highlights these key recommendations to encourage MURB participation.

*Table 7 - Key recommendations to increase MURB participation. (Source: Guidehouse analysis of survey data.)*

| Category | Key Recommendations |
|---|---|
| **Address Financial Constraints** | **Offer Financial Incentives:** Many MURB participants cited budget constraints has a primary concern. Therefore, providing financial incentives such as discounts, rebates, or financing options could encourage participation. This could be facilitated by pursuing grants and funding for installations. |
| | **Demonstrate ROI:** Create clear case studies showing the return on investment (ROI) from program participation, emphasizing long-term savings and value. |
| **Resolve Technical Issues** | **Ensure Connectivity:** Wi-Fi connectivity is vital for EVs as it enables smart charging management, allowing EVs to charge during off-peak hours enabling remote monitoring and control of the charging process, enhancing user convenience and grid management. Ensuring this connectivity in MURBs (in basement parking garages) will be crucial for allowing those drivers to participate in managed charging. |
| | **Provide Technical Support:** Establish a robust technical support system to assist participants with any issues they encounter, ensuring quick and effective resolutions. |
| | **Simplify Technology:** If participants faced difficulties with the technology, consider simplifying or offering alternative, more user-friendly solutions. |
| | **Work with new and upcoming condos to integrate EV infrastructure in planning phase:** To avoid the retrofit complications from MURB physical and electrical infrastructure, and to ensure that EV infrastructure is available and integrated into new buildings, partner with designers and contractors during project planning. |
| **Enhance Communication and Outreach** | **Tailored Communication:** Communicate program benefits and procedures clearly and effectively. Tailor your message to address the specific needs and concerns of MURB managers or owners. |
| | **Engage Community Leaders:** Use MURB community leaders to advocate for the program, as they can relate better to residents and provide more personalized encouragement. |
| **Offer Customization and Flexibility** | **Flexible Options:** Recognize that one size doesn't fit all. Offer options that cater to different budgets, preferences, and building capacities. |
| | **Custom Solutions:** Provide opportunity for MURBs to have a say in the program's specifics, ensuring it fits their needs and constraints. |
| **Provide Education and Training** | **Workshops and Seminars:** Organize educational sessions to inform participants about the importance and benefits of the program and train them on any technical aspects. |

| Category | Key Recommendations |
| --- | --- |
| | **Resource Materials:** Offer guides, FAQs, and other resources that participants can refer to at any time. Focus on providing easily understood information to an audience with limited to no technical understanding. |
| **Build Trust with Transparency** | **Share Success Stories:** Highlight successful case studies from other MURBs that have benefited from the program. |
| | **Transparent Processes:** Be clear about costs, expectations, processes, and the support available, so there are no surprises. |
| **Streamline the Participation Process** | **Simplify Enrollment:** Make it easy to join the program, with minimal paperwork and red tape. |
| | **Dedicated Support Team:** Have a team ready to help new participants through the enrollment process and any initial hurdles. |
| **Feedback Loop** | **Regular Surveys:** Continue to gather feedback to understand ongoing challenges and successes participants are experiencing. |
| | **Adapt and Improve:** Show that you are listening by adapting the program based on the feedback received. |

Based on the interview responses from various MURB participants involved in the pilot, several insights emerged regarding best practices, successful approaches, and strategies for effective communication and collaboration with condo boards and property managers. Guidehouse synthesized three practices to encourage MURB participation:

- **Inclusive Decision-Making:** Engaging all stakeholders, including tenants, owners, and board members, in the decision-making process was crucial. This approach ensured broad support and facilitated smoother implementation. Participants who were decision-makers or had a significant influence, such as property managers and board members, played a pivotal role in advancing these initiatives.

- **Proactive Communication:** Effective communication strategies, including distributing notices and holding informative meetings, were essential in promoting the EV charging programs. These efforts helped in addressing misinformation, setting expectations, and enhancing the acceptance of the program.

- **Leveraging Incentives:** Financial incentives or support programs, such as those offered by the pilot, were significant motivators. They not only made participation financially attractive but also encouraged stakeholders by offsetting some installation costs and adding perceived value to the property.

