# Alectra Utilities Regulated Price Plan Pilot – Interim Report

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Alectra Utilities with its partner BEworks

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## About Alectra

Alectra's family of energy companies distributes electricity to more than one million homes and businesses in Ontario's Greater Golden Horseshoe area and provides innovative energy solutions to these and thousands more across Ontario. The Alectra family of companies includes Alectra Inc., Alectra Utilities Corporation and Alectra Energy Solutions. Learn more about Alectra at alectrautilities.com.

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## About BEworks

Founded in 2010, BEworks is an unconventional management consulting firm that applies scientific thinking to transform the economy and society. BEworks' team of experts in cognitive and social psychology, neuroscience, and marketing answer clients' most complex business questions, execute disruptive growth strategies, and accelerate innovation.

Part of the kyu collective of companies since January 2017, the firm's client list includes Fortune 1000 companies, not-for-profit organizations and government agencies. BEworks was co-founded by Dan Ariely, renowned behavioural scientist, Kelly Peters, the firm's CEO and BE pioneer, and top marketing scholar Nina Mažar.

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## Executive Summary

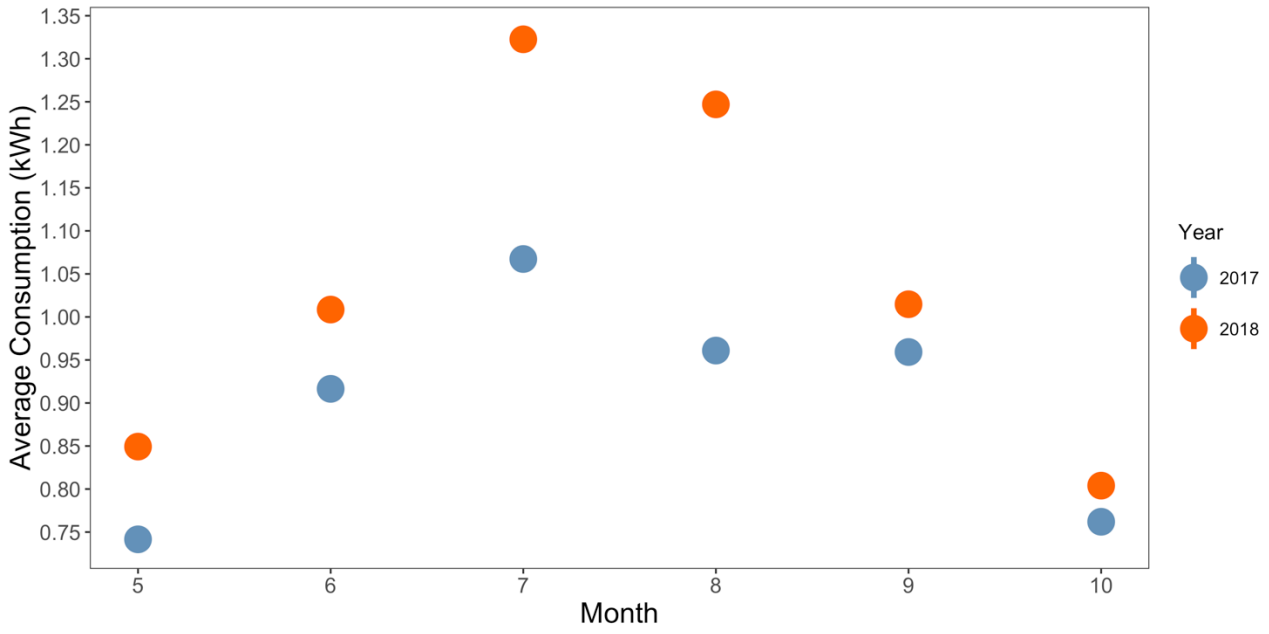
The Ontario Energy Board (OEB), through its Regulated Price Plan (RPP) pilots, seeks to examine the impact of alternative pricing schemes and non-price interventions on conservation and demand management behaviors among utility users. Alectra Utilities (Alectra), and its partners, is currently testing the impact of three separate time-of-use pricing schemes (Dynamic, Overnight, and Enhanced) with two non-price interventions (Nudge Reports and thermostats to achieve the OEB's RPP pilot objectives) in a program named Advantage Power Pricing (APP).

### Program Preliminary Results

The preliminary results (May to October 2018) of both the APP price plans and the non-price interventions come out with clear, informative results that suggest that conclusions can be obtained from the study, as summarized in the tables below.

To begin, we first present a figure displaying the overall change in energy consumption from 2017 – 2018 (see Figure 1). Mainly due to weather effects, there was an overall increase in energy consumption in 2018. For this reason, our analyses will present the results using a difference-in-difference (DID) approach. The DID compares the year-to-year difference in a control to the year-to-year difference in a treatment. For example, if from 2017-2018 the control group consumed 30% more electricity, but the treatment condition consumed only 15% more electricity, we can then conclude that the treatment lead to a 15% reduction in consumption relative to the control group.

*Figure 1* – Overall Energy Consumption (kWh) in Year 2017 and 2018



Overall, the effect of the pricing treatments[1] resulted in substantial decreases in consumption during Overnight and Dynamic On-Peak hours (7.4% and 15.6% respectively). In addition, there was a substantial increase in consumption during Overnight Off-Peak hours (29.6%) and no change in consumption during Dynamic Off-Peak hours. The Enhanced plan however showed no change in On-Peak consumption, and an increase in Off-Peak consumption of 0.6%. These changes are compared to the control condition which included the standard TOU pricing system. For all three pricing pilots, only households with full compliance were included in the analysis (move-outs and opt-outs were excluded). A further intent-to-treat analysis was performed in the Enhanced group to measure the impact of households opting out which concluded no significant differences from the original findings.

*Table 1*: Main effects of price plans (comparing treatment group versus control group)

| APP Price Plan | Main Effect of Price (Relative to Control) | |
|---|---|---|
| Enhanced | On-Peak | Off-Peak |
| | +0.17% | **+0.64%*** |
| Overnight | On-Peak | Super Off-Peak |
| | **-7.4%***** | **+29.6%***** |
| Dynamic | High On-Peak | Off-Peak |
| | **-15.6%***** | +0.18% |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

The results of the pricing interventions show strong impacts from the Overnight and Dynamic pricing plans, and weaker impacts for the Enhanced plan. This may be due to one or more of the following reasons: 1) the energy savings were more substantial for households which participated in pilots which required a voluntarily sign-up compared to households who were randomly opted-in to the pricing programs; and 2) the price differential in the Enhanced Plan may not be a big enough change from standard TOU rates, compared to the Dynamic and Overnight plans.

In addition to the pricing interventions, half of the participants in each of the pricing Treatment and Control groups were randomly assigned to receive a non-price intervention. This non-price intervention is a monthly report that accompanies the shadow bill for pricing Treatment participants (or is sent as a stand-alone report in the case of pricing Control participants). This monthly report is referred to as a 'Nudge Report' because it contains information drawn from the field of behavioural economics intended to nudge conservation behaviours among recipients. Specifically, the Nudge Report encourages recipients to 'pledge' to reduce their on-peak electricity consumption, displays personalized tips for achieving this goal, and provides personal benchmarking feedback so that recipients can track their on-peak consumption behavior month-to-month. The effect of the Nudge Report resulted in decreased On-Peak consumption relative to the standard control for both the Enhanced and Dynamic plans. No

[1] The main effect of price reported in *Table 1* is averaged across recipients and non-recipients of Nudge reports.

Overnight participant received a Nudge Report. This was due to a small number of participants under this price plan making it difficult to achieve desired levels of confidence if we further break down the participants to a subgroup receiving Nudge Report versus not. In the Enhanced plan, the Nudge Reports resulted in a 1.5% decrease in On-Peak consumption with no change in the Off-Peak consumption. Moreover, in the Dynamic plan, the Nudge Report reduced consumption during Critical Peak Price (CPP) hours by 3.5% but did not significantly decrease consumption for On-Peak or Off-Peak hours.

Table 2: Main effects of Nudge Report (comparing Nudge Report recipients versus non-recipients)

| APP Price Plan | Main Effect of Nudge Report (Relative to non-recipients) | | |
|---|---|---|---|
| Enhanced | On-Peak | Off-Peak | |
| | -1.5%* | -0.23% | |
| Dynamic | High On-Peak | Off-Peak | CPP Days |
| | -1.46% | +0.01% | -3.49%* |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1*

The evidence suggests that the Nudge Report was a successful method of reducing consumption during On-Peak hours, with savings ranging from 1.5% - 3.5%. This effect was consistent and generalizable between the Opt-In and Opt-Out households. This is in contrast with the price plans which showed substantial savings ranging from approximately 9% - 15% during On-Peak hours only for opt-in programs, with such savings not achieved by participants in the Opt-out program.