Through our analysis of interview responses and survey data, Guidehouse identified success stories of addressing the program implementation and any challenges. Those successful approaches included:

- **Collaborative Planning:** Successful implementations were often those where there was close collaboration between the property management, condo board, and service providers. This collaboration was particularly important during the installation phase, addressing technical or regulatory hurdles, and ensuring the solutions met specific building requirements.

- **Addressing Technical Challenges:** Buildings that anticipated and effectively managed technical barriers, such as internet connectivity for chargers or electrical infrastructure limitations, avoided delays and ensured a better experience for end-users.

- **Regulatory Navigation:** Understanding and navigating through regulatory requirements, including zoning, permitting, and building codes, were critical factors in the timely and compliant installation of EV charging stations.

To enable effective communication and collaboration with MURBS, Guidehouse identified the following three best practices:

- **Transparency:** Open lines of communication between the board members, property managers, and residents helped in pre-empting opposition, especially concerning changes in common spaces or alterations affecting individual units.

- **Education and Information Sharing:** Providing clear and accessible information helped alleviate concerns from residents. This strategy was particularly effective in countering misinformation regarding safety or financial implications.

- **Responsive Feedback Mechanisms:** Establishing a system for addressing feedback, both positive and negative, contributed to the program's success. This approach included dealing with technical issues promptly and having clear protocols for residents to report problems or concerns.

Considering the challenges in navigating condo boards and property managers, the following activities would be necessary in scaled projects:

- **Building Consensus:** For initiatives requiring collective agreement, such as MURB by-law changes, successful strategies involved early board member engagement and comprehensive information dissemination to build consensus.

- **Facilitating External Engagements:** Some participants found value in external engagements, such as consultations with installation experts or interactions with other condos that had successfully implemented similar programs. These engagements provided valuable insights and reassured stakeholders.

- **Managing Expectations:** It was important to set realistic timelines and be transparent about potential disruptions during installation. Effective communication about the scope, benefits, and procedural aspects of the program helped in managing expectations and reducing dissatisfaction or resistance.

***Value of the Program and Participation***

Several MURB respondents expressed satisfaction with the program, noting it as a "game changer" and appreciating the ease of charging at home. As noted earlier in this report, 82% of respondents indicated they were satisfied with the value for their money. MURB respondents also highlighted the importance of having management with forward-thinking goals.

Concerns were raised about the need for better internet connectivity especially in underground parking areas, the desire for the special program rates to be made permanent, and access to EV charging stations (in MURBs where there wasn't 1:1 EV to charger ratios). These points suggested that ongoing costs and the permanence of favourable rates are significant factors in customer decisions.

Some SFH respondents mentioned the importance of clear communication and the need for earlier notice about charging events, which points to the value placed on transparency and predictability in program participation. MURB and SFH respondents appreciated the charging experience reliability and Alectra's clear communications. However, there were suggestions for improvements, such as better explanations at the start of the program and more responsive support.

Overall, the survey results reflect a general willingness to engage with EV charging programs, particularly when they are accompanied by clear benefits, such as convenience and cost savings. However, the data also highlights the need for programs to address potential barriers, such as technical issues and the need for better communication and support.

## *Program Improvement Recommendations*

The recommendations presented below are designed to enhance future EV program operational frameworks, participant engagement, and overall impact. By addressing the financial, technical, and educational aspects of the program, and advocating for forward-thinking policy changes, Alectra can ensure a more scalable transition to sustainable electric transportation solutions for both SFH and MURB residents. Further research should be conducted to monitor the long-term effectiveness of these recommendations and to explore their applicability to other regions and programs. Please see Table 7: Key Recommendations to Increase MURB Participation for an exhaustive list of key improvement recommendations.

- **Financial Accessibility and Incentivization**
    - A recurrent theme across participant feedback was the financial barrier to entry. A robust incentive framework would support continued expansion of MURB installations. This could include targeted discounts, rebates, and flexible financing options, all designed to lower the participation threshold. Additionally, by presenting clear, demonstrable case studies articulating the ROI, Alectra can reinforce the program's value proposition and long-term economic advantages. Perhaps these financial incentives can also be achieved through securing grants, rebates, or subsidies that target MURBs to enable more economic options.

- **Advocate for Regulatory Changes to Building Code**
    - Technical challenges, particularly retrofitting EV charging stations within existing MURB infrastructures, have been a notable concern. To address this, Alectra should consider advocating for policies to mandate that EV-ready electric systems be included in the construction of new MURBs.

- **Community Engagement and Educational Resources**

- The evaluation underscores the necessity for communication strategies that are tailored to the needs of MURB stakeholders. To facilitate this, improved community engagement and educational resources will be crucial.
- Engaging with community leaders and leveraging their influence can enhance program advocacy, driving deeper engagement and participation. For SFHs, where decision-making is typically less complex, maintaining clear and consistent communication channels will continue to be essential for program transparency and participant satisfaction.
- To empower participants with the knowledge and skills required to navigate the program, Guidehouse recommends that Alectra consider developing educational resources that are accessible and easily understood by a non-technical audience. These could include user-friendly guides and FAQs, or short instructional videos designed to support both SFH and MURB participants. To adapt resources that will be understood by customers, Alectra should consider using focus groups to probe for preferred modalities of accessing information. This approach will facilitate a better understanding of the program's benefits and ensure that participants are well-equipped to leverage the technology effectively.

- **Streamlining Enrollment and Support**
  - The enrollment process should be as frictionless as possible. Alectra should consider ways of simplifying the enrollment process to minimize administrative effort. A full deployment of the program to Alectra's service territory would benefit from a dedicated support team, tasked with guiding potential participants through the initial program stages and addressing preliminary concerns. MURB stakeholder interviews demonstrated the importance of focusing enrollment with the MURB management rather than with tenants who would need to work through MURB leadership to have a charger installed.
  - This further underscores the idea that working with MURBs *before* construction, rather than retrofitting EVSE to the MURB would reduce costs and administrative overhead. Pre-construction engagement would ensure that EV Charging stations meet electrical, zoning and building codes, are more likely to be situated in areas that are more useful for tenants, and is coordinated by the MURB leadership, thereby making the enrollment and setup as seamless as possible for prospective customers.

- **Feedback Mechanisms and Continuous Improvement**
  - A structured feedback mechanism is vital for capturing participant's evolving needs and experiences. Regular surveys and feedback channels should be instituted, with the dual aim of gauging participant sentiment and identifying areas for programmatic refinement. Demonstrating adaptability by evolving the program in response to this feedback will be critical to its ongoing success.

## *Summary of Process Evaluation Results*

Process evaluation findings aligned with those of the impact evaluation; survey respondents stated that adjustments in pricing would drive their charging habits. Other key process findings include:

- **Unlocking Potential.** MURB drivers referred to being provided access to EVSE in parking as a “game-changer”. Although these (and SFH) drivers expressed dissatisfaction with time-varied pricing, price response (as documented by the impact evaluation) was very strong, exceeding pilot expectations.

- **MURB Barriers.** It is more costly and more challenging to implement managed charging in MURBs than in SFHs. This has impacts on customer satisfaction and perceived value, with MURB drivers generally less positive than SFH drivers.

- **Technology Development and Support.** Device malfunctions, problems with inter-operability across platforms and coordination across vendors impacted the perceived value and customer satisfaction; for example, Wi-Fi connectivity problems due to EVSE installation locations appears to have constrained MURB driver price response and program satisfaction.

- **Communication is King.** Participants and stakeholders indicated a high level of satisfaction with the degree of consultation, communication, and transparency provided by Alectra. Expanding the pilot to a wider deployment will challenge the delivery team. To build on the pilot’s success and manage the costs of communication and education, Alectra will require a communications strategy that is structured for scale, but one that provides the team with the flexibility to address client-specific challenges as they arise.

Table 8 shows which motivators most influenced MURB and SFH participants.

For each motivator, responses for each group were analyzed in two categories: motivated versus least motivated. The strongest motivators for charging behaviour (75% of respondents or higher) are highlighted in bright green cells, and least important motivators (75% of respondents or higher) in pink cells.

Table 8 shows that monetary incentives are the strongest motivators for both MURBs and SFH. The least important motivators were social incentives such as comparing charging behaviour with peers and reducing environmental impacts.