These consumption savings (or increases) equate to customers' bill savings (or additional costs). The average monthly APP bills (covering the period of May to October) for each price plan were calculated and compared to the average monthly TOU bills (what participants would have paid if they were on standard TOU rates). The analysis shows that Overnight participants obtained savings on their monthly bills, Enhanced participants experienced small costs, and Dynamic participants experienced costs in July and August and savings in shoulder months netting to a small total amount of savings. Figures showing the distribution of the total savings per pricing pilot are shown in Appendix C.

## CONCLUSIONS

In summary, this project thus far has successfully tested three separate pilot pricing programs in combination with a Nudge Report. The results/effects associated with the thermostats and in-home technology will be included in an addendum to this report to be submitted to OEB in Spring 2019. At the time of this report's writing, the first eight months (up to December 2018,) of the unprotected pilot period have been completed, and this report covers the first six months (May-October) of data. April data will be included in the final report as part of the RPP Winter period.

To date, it appears that both the Dynamic plan and the Overnight plan have yielded reductions in On-Peak consumption and Overnight pricing resulted in noticeable customer bill savings. At this time, no effect from of the Enhanced plan on On-Peak consumption has been seen; however, an increase in Off-

Peak consumption was observed. Furthermore, the Nudge Report was consistent at reducing On-Peak consumption by approximately 1.5%-3.5% for all customer groups.

There are two potential causes for why savings were observed in the Dynamic and Overnight plans and not in the Enhanced plan, the exploration of which will be a focus for continued study. The first possibility is that the Enhanced plan did not offer a large enough price differential between On-Peak and Off-Peak prices to motivate customers to change their behavior. The Enhanced plan offers customers moderately lower Off-Peak rates (from 6.5¢/kWh to 4.4¢/kWh) and moderately higher On-Peak rates (from 13.2¢/kWh to 17.6¢/kWh) compared with standard TOU rates. In contrast, the Overnight plan offered a considerable discount on the Overnight Off-Peak Rate from to 2¢/kWh, with higher On-peak prices of 18.3¢/kWh. Dynamic pricing incorporated a considerably higher On-Peak rate at up to 39.7¢/kWh during Peak periods and 49.8¢/kWh during Critical Peak Pricing periods. These substantial rate differences may have been enough to encourage households to make substantive technological changes or shift their energy consumption behavior.

It is important to note that both Dynamic and Overnight plans required customers to volunteer and opt-in to the pilot pricing initiatives. This is in contrast to Enhanced Pricing where customers were selected at random to participate. It is possible therefore that there are intrinsic differences between customers on Enhanced pricing and those customers who volunteered for Dynamic or Overnight. Specifically, it is possible that the latter group chose these programs because they intended to change their consumption behavior to save money. Nonetheless, the observed interim impacts observed for the Dynamic and Overnight pilots are externally valid provided any rollout of the program is also offered on an opt-in basis. The same is true of the Enhanced pilot interim findings, assuming this program was rolled out Province-wide on an opt-out basis.

Based on the summer interim pilot data, our findings suggest that there is no evidence yet that the Enhanced plan was able to successfully reduce consumption during either On-Peak or System-Coincident Peak hours or reduce total consumption. There was strong evidence that the Dynamic and Overnight plans were successful in reducing consumption during On-Peak and System-Coincident Peak hours.

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# 1. Introduction

In an effort to improve the efficiency of the electricity grid in the province of Ontario, the Ontario Energy Board is seeking to examine the impact of alternative electricity pricing schemes under the Regulated Price Plan (RPP) and the impact of non-price interventions on conservation and demand management behaviors among rate payers. Alectra Utilities is currently participating in the RPP Pilot Program to test the impact of three separate Time-of-Use (TOU) pricing schemes and two non-price interventions on conservation and load-shifting behaviors amongst a sub-set of its customers, with a program named Advantage Power Pricing (APP).

Time-of-Use pricing was introduced in Ontario with the goal of reducing electricity consumption among residential and commercial consumers during 'peak' times of day when demand on generation and distribution infrastructure is highest. TOU pricing charges consumers different hourly Kilowatt-Hour (kWh) prices depending on the time of day. Ontario adopted a three-period TOU pricing structure comprised of Off-Peak (when prices are lowest), Mid-Peak, and On-Peak (when prices are highest) periods. TOU pricing periods are meant to closely mirror actual system peak demand (as per the Independent Electricity System Operator). The logic behind TOU pricing is based on traditional economic theory which holds that consumption of a given commodity will decrease as the price of that commodity increases. TOU pricing is therefore meant to function as a disincentive to electricity consumption during On-Peak periods when prices are highest.

In an effort to further improve the efficacy of TOU pricing in achieving the Province's conservation and demand management objectives, the OEB has undertaken a re-examination of the RPP in an effort to uncover new ways of achieving those objectives. The OEB identified two primary areas of opportunity to better align the RPP with the province's conservation goals:

1. *Implementing price pilots: The OEB stated that it would work with LDCs to undertake several pricing (and non-price) pilots. The pilots will run for at least one calendar year to assess whether there is persistence in the impact of the intervention.*
2. *Empowering Consumers: Enhancing energy literacy and non-price tools: The OEB stated that it intends to launch non-price pilot initiatives, such as piloting automated load control technology and behavioral interventions.*

The first prioritized opportunity area outlined by the OEB acknowledges that perhaps the rate differential between On-Peak and Off-Peak TOU periods is currently insufficient to function as meaningful financial disincentive to the consumption of electricity during peak hours. It is therefore hypothesized that more severe financial disincentives for On-Peak consumption might result in On-Peak conservation and/or load-shifting behaviors among consumers. The second prioritized opportunity area outlined by the OEB acknowledges that perhaps financial levers are not the only (and perhaps not the most effective) method of promoting behavior change. This perspective (grounded in the field of behavioral economics) holds that individuals do not always respond to pricing signals in the way that traditional economic theory would predict. This occurs because we are subject to myriad cognitive

biases such as *temporal* discounting. In the context of electricity consumption, this means we are prone to value our comfort in the present moment (resulting in over-use of electricity consuming appliances such as air conditioners) and to discount the future costs associated with that behavior. It is therefore hypothesized that non-price behavioral interventions that mitigate the effects of these cognitive biases may represent a complementary approach to financial disincentives in promoting conservation and/or load shifting behaviors.

## 2. APP Price Plans

Alectra Utilities and the Ontario Energy Board identified three priority pricing schemes to be piloted amongst the Alectra Utilities customer base (specifically a sub-set of those residing within the legacy Powerstream service territory). These pricing pilots were chosen with the following considerations in mind:

1. *Feasibility of implementation: Pricing pilots were prioritized in which the necessary implementation infrastructure (due to legacy pricing pilots) was already at least partially in place.*
2. *Access to pilot participants: The nature and number of pricing pilots was constrained by the necessary sample sizes required to achieve statistically valid results, coupled with the available participant pool (i.e., the number of customers residing within the legacy Powerstream service territory not participating in other pilot programs or potentially conflicting initiatives).*
3. *Compatibility with other RPP pilot programs: As part of the re-examination of the RPP, several LDCs in the province have undertaken pricing pilot initiatives. Specific pricing pilots chosen in the present initiative should complement existing RPP pricing pilots by yielding novel insights.*

With these considerations in mind, the following three pricing pilots were selected:

### 2.1 Enhanced Plan

Customers participating in the Enhanced plan will experience a larger On- to Off-Peak price differential (4:1) relative to standard TOU pricing (2:1) as well as a larger Mid- to Off-Peak price differential (3:1) relative to standard TOU pricing (1.5:1). The exact kWh rates and associated periods are shown below:

*Table 3*: Enhanced Price Table

| Price Period | Summer Hours (May – October) | Winter Hours (November – April) | Price (cents/kWh) | |
|---|---|---|---|---|
| | | | Nov 2017 – April 2018 | May 2018-Oct 2018 |
| Off-Peak | Weekdays: 12am-7am and 7pm-12am<br>Weekends: All day | Weekdays: 12am-7am and 7pm-12am<br>Weekends: All day | 4.4 | 4.4 |
| Mid-Peak | Weekdays: 7am-11am and 5pm-7pm | Weekdays: 11am-5pm | 13.2 | 13.2 |
| On-Peak | Weekdays: 11am-5pm | Weekdays: 7am-11am and 5pm-7pm | 17.5 | 17.6 |

### 2.2 Dynamic Pricing

Customers participating in the Dynamic plan will experience variable On-Peak kWh rates depending on anticipated demand determined by the IESO. There will also be Critical Peak Periods (maximum of 6 summer and 6 winter, lasting 4 hours each) in which customers will experience an especially high kWh

rate. In addition, there will be no Mid-Peak period. The kWh rates and associated periods are shown below:

*Table 4*: Dynamic Price Table

| Price Period | Hours | Price (cents/kWh) | |
|---|---|---|---|
| | | Nov 2017-April 2018 | May 2018 – Oct 2018 |
| Off-Peak | Weekdays: 12am-3pm and 9pm-12am<br>Weekends: All day | 4.9 | 4.9 |
| Low On-Peak | 50% of Weekdays: 3pm-9pm | 10.0 | 9.9 |
| Medium On-Peak | 30% of Weekdays: 3pm-9pm | 19.9 | 19.8 |
| High On-Peak | 20% of Weekdays: 3pm-9pm | 39.8 | 39.7 |
| Critical Peak | On the top six system peak days in summer and winter, each event lasting four hours. Start time of events determined by peak demand hour of event day | 49.8 | 49.8 |

## 2.3 Overnight Plan

Customers taking part in the Overnight plan will experience a super-low Off-Peak kWh rate overnight. This pricing pilot is designed to appeal to customers working irregular shifts or who are electric vehicle owners (or prospective electric vehicle owners). The kWh rates and associated periods are shown below:

*Table 5*: Overnight Price Table

| Price Period | Summer Hours (May – October) | Winter Hours (November – April) | Price (cents/kWh) | |
|---|---|---|---|---|
| | | | Nov 2017 - April 2018 | May 2018 –Oct 2018 |
| Overnight Off-Peak | 12am-6am | 12am-6am | 2.0 | 2.0 |
| Off-Peak | Weekdays: 6am-7am and 7pm-12am<br>Weekends: 6am-12am | Weekdays: 6am-7am and 7pm-12am<br>Weekends: 6am-12am | 6.5 | 6.5 |
| Mid-Peak | Weekdays: 7am-11am and 5pm-7pm | Weekdays: 11am-5pm | 9.2 | 9.2 |
| On-Peak | Weekdays: 11am-5pm | Weekdays: 7am-11am and 5pm-7pm | 18.4 | 18.3 |

## 2.4 Standard Time-of-Use Pricing

Customers assigned to control conditions for each of the three pricing pilots described above will experience status quo TOU rates. The standard TOU rates and associated periods are shown below:

*Table 6*: Standard TOU Price Table

| Price Period | Summer Hours (May – October) | Winter Hours (November – April) | Price (cents/kWh) | |
|---|---|---|---|---|
| | | | Nov 2017 - April 2018 | May 2018-Oct 2018 |
| Off-Peak | Weekdays: 12am-7am and 7pm-12am<br>Weekends: All day | Weekdays: 12am-7am and 7pm-12am<br>Weekends: All day | 6.5 | 6.5 |
| Mid-Peak | Weekdays: 7am-11am and 5pm-7pm | Weekdays: 11am-5pm | 9.5 | 9.4 |
| On-Peak | Weekdays: 11am-5pm | Weekdays: 7am-11am and 5pm-7pm | 13.2 | 13.2 |

## 3. Non-Price Pilots

In order to address the second key objective of the RPP pilot program as outlined by the OEB (i.e., *Empowering Consumers: Enhancing energy literacy and non-price tools)* Alectra, in collaboration with BEworks, Util-Assist, and Bidgley, have created communications that are distributed to pricing pilot participants on a monthly basis. These reports serve two broad functions.

### SHADOW BILL

A monthly electricity consumption report that communicates to pilot participants how much electricity they have consumed in the prior billing period and how the associated costs of that electricity compare with that of standard TOU pricing. The primary function of this shadow bill is to communicate bill cost savings or increases as a result of pricing pilot participation. It is hypothesized that (1) positive feedback (i.e., bill cost savings) will encourage participants to further augment their consumption patterns to realize additional savings and remain in the program. It is hypothesized that (2) negative feedback (i.e., bill cost increases) will encourage participants to begin to augment their consumption behaviors in order to realize bill cost savings. The Shadow Bill is mailed in paper form to pilot participants each billing period as a separate piece of communication to the actual monthly Alectra Utilities bill. An example Shadow Bill is shown in Appendix A.

### NUDGE REPORTS

These reports accompany the Shadow Bill and provide customers with feedback on their On-Peak electricity consumption in the prior billing period relative to a household historical benchmark. By explicitly telling consumers whether their consumption is the same, more, or a lot more than usual, it is hypothesized that (1) this may encourage customers to exert more effort towards behavior change accordingly. Accompanying the feedback message is a dynamic saving strategy section with three specific recommendations for how households can alter their consumption behavior to reduce their On-Peak consumption and realize cost savings for the upcoming period. It is hypothesized that (2) introducing a specific plan for how households can work towards reducing their On-Peak consumption can increase customers' perceived control in their ability save on electricity costs and in turn increase adoption of these On-Peak conservation behaviors. In addition, the initial cycles of Nudge Reports included a monetary offer whereby customers were asked to take a pledge to reduce their usage during On-Peak periods in return for a $5 credit on their next bill. By actively engaging with the pledge regardless of the incentive, it is hypothesized that (3) customers will attempt to remain consistent to avoid cognitive dissonance or mental discomfort and as such will be encouraged to reduce their On-Peak usage. The pledge campaign ran for 3 months (bills mailed from June to August 2018). There were a total of 331 participants (101 Dynamic, 68 Enhanced, 11 Overnight[2] and 151 Control) who responded to the pledge and therefore, eligible for the $5 incentive.

[2] These pledges are due to "spillover". Although Overnight group participants did not receive nudge reports, it is possible that customers from other groups showed the pledge promotion to Overnight customers.

Finally, a visually salient linear timeline provides a reminder of when each pricing period occurs and how much more On-Peak and Mid-Peak periods cost relative to Off-Peak. An example Nudge Report is shown in Appendix B.

As detailed in Section 5, the Nudge Report was consistent at reducing On-Peak consumption by approximately 1.5%-3.5% for all customer groups. We observed consistent reductions in On-Peak consumption of approximately 1.5% in the Enhanced Pilot. These reductions occurred regardless of whether the households received Enhanced or Regular TOU pricing. Similarly, in the Dynamic Pilot we observed a reduction in the High On-Peak of 1.5%, and reduction during CPP hours of 3.5%, these were consistent across households with Dynamic or Regular TOU pricing. One caveat to these findings was that only reductions which occurred during CPP hours were statistically significant. This is potentially due to the reduced power of the Dynamic Pilot in comparison to the Enhanced Pilot; however, a larger experiment would need to be done to confirm this hypothesis.

### THERMOSTAT TECHNOLOGY

In addition to measuring the effect of Nudge Reports as a non-price intervention, a variable will be included to measure the presence of a smart thermostat for each household. As smart thermostats can be programmed and be adjusted dynamically with weather effects and changes in price, we want to test the independent effects of smart thermostats, as well as if any of the price or nudge report interventions may be more/less effective with the presence of a smart thermostat.

Currently, Alectra only has data on household smart thermostat adoption from households who had a smart thermostat installed through Alectra or who registered their device with their thermostat vendor in partnership with Alectra. This gap means it is unknown whether households who did not receive/enroll a smart thermostat through Alectra do not have a device, or have purchased one on their own accord. To solve this, we have included questions pertaining to smart thermostat adoption in the interim survey submitted to all participants. The survey is currently being analyzed and insights/results from it will be included into the results as the addendum to be submitted in Q2, 2019.

## 4. Program Milestones

The implementation of APP under the OEB's framework for RPP pilots started in mid-2017. Since then, a number of milestones and accomplishments have been achieved.

*Table 7*: APP 2018 Milestones

| Milestones | Description |
|---|---|
| 1. Customer recruitment completed | A total of 6,960* customers are in APP, of which there are approximately an equal number in the treatment and control group for each pricing group as follows: 688 Dynamic, 315 Overnight and 5,957 Enhanced. Dynamic and Overnight are voluntary (opt-in) while customers in the Enhanced group were automatically enrolled in the program (opt-out). Recruitment began August 1, 2017 for the Enhanced group and October 1, 2017 for the Dynamic and Enhanced groups. |
| 2. Successfully transitioned from risk-free period to unprotected period | The unprotected period started March 1, 2018 - customers were informed that the risk-free period would end during enrollment, and were reminded of the change weeks ahead and were given ample time to try the plans before the transition. For clarity, the timeframe included in this report covers the Summer period (May to October 2018). The month of April will be included in the Winter analysis. The month of March is considered as transition period since during this month, Alectra was still recruiting for the Overnight group. The data from March 2018 could be included in the analysis in the final report, if possible and/or needed. |
| 3. Shadow bill and Nudge Report developed and distributed | With the help of BEworks (experimental design, program evaluation), Util-assist (billing and customer service), and Bidgely (data disaggregation and analysis), Alectra completed and distributed the first shadow bills and Nudge Reports in June 2018. |
| 4. Successful integration of APP to Alectra bills | Customers receive monthly bill credits (or debits) on their Alectra Utilities monthly bills depending on their savings (or additional costs) under APP as opposed to being billed with the standard TOU in Ontario. From May to October, the overall total TOU cost would have been $2,492,563 but the APP cost was only a total of $2,485,758, generating a cost savings of $6,805. |
| 5. Thermostat installations and incentives | There are 366* APP participants that opted for free-direct installed Energate Foundation thermostats to September 30, 2018, and a total of 1,465* customers received an incentive to register their existing thermostats (Nest, ecobee, or Honeywell) to enable response to peak pricing/load reduction signals. |
| 6. Completion of customer surveys | Two surveys** to help measure customer energy literacy and adoption of energy efficient technologies and upgrades were completed in 2018: the Baseline Survey (Aug 2018) and the Interim Survey (December 2018). |
| 7. Completion of Focus Groups | Four focus groups, one for each pricing plan and one for control group, were successfully conducted and key findings/learnings were provided to the OEB and are being used by Alectra for continuous program improvement. |
| 8. Settlement with the IESO | On a monthly basis, Alectra settles the APP bill adjustments applied to eligible customers with the IESO to reconcile APP rates with standard |

| | |
|---|---|
| | TOU rates. |
| 9. Full audit of the APP shadow billing system and APP bill adjustments | An audit was conducted to ensure that all adjustments are being correctly applied to customer accounts. Another audit will be undertaken and scheduled to be complete by March 31, 2019. |
| 10. Submission of Interim Report | Monthly (or bi-monthly) monitoring reports were submitted to OEB to ensure that Alectra was on track with the program milestones and requirements. This Interim Report, which includes impact results from the first 6 months of unprotected period, was first submitted to the OEB in January 2019. This revised version was submitted in March 2019. |

*as of September 30, 2018. These numbers change over time since participants can opt out of the program at any time.

**analysis of surveys will be included as addendum to this report.

# 5. APP Preliminary Results

## 5.1 Methodology

In this section, we outline the methodological approach for the participant sampling and experimental design employed to assess impacts of the interventions on conservation and demand management behaviors. We first describe the general approach before discussing the specific design and sampling specifications of each of the Price and Non-Price interventions.

The first step in the sampling procedure was to isolate the sample frame from which participants would be drawn for participation in the pilot. In doing so, there were several considerations/constraints. First, only households within the Powerstream legacy service territory were considered eligible. Second, eligible participants must not be participating in any other pilot programs with CDM objectives. Specifically, households receiving Home Energy Reports (or designated as part of the control group for the Home Energy Report program) were not included in the sample frame. The remaining households were then recruited or assigned to Pricing Pilot treatment and control groups. The specifics of the assignment of households to the various Pricing pilots are described below, separately for each of the three pricing pilots.

For each of the pricing pilots, we estimated a required sample size of approximately 300 participants per condition in order to detect a small effect size (f = 0.1) at a 90% power. The sample size was achieved in all three pricing pilots. For Dynamic and Overnight pricing, with a smaller sample size, the required sample size was met and effect sizes higher than f=0.1 were observed. We conclude that all pricing pilots had sufficient numbers of participants. For calculations, assumptions, and detailed breakdown of the power analysis see Appendix D.

### 5.1.1 Bill Savings

Figures showing the distribution of the total savings per pricing pilot are shown in Figures 2-4 and Appendix C.

Figures 2, 3, and 4 show the distribution of total bill savings across the 6 months of the pilot for each condition. In the Enhanced and Dynamic conditions, savings are approximately normally distributed around 0, meaning there appears to be an equal number of households with positive and negative total savings. This is in contrast to the Overnight condition in which the distribution is right skewed, meaning the majority of the households are evenly distributed around 0 savings but, there are a small number of households ***with large savings.***

*Figure 2: Total Bill Savings - Enhanced Condition*

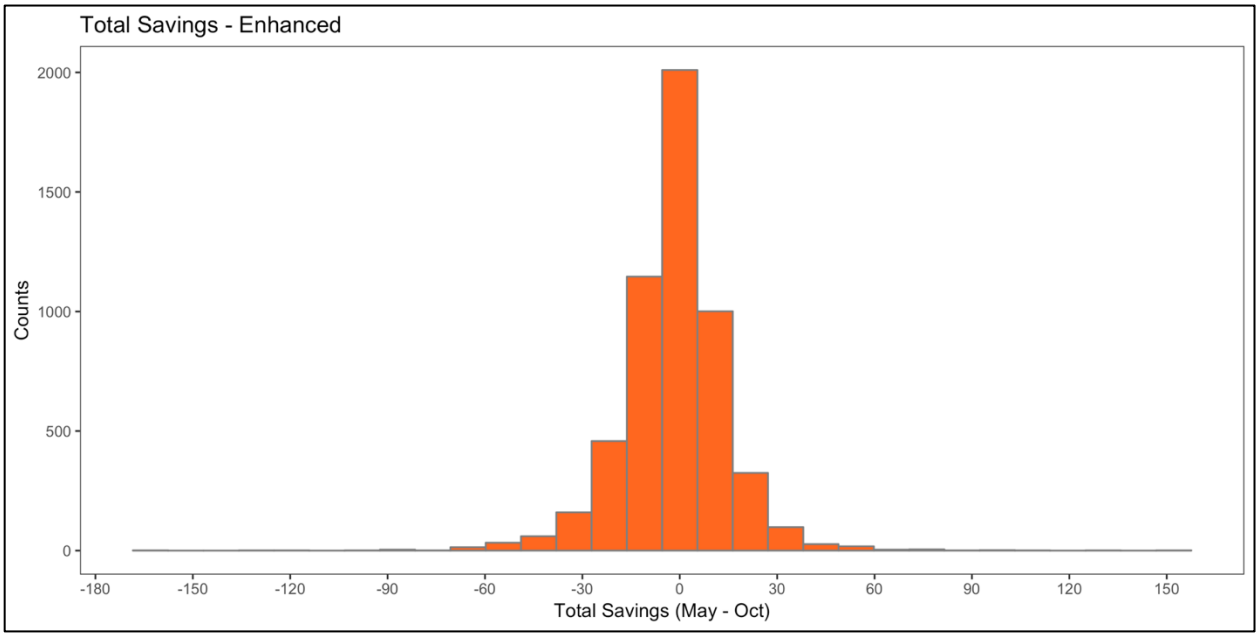



*Figure 3: Total Bill Savings = Dynamic Condition*

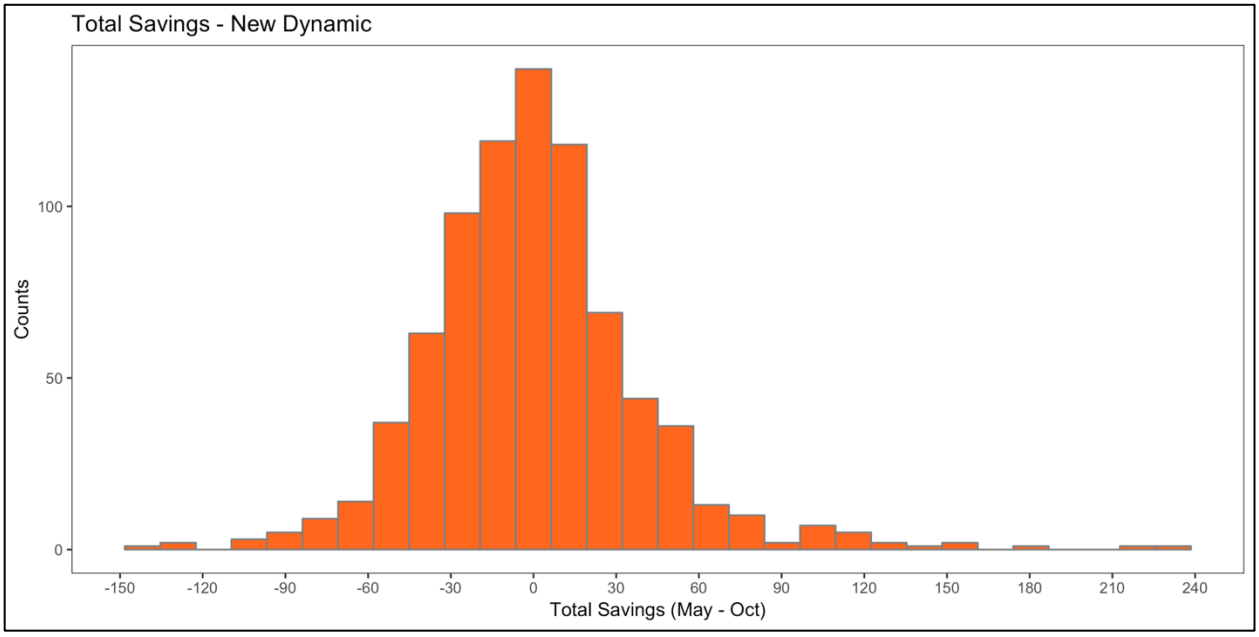
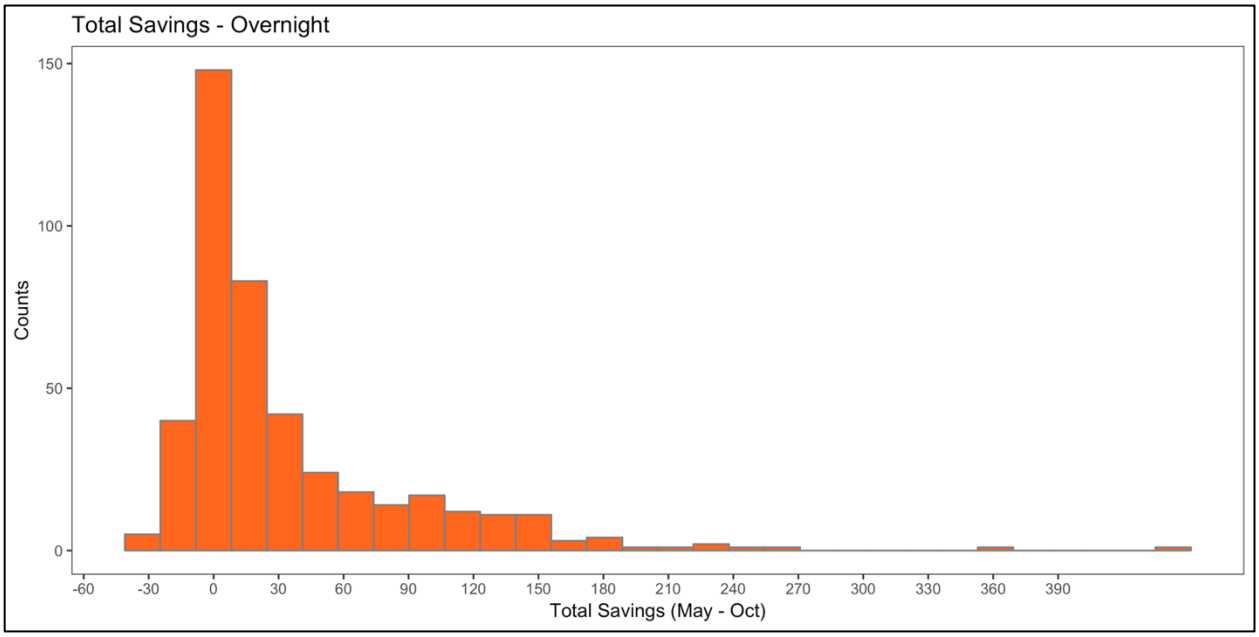


*Figure 4: Total Bill Savings = Overnight Condition*




### 5.1.2 Enhanced Plan

Since the Enhanced Plan observes the exact same Time-of-Use pricing schedule as Standard TOU, the only material change from the experience of the customer is the kWh hourly rates charged during Off-, Mid-, and On-Peak periods. For this reason, the Enhanced plan is run as an opt-out randomized controlled trial (RCT). In addition to the Enhanced Pricing treatment, non-pricing communications in the form of Nudge Reports will be randomly distributed to half of Enhanced Pricing Treatment and half of Enhanced Pricing Control customers. This results in a total of four distinct customer groups in the Enhanced plan. Given that the rate of opt-out cannot be known in advance, a relatively large sample size is required in order to account for opt-outs and move-outs over the 12-month duration of the pilot. To that end, 14,000 residential customers were randomly selected from the sample frame and randomly assigned to each of the four groups. The distribution of program participants to each of the four groups is shown in the table below.

*Table 8*: Enhanced Pilot Sample Size

| | Starting N | Opt-Outs | Move-Outs | Outliers[3] | Missing Data[4] | Interim Impact Total |
|---|---|---|---|---|---|---|
| Enhanced Pricing | 3,500 | 233 | 237 | 55 | 2 | 2,996 |
| Nudge Reports | 3,500 | 31 | 191 | 52 | 2 | 3,237 |

[3] An outlier was defined as any household who consumed more than 15kWh or less than 0.05kWh during any hour of the analysis period.
[4] Households who had missing data during any hour in the analysis period were removed.

| | | | | | | |
|---|---|---|---|---|---|---|
| Enhanced Pricing + Nudge Reports | 3,500 | 245 | 247 | 61 | 7 | 2,964 |
| Control | 3,500 | 3 | 197 | 67 | 9 | 3,239 |
| Total | 14,000 | 512 | 872 | 235 | 20 | 12,436 |

### 5.1.3 Dynamic Plan

Since the Time-of-Use pricing periods under the Dynamic plan do not align with Standard TOU pricing periods, customers participating in the Dynamic plan will experience significant material changes to their TOU schedules. In addition, the inclusion of Critical Peak Pricing events and Variable Peak Pricing requires that participating residential customers be notified on a daily basis of whether there will be Low-, Medium-, High-, or Critical-Peak periods. For these reasons, the Dynamic plan is run on an opt-in basis, requiring that eligible residential customers sign-up for (opt-in) to Dynamic Pricing. As such, the Dynamic plan is run as a Matched Controlled Trial, meaning that once enrollment into the Pricing Treatment group is completed, a control group is created from the remaining sample frame that matches Pricing Treatment participants on historical consumption behaviors. Once the Treatment and Matched Control groups for the Dynamic plan were established, half were randomly assigned to receive Nudge Reports. The distribution of participants to each of the four Dynamic Pricing Pilot groups is shown in the table below.

*Table 9*: Dynamic Pilot Sample Size

| | Starting N | Opt-Outs | Move-Outs | Outliers | Missing Data | Interim Impact Total |
|---|---|---|---|---|---|---|
| Dynamic Pricing | 385 | 34 | 9 | 5 | 0 | 338 |
| Nudge Reports | 385 | 1 | 17 | 7 | 0 | 362 |
| Dynamic Pricing + Nudge Reports | 385 | 29 | 6 | 6 | 0 | 345 |
| Control | 385 | 0 | 14 | 11 | 0 | 364 |
| Total | 1,540 | 64 | 46 | 29 | 0 | 1,409 |

### 5.1.4 Overnight Plan

Since the Time-of-Use pricing periods under the Overnight plan do not align with Standard TOU pricing periods, customers participating in the Overnight plan will experience significant material changes to their TOU schedules. In particular, for customers to benefit, they must be able to shift significant load to the 12:00am -6: 00am period. For these reasons, the Overnight plan is run on an opt-In basis, requiring that eligible residential customers sign-up for (opt-in) to Overnight Pricing. As such, the Overnight plan is

run as a Matched Controlled Trial, meaning that once enrollment into the Pricing Treatment group is completed, a control group is created from the remaining sample frame that matches Pricing Treatment participants on historical consumption behaviors. The distribution of participants to each of the two Overnight Pricing Pilot groups is shown in the table below.

*Table 10*: Overnight Pilot Sample Size

| Treatment Group | Starting (N) | Optouts (N) | Moveouts (N) | Outliers (N) | Missing Data | Final (N) |
|---|---|---|---|---|---|---|
| Overnight Pricing | 366 | 18 | 7 | 3 | 0 | 340 |
| Control (Regular Pricing) | 366 | 0 | 0 | 4 | 1 | 361 |
| Total | 732 | 18 | 7 | 7 | 1 | 701 |

## 5.2 Data

### *5.2.1 Description of the Data*

This pilot used quantitative data to perform statistical analyses to test the effects of multiple pricing treatments and a Nudge Report treatment on household energy consumption. The outcome data received was hourly smart meter readings for each household over the course of 2 years. All data received was raw hourly consumption rates measured in kWh and was delivered from Savage Data Systems, Alectra's Operational Data Store.

### *5.2.2 Preprocessing Activities*

The data cleaning process to convert raw hourly data to the data used for the statistical analysis was minimal. The bulk of the process was converting the hourly data into means tables based on the appropriate timeframe. In total, there were 4 means tables created for each of the three pilots for a total of 12 mean tables. The process of creating mean tables for each household is defined below.

- Peak and Off-Peak Impacts: Hourly means in kWh for each defined peak period, for each month, for each household
- Average Conservation Impacts: Hourly means in kWh for each month, for each household

### *5.2.3 Estimated Elasticities*

From this data set, we established two elasticities. The purpose of the Estimated Price Elasticity analysis is to measure the % change in consumption relative to a % change in price. Both own-price (daily) elasticity and inter-period substitution elasticity will be measured:

- Own Price Elasticity: Daily means in kWh for each household
- Inter-Period Substitution Elasticity: Hourly means in kWh for each on-peak and Off-Peak periods, for each month, for each household

Some households were removed as the occupants either 1) moved out of the premise, 2) opted-out of the program, or 3) were deemed outliers based on consumption behaviour.

#### 5.2.4 Issues or Concerns

There were no issues or concerns regarding the quality or integrity of the data collected. However, there existed some households who moved and/or opted out of the program during the time-frame of the pilot prior to this interim impact analysis. In addition, some households had missing data and/or had consumption which was deemed too extreme. The treatment of these households is discussed more specifically in the ensuing results section.

There were issues concerning the completeness of the *technology* data. One of the intended control variables in the models is the presence of a *smart thermostat*. Alectra has data on households who had purchased a smart thermostat through their services, but this does not cover households who purchased a smart thermostat outside of Alectra. Households were asked about the presence of a smart thermostat in the baseline and interim surveys. As interim surveys are still being deployed at the time of this writing, technology data will be re-evaluated to be included in the addendum to this report to be submitted in Spring 2019.

### 5.3 Dependent Variables

In this chapter, we present the three main dependent variable categories:

- Peak and Off-Peak Impacts (Including Critical Peak for Dynamic Group Only)
- Average Conservation Impacts
- Estimated Price Elasticities

A definition, model specifications, and a sample results table will be presented for each dependent variable category. Each dependent variable will be used to assess the results of the three pilot groups: Enhanced, Dynamic, and Overnight.

#### 5.3.1 Peak and Off-Peak Impacts

The purpose of the Peak and Off-Peak Impact analysis is to measure the change in energy consumption for a treatment group compared to a control group during specific TOU periods based on a price and/or communication manipulation.

We define Peak and Off-Peak Impacts as: The year-over-year difference in the average hourly consumption per month, calculated separately for each TOU period.

Each TOU period will depend on the specific pilot group that the customer was placed in (Enhanced, Dynamic, or Overnight; see Table 15.

*Table 11*: TOU Periods

| TOU Period | Summer<br>May 1 – October 31 | Winter<br>November 1 – April 30 | Pilot Group |
|---|---|---|---|
| On-Peak | 11am – 5pm | 7am – 11am and<br>5pm – 7pm | Enhanced and Overnight |

| | | | |
|---|---|---|---|
| Mid-Peak | 7am – 11am and 5pm - 7pm | 11am – 5pm | Enhanced and Overnight |
| Off-Peak | 7pm – 7am | 7pm – 7am | Enhanced and Overnight |
| Overnight Off-Peak | 12am – 6am | 12am – 6am | Overnight |
| High, Medium, Low Peak | 3pm-9pm | 3pm-9pm | Dynamic |
| Off-Peak (Dynamic) | 12am-3pm and 9pm – 12am and Weekends and Holidays | 12am-3pm and 9pm – 12am and Weekends and Holidays | Dynamic |
| Critical Peak Period | Top six system peak days, each event lasting four hours. Start time of events determined by peak demand hour of event day | Top six system peak days, each event lasting four hours. Start time of events determined by peak demand hour of event day | Dynamic |
| System-Coincident Peak Impact | 1pm-7pm (June, July, August) Weekdays and is based on the IESO's analysis of peak hourly load | | Enhanced, Dynamic, and Overnight |

Using a difference-in-difference approach, the regression models for Peak and Off-Peak Impacts are represented algebraically in Equation 5.1 and Equation 5.2.

**(5.1)** $$\left(PostTOUUsage_{i,m} - PreTOUUsage_{i,m}\right) = \alpha + \beta_1 Price_P + \beta_2 Communication_C + \beta_3 Price_P * Communication_C + \beta_4 Month_m + \varepsilon_{i,m}$$

**(5.2)** $$ln\left(\frac{PostTOUUsage_{i,m}}{PreTOUUsage_{i,m}}\right) = \alpha + \beta_1 Price_P + \beta_2 Communication_C + \beta_3 Price_P * Communication_C + \beta_4 Month_m + \varepsilon_{i,m}$$

Where,

| | | |
|---|---|---|
| PostTOUUsage | = | Average hourly TOU-period kWh consumed during experimental period by household i in month m |
| PreTOUUsage | = | Average hourly TOU-period kWh consumed during pre-experiment period by household i in month m |
| Price | = | Dummy indicator denoting presence of price manipulation |
| Communication | = | Dummy indicator denoting presence of communication manipulation |
| Month | = | Month indicator denoting months January – December (Inclusive) |
| I | = | Indicates individual household |
| M | = | Indicates month 1-12 |
| E | = | Indicates regression error term |

Results will be averages based on the time of year including Summer (May – October) and Winter (November – April; to be included in final impact analysis). Moreover, results will be calculated based on kW savings (Equation 5.1) and % (Equation 5.2). These kW and % savings will be broken down based on impacts stemming from pricing manipulation, communication manipulation, and the interaction of the price and communication manipulation.

### 5.3.2 *Average Conservation Impacts*

The purpose of the Average Conservation Impact analysis is to measure the change in energy consumption for a treatment group compared to a control group during the Summer period (May-Oct), Winter period (Nov-April; to be included in final impact analysis), and the entire year of the pilot (April, 2018 – March, 2019) based on a price and/or communication manipulation.

We define Average Conservation Impact as: The year-over-year difference in the average hourly consumption per month, calculated in the Summer, Winter, and 12-month pilot period.

Using a difference-in-difference approach, the regression models for the Average Conservation Impact analysis is represented algebraically in Equation 5.3 and Equation 5.4.

**(5.3)** $$\left(PostAvgHourlyUsage_{i,m} - PreAvgHourlyUsage_{I,m}\right) = \alpha + \beta_1 Price_P + \beta_2 Communication_C + \beta_3 Price_P * Communication_C + \beta_4 Month_m + \varepsilon_{i,m}$$

**(5.4)** $$ln\left(\frac{PostAvgHourlyUsage_{i,m}}{PreAvgHourlyUsage_{i,m}}\right) = \alpha + \beta_1 Price_P + \beta_2 Communication_C + \beta_3 Price_P * Communication_C + \beta_4 Month_m + \varepsilon_{i,m}$$

Where,

| | | |
|---|---|---|
| PostAvgHourlyUsage | = | Average hourly kWh consumed during experimental period by household i, in month m |
| PreAvgHourlyUsage | = | Average hourly kWh consumed during pre-experiment period by household i, in month m |
| Price | = | Dummy indicator denoting presence of price manipulation |
| Communication | = | Dummy indicator denoting presence of communication manipulation |
| Month | = | Month indicator denoting months January – December (Inclusive) |
| I | = | Indicates individual household |
| M | = | Indicates month 1-12 |
| E | = | Indicates regression error term |

Results will be calculated based on kW (Equation 5.3) and % (Equation 5.4) for Summer, Winter, and total pilot duration (12-months). These kW and % savings will be broken down based on impacts stemming from pricing manipulation, communication manipulation, and the interaction of the price and communication manipulation.

### 5.3.3 *Estimated Price Elasticity*

The purpose of the Estimated Price Elasticity analysis is to measure the percentage change in consumption relative to a percentage change in price. Both own-price (daily) elasticity and inter-period substitution elasticity will be measured.

We define Own-Price (Daily) Elasticity as: The % change in hourly energy consumption relative to the percentage change in hourly energy price.

We define Inter-Period Substitution Elasticity as: The percentage change in the ratio of on-peak to Off-Peak energy consumption relative to the percentage change in the ratio of on-peak to Off-Peak energy price

The regression models for the Estimate Price Elasticity analysis is represented algebraically in Equation 5.5 for own-price elasticity and Equation 5.6 for inter-period substitution elasticity.

**(5.5)** $$ln(Q_d) = \alpha + \eta\, ln(P_d) + \delta_1\, CDH_d + \delta_2\, HDH_d + \sum_{i=1}^{N} \theta_i D_i + \varepsilon_{i,d}$$

**(5.6)** $$ln\left(\frac{Q_{on-peak,d}}{Q_{off-peak,d}}\right) = \alpha + \sigma\, ln\left(\frac{P_{on-peak,d}}{P_{off-peak},d}\right) + \delta_1\, (CDH_{on-peak,d} - CDH_{off-peak,d}) + \delta_2\, (HDH_{on-peak,d} - HDH_{off-peak,d}) + \sum_{i=1}^{N} \theta_i D_i + \varepsilon_{i,d}$$

Where,

| | | |
|---|---|---|
| Q | = | kWh consumed per hour averaged across day d |
| P | = | Electricity Price per hour averaged across day d |
| CDH | = | Cooling Degree hours per hour averaged across day d |
| HDH | = | Heating Degree hours per hour averaged across day d |
| D | = | Dummy indicator for each household i |
| D | = | Dummy indicator for each individual day |
| I | = | Indicates individual household |
| ε | = | Indicates regression error term |

## 5.4 Enhanced Plan Preliminary Results

The number of participants selected for the Enhanced Pilot (N size) is displayed in Table 16. The Enhanced Pilot began with 14,000 participants evenly distributed between the four treatment and control groups. As of September 30th, the number of participants was 12,436. Participant drop off was due to either households moving out of the service territory, households opting out of the program, missing data[5], or the household consumption was deemed to be an outlier[6]. Summary statistics for On-Peak, Off-Peak, and Total consumption in both 2017 and 2018 are provided in Table 17.

*Table 12*: Number of Participants for Enhanced Pilot

| | Starting N | Opt-Outs | Move-Outs | Outliers[6] | Missing Data[5] | Interim Impact Total |
|---|---|---|---|---|---|---|
| Enhanced Pricing | 3,500 | 233 | 237 | 55 | 2 | 2,996 |
| Nudge Reports | 3,500 | 31 | 191 | 52 | 2 | 3,237 |
| Enhanced Pricing + Nudge Reports | 3,500 | 245 | 247 | 61 | 7 | 2,964 |
| Control | 3,500 | 3 | 197 | 67 | 9 | 3,239 |
| Total | 14,000 | 512 | 872 | 235 | 20 | 12,436* |

*Note: As some households may have been removed for multiple criteria, Final (N) may be greater than the total number of ineligibilities

*Table 13*: Summary of Average Hourly Consumption (kWh) per Condition for Enhanced Pilot

| | On-Peak Hours 2017 (kWh) | On-Peak Hours 2018 (kWh) | Off-Peak Hours 2017 (kWh) | Off-Peak Hours 2018 (kWh) | All Hours 2017 (kWh) | All Hours 2018 (kWh) |
|---|---|---|---|---|---|---|
| Control | 0.98 | 1.16 | 0.88 | 1.01 | 0.90 | 1.05 |
| Price | 0.97 | 1.15 | 0.87 | 1.01 | 0.90 | 1.04 |
| Nudge Repot | 1.00 | 1.16 | 0.88 | 1.01 | 0.91 | 1.05 |
| Price + Nudge | 0.98 | 1.15 | 0.88 | 1.01 | 0.91 | 1.05 |

[5] Any household who had missing data for any hour throughout the period of analysis was removed; households with missing data amounted to only 0.16% of the sample

[6] An outlier was defined as any household who consumed more than 15kWh per hour or less than 0.05kWh per hour during any hour in the analysis period.

Results for Peak and Off-Peak Impacts are displayed in Table 18. Overall, we saw no effect of Enhanced Pricing on electricity consumption during On-Peak hours. However, we observed a positive relationship between Enhanced Pricing and consumption during Off-Peak hours. The data shows that over the summer period, households who paid Enhanced Pricing consumed approximately 0.64% more electricity during Off-Peak hours with no change in their electricity consumption On-Peak or Mid-Peak hours.

In contrast, we observed a negative relationship between the Nudge Report and electricity consumption during On-Peak hours, with no effect on consumption during Mid-Peak or Off-Peak hours. The data shows that over the summer period, households who received a Nudge Report consumed approximately 1.5% less electricity during On-Peak hours regardless of whether they paid Enhanced or Regular TOU prices. Finally, we observed no effects of Enhanced Pricing or the Nudge Report on electricity consumption during the System-Coincident Peak hours.

*Table 14*: Enhanced Pilot Average Hourly Consumption per TOU Period (Summer Impacts)

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Enhanced Pricing (Main Effect) | | Nudge Report (Main Effect) | | Nudge Report * Enhanced Pricing | |
| TOU Period | kWh | % | kWh | % | kWh | % |
| On-Peak | -0.001 | +0.17 | **-0.013*** ** | **-1.50%*** ** | +0.010 | +0.63 |
| Mid-Peak | -0.001 | +0.01 | -0.005 | -0.50† | +0.007 | +0.66 |
| Off-Peak | **+0.006*** | **+0.64*** | -0.001 | -0.23 | -0.000 | -0.22 |
| System-Coincident Peak | -0.008 | -0.41 | -0.009 | -1.01 | +0.011 | +1.11 |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

For clarity, the last column on Table 18 indicates the how much the main effect was altered due to the combination of price plan and Nudge Report. To simplify, here is an example. Assume the first row, we observed a 1.5% decrease in consumption from the nudge report. We can think of the interaction effect as either reducing or increasing that effect. So a +0.6% interaction effect, would roughly mean that the effect of the nudge report changes from -1.5% --> *-0.9%* (-1.5 + 0.6) by including the price treatment.

Results for Average Conservation Impact are shown in Table 19. Overall, there were no significant effects of either Enhanced Pricing or the Nudge Report on total electricity consumption over the course of the summer. Winter and Year-Round impacts will be included at the conclusion of the in-field trial.

*Table 15*: Enhanced Pilot Average Hourly Consumption per Season

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Enhanced Pricing (Main Effect) | | Nudge Report (Main Effect) | | Nudge Report * Enhanced Pricing | |
| TOU Period | kW | % | kW | % | kW | % |
| Summer Impact | +0.003 | +0.35 | -0.004 | -0.46† | +0.004 | +0.12 |
| Winter Impact | NA | NA | NA | NA | NA | NA |
| Year-Round Impact | NA | NA | NA | NA | NA | NA |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

Daily and Substitution Elasticities are reported in Table 20. Daily elasticity of demand was estimated at -0.132. The daily elasticity of demand was negative and less than 1, indicating an inelastic daily demand curve. Inter-Period Substitution Elasticity was estimated at -0.017 indicating a negative and inelastic elasticity.

*Table 16:* Enhanced Pilot Daily and Substitution Elasticities of Demand

| Elasticity Estimate | (%) |
|---|---|
| Daily Elasticity | **-0.132*** ** |
| Substitution Elasticity On/Overnight Off-Peak | **-0.017*** |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

The data indicates that the overall impact of offering Enhanced TOU pricing for customers leads to an increase in Off-Peak energy consumption (0.6%).

In contrast, households who received a Nudge Report, regardless of whether they received Enhanced Pricing consumed 1.5% less electricity during On-Peak hours than Control. The changes in On-Peak and Off-Peak consumption were not significant enough to detect a change in overall consumption for any of the treatment groups.

Finally, we compare results between households who signed a pledge versus households who received the Nudge Report, but didn't sign the pledge. In the Nudge Report, households had the option to sign a pledge to commit to reducing their on-peak energy use. Households who signed and returned the pledge were offered a $5 rebate. While the pledge was not experimentally manipulated, we compare the results of households who signed the pledge versus households who received the nudge report, but didn't sign the pledge in Table 21. A t-test was used to test the means between households who received the nudge report and signed the pledge versus those who didn't, p-values are reported in Table 22.

*Table 17: Pledge Numbers – Enhanced Condition*

| Control Pledge Not Signed | Control Pledge Signed | Enhanced Pricing Pledge Not Signed | Enhanced Pricing Pledge Signed |
|---|---|---|---|
| 3,086 | 145* | 2,906 | 54* |

**does not include opt-outs and moved-outs*

*Table 18: Pledge Analysis – Enhanced Condition*

| | Year-Year Average Hourly Consumption Change | | | |
|---|---|---|---|---|
| | Control Group (kWh) | No Pledge (kWh) | Signed Pledge (kWh) | P-Value |
| On-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.176 | - | - | - |
| Control -Nudge Report | - | 0.161 | 0.108 | 0.001 |
| Enhanced Pricing and Nudge Report | - | 0.165 | 0.049 | 0.000 |
| Mid-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.145 | - | - | - |
| Control -Nudge Report | - | 0.138 | 0.110 | 0.032 |
| Enhanced Pricing and Nudge Report | - | 0.141 | 0.103 | 0.122 |
| Off-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.144 | - | - | - |
| Control -Nudge Report | - | 0.144 | 0.127 | 0.154 |
| Enhanced Pricing and Nudge Report | - | 0.147 | 0.195 | 0.036 |
| Monthly Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.151 | - | - | - |
| Control -Nudge Report | - | 0.147 | 0.122 | 0.040 |
| Enhanced Pricing and Nudge Report | - | 0.149 | 0.164 | 0.491 |

Overall, results from Table 22 show that households who signed the pledge show consumption savings relative to households who have not signed the pledge. As this pledge was not experimentally manipulated and served as an aspect of the nudge report, we cannot make a causal inference that the

pledge created energy savings or if is the case that households who were already more motivated to save were more likely to sign the pledge.

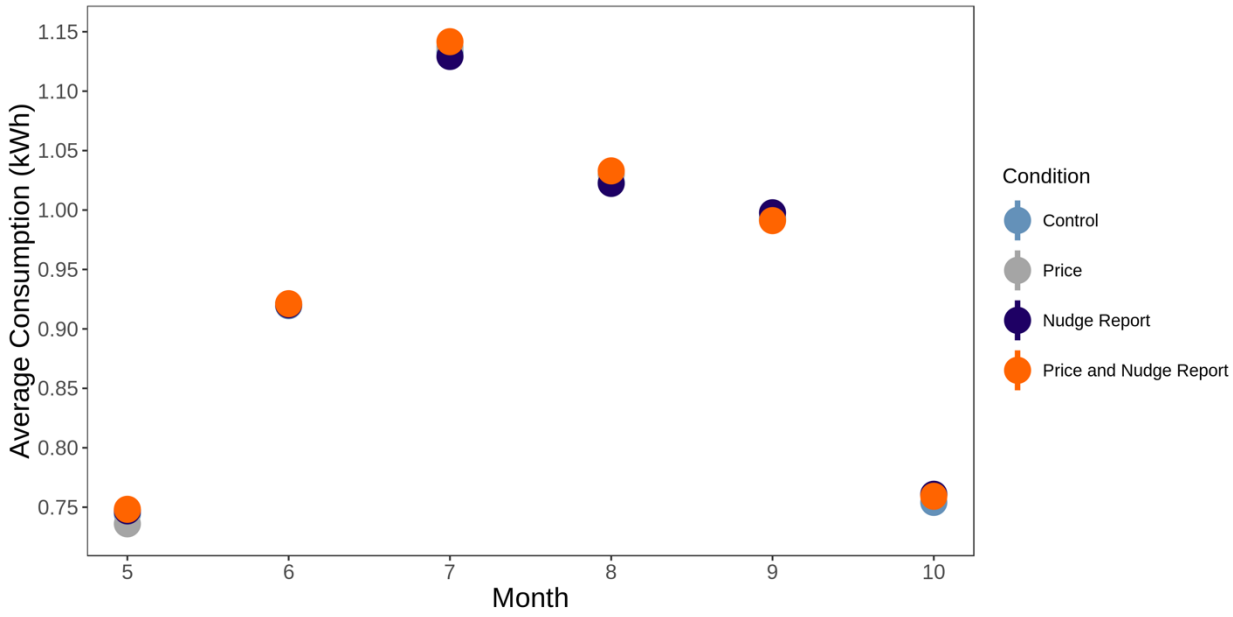
We conclude that both Enhanced Pricing and Nudge Reports were able to affect households' behavior in different ways. Standard economic theory would predict that an increase in price would lead to a decrease in consumption and vice-versa. However, what we observed in the pilot was a decrease in the Off-Peak price, as predicted, resulting in an increase in consumption. However, the increase in the On-Peak price had no effect on consumption. Behavioral Economics offers a more nuanced theoretical prediction, in that consumers may not always behave rationally. This pilot showed that by drawing attention to and being clear about energy prices to consumers through the Nudge Report, we were able to successfully reduce On-Peak consumption without changing Off-Peak consumption regardless of the treatment price offered.

### Additional Analyses for Households who Opt-Out (Intent-to-Treat Analysis)

In the Enhanced Pilot, households were randomly assigned to either control or pricing treatment, households assigned to the pricing treatment were allowed to opt-out of the pilot at any time. Households in the control condition were not aware they were part of the experiment and thus were not able to opt-out. This scenario introduces a potential bias to occur in the data, if opt-outs do not occur randomly, this would create an asymmetry between the control and price treatment. The purpose of this follow-up section is to first highlight this potential asymmetry, test whether this asymmetry exists, and if so test whether correcting for this bias influences the results from the analysis.

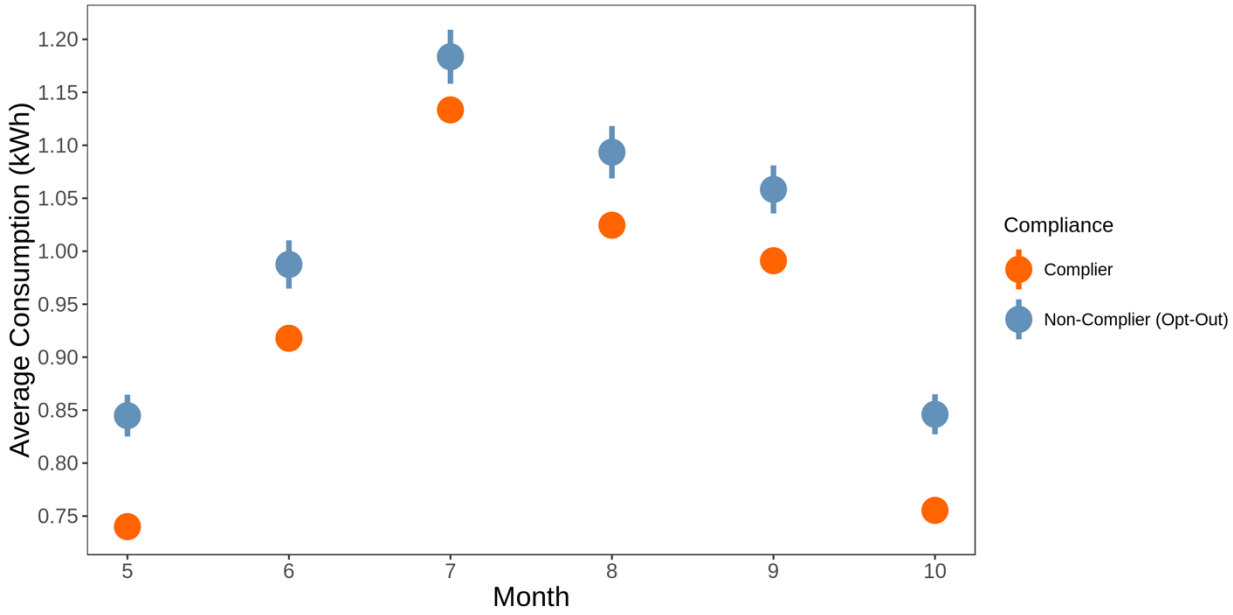
We begin by observing the randomization data between the four conditions in the pre-treatment period. Figure 2 shows a comparison of the Control group to the three treatment groups (Price, Nudge Report, and Price + Nudge Report) during the pre-treatment period. As expected, the randomization process created statistically similar consumption patterns between households in the treatment and control groups at the time when the treatment was introduced.

Figure 5 - Average Monthly Consumption Pre-Treatment per Condition




Next, in Figure 3, we compare the difference in consumption between households who were labelled ***compliers*** (none moveouts, none opt-outs, and none outliers) and ***non-compliers*** (opt-outs). In this figure we observe a systematic difference between households who opted-out and households who remained in the study. For these reasons, we conclude that households who opted-out of the pilot, were on average higher energy users.

Figure 6 - Average Monthly Consumption Pre-Treatment per Complier vs. Opt-Outs



The procedure to estimate the effect of this asymmetric bias follows. In the Enhanced Price condition and Enhanced Price plus Nudge Report condition, there were 233 and 245 opt-outs (7% opt-out rate). Our approach was to match these 233 and 245 households with households who ***did not*** opt-out and who were assigned to the same treatment condition. To achieve this we used a matching algorithm in both conditions to create a **matched treatment group** of 233 and 245 households who displayed statistically similar consumption patterns as the opt-outs, but chose to remain in the pilot.

After creating this matched treatment group, we were able to measure the average treatment effects on this group in-order to estimate a measure of asymmetric bias in the data. We then re-run the analyses from the previous section however, in this analyses we kept the opt-outs in the data and assumed their consumption data was that of the matched treatment group. This process allows us to scale the effects of the opt-outs and compare this scaled estimate to our original estimate.

*Table 19*: Comparison of Coefficients Between Removing Opt-Outs and Estimating Opt-Outs

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Enhanced Pricing (Main Effect in %) | | Nudge Report (Main Effect in %) | | Nudge Report * Enhanced Pricing (Interaction Effect in %) | |
| TOU Period | Original Estimate | Opt-Outs Estimated | Original Estimate | Opt-Outs Estimated | Original Estimate | Opt-Outs Estimated |
| On-Peak | +0.17 | -0.01 | **-1.50%*** ** | **-1.44%*** ** | +0.63 | +0.71 |
| Mid-Peak | +0.01 | -0.04 | -0.50† | -0.44 | +0.66 | +0.75 |
| Off-Peak | **+0.64*** | **+0.60*** | -0.23 | -0.25 | -0.22 | -0.24 |
| System-Coincident Peak | -0.41 | -0.54 | -1.01 | -1.06 | +1.11 | +0.97 |
| Monthly Usage | +0.35 | +0.28 | -0.46† | -0.45† | +0.12 | +0.14 |

Next, we present the results of the intent to treat analysis. In this analysis we leave all the households who opted-out in the data. From there, we will compare the coefficients to the original data and divide the coefficient by the percentage of the households remaining in the sample. Based on the number of opt-outs, we report 6.8% opt-opt of the Pricing condition and will divide the coefficient by 93.2%, in the Nudge Report Condition