*Table 8 - Charging Behaviour Motivations. (Source: Guidehouse analysis of survey data.)*

*Question: To what extent would the following motivate you to change your current charging behaviour? Please rank the below from most motivated […] to least motivated […]*

| | | MURB | | SFH | |
|---|---|---|---|---|---|
| Motivator | Type of Motivation | Most Motivated | Least Motivated | Most Motivated | Least Motivated |
| Knowing that my changes would enable the grid to better support more EVs | Social / Environmental | 64% | 36% | 69% | 31% |
| Knowing that my changes would help enable more EV charging infrastructure | Social / Environmental | 55% | 45% | 31% | 69% |
| Changes to Alectra's Time of Use electricity rates that charge less for charging overnight, for example. | Financial | 73% | 27% | 81% | 19% |
| Monthly monetary incentives to charge my EV at certain times of day | Financial | 73% | 27% | 81% | 19% |
| Monthly monetary incentives to avoid charging my EV at certain times of day | Financial | 82% | 18% | 87% | 13% |
| Comparison of my electricity use with others in my community | Social / Environmental | 9% | 91% | 0% | 100% |
| Reduction in environmental impacts | Social / Environmental | 18% | 82% | 25% | 75% |
| Lower electricity charges for everyone | Social / Environmental | 27% | 73% | 25% | 75% |

The program demonstrated the potential for sustainability and scalability. Sustainability is closely tied to the program's ability to present an attractive value proposition to customers, to continue to influence consumer behaviour. The introduction of financial incentives and a technical support framework has proven effective and will remain integral as the program expands. Additionally, the program's focus on education has laid a foundation for sustained participant engagement and informed decision-making.

The feasibility of scaling up the pilot may depend on the evolution of EV policy within the relevant regulatory bodies, and the support these provide for EV adoption. For instance, as and when building codes grow to encourage or require the inclusion of EV charging infrastructure in new MURB developments, the opportunity and potential for applying the pilot design to manage distribution system costs will grow.

## Conclusions and Recommendations

The evaluation identified several findings that carry implications for the future of EV infrastructure installation in both SFHs and MURBs. Notably, the pilot illuminated the important role of pricing structures to influence participant behaviours. Survey respondents stated that adjustments in pricing would drive their charging habits, with a marked shift to prioritize charging during off-peak hours. This behavioural adaptation has important ramifications for managing peak demand and ensuring the stability of the electrical grid as EV adoption escalates.
The most material conclusions of Guidehouse's evaluation of the Group 1 component of the "@Home" EV Rewards program are:

1. **EV drivers' charging behaviours were highly price-elastic.**
    a. Pilot participants reduced EV charging demand by over 80% during the on-peak period (1 pm-9 pm on non-holiday weekdays). This was the period in which the price of EV charging increased – participants were subject to a fee of $2 - $4 per hour (depending on building type) to charge their vehicle during this time, incremental to the cost of electricity.
    b. MURB and SFH participants were more motivated by financial incentives than environmental or social incentives to change charging behaviour. Most SFH (87%) and MURB (82%) participants reported that monetary incentives to avoid charging their EV at certain times of day would affect their behaviour.
    c. This finding was consistent with the Group 2 evaluation, as well as recent professional literature, including the work recently conducted by the Ontario Energy Board (OEB) that resulted in the development of the new ULO voluntary RPP TOU rate that became available to RPP consumers as of May 1, 2023.

2. **DR events were an effective mechanism for reducing load during periods *when pricing is not in place*. Reliable Wi-Fi connectivity was essential for ensuring efficacy.** During DR events that did not overlap with the on-peak pricing period, MURB and SFH participants reduced demand by an average of -0.92 kW and -0.65 kW per EVSE, respectively. DR events consistently delivered meaningful demand reductions, typically over 70% of estimated baseline demand. However, for events overlapping with the on-peak period from 5 pm – 9 pm, demand reductions were close to zero for all participants due to low baseline demand, due to the pricing response.

3. **Managed charging in MURBs faced many logistical challenges.** Wi-Fi connectivity was essential for EVs and charging stations to participate in DR programs and ensure its efficacy. MURB sub-terranean parking garages presented challenges in accessing Wi-Fi and may have prevented drivers from remotely managing charging schedules, which was critical when charging is disrupted by DR events. The Alectra program team experienced challenges with some pilot implementations (e.g., PDM dispatch, pricing applied to drivers, etc.) and drivers themselves encountered device malfunctions or other hardware problems that impacted engagement.

4. **PDM events delivered modest demand reductions but may not be an effective tool for materially reducing non-coincident peak load for a building or delivering value for the distributor.**
    a. PDM events delivered modest demand reductions, with projected ex-ante non-coincident peak demand impacts of less than 0.15% of peak building load. Even if a customer specific non-coincident peak demand reduction is achieved, this delivers value only if a customer's demand is coincident with the peak demand experienced by the distribution asset that serves it.
    b. PDM dispatch does not guarantee a MURBs monthly demand charge will be reduced. Customers' peak demand is a highly dynamic and volatile moving target, and EV loads are generally a small component of peak load.

As of December 2022, the OEB has amended the Standard Supply Service Code and RPP to allow RPP consumers the option to enroll the RPP ULO TOU price plan as of May 1, 2023. This new price plan, if adopted by individual EV owners, provides a substantial incentive to drivers to shift their charging behaviours even further away from existing patterns than did this pilot.

Given these findings, Guidehouse recommends current and future programs consider the following:

- **Focus on Pricing:** Pricing is very effective at shifting EV charging loads. Pricing leaves control in the hands of drivers (several drivers referenced concern about allowing Alectra direct control over their charging). When pricing reflects upstream costs, drivers will make decisions that efficiently balance their preferences with system costs. Alectra may wish to consider (in future implementations) allowing individual MURBs to define their own on-peak period to control their building specific demand and wholesale electricity costs more effectively.

- **Continue to Test Active EV Managed Charging.** Pricing is effective at shifting EV loads as a group, but if EV adoption grows to the point that EV loads define local peaks additional solutions will be required to manage distribution and bulk energy system costs. As shown by this pilot, and others, active EV charging is a much more complex implementation than (e.g.,) A/C direct load control due to the proliferation in control avenues (OEM telematics, EVSE, third-party devices) and major and on-going interoperability challenges. However, solutions such as DR offer predictable and consistent demand reductions when properly implemented. Continued testing of different ways to dispatch EV loads will allow Alectra to refine and develop the technology into a satisfactory non-wires solution for use on its network and others.

- **Promote Pricing Models that Emphasize Money Savings:** Pilot participants reported their charging behaviour is more motivated by financial *incentives* than *disincentives*. More than half of MURB participants reported that they are "Uncomfortable" or "Very uncomfortable" with being charged a higher rate in the peak charging model. Off-peak benefits should be promoted and messaging the consequential increased on-peak costs should be refined with the assistance of market research professionals.

- **Tailored Communication and Technical Support:** Alectra's communications must cater to the diversity in customer comprehension of EV technologies and time-varied pricing. For example, participants reported the most successful MURB installations featured clear guidelines, robust support, and effective communication channels, enhancing resident satisfaction. For instance, one MURB respondent appreciated the “Process [was] explained clearly step by step. Even when there were hurdles in the process, Alectra was flexible in pivoting to other solutions to continue the process of getting the charging hubs to reality. (I can think of other organizations that would have ground to a halt or abandon altogether.” SFH and MURB tenants cited the importance of emails, clear instructions, and direct contact with Alectra. Adopting a tailored communication strategy will enhance customer satisfaction, streamline service delivery, and foster an informed, engaged community, leading to efficient query resolution and improved customer interaction.

- **Feedback Integration**: Considering the transition from pilot to program, Alectra should continue to provide an ongoing mechanism for collecting EV driver feedback to refine and adapt its offerings to support cost-effective EV adoption. This feedback is crucial for maintaining understanding and buy-in, can help in identifying unforeseen issues, and offer continued program improvement opportunities. Alectra should consider providing participants opportunities to provide feedback through surveys, focus groups, and interviews to capture greater insights. To encourage participation, consider offering small incentives (especially when there is apathy or reluctance to engage) to acknowledge the effort and time that was given by customers who provide feedback. Models that promote immediate rewards (digital gift card upon completion of survey or focus group discussion) may be most effective for encouraging feedback.

- **Engage with MURB Management During Pre-Construction Design Phases; Advocate for Policy Supportive of EV Infrastructure in all New Builds:** Findings from the process evaluation underscored the challenges of retrofitting EV charging stations into existing infrastructure, especially in MURBs. Policies that result in the installation of charging stations during the construction phase of MURBs would provide Alectra, EV drivers, and MURBs with more efficient, cost-effective, and conveniently located charging stations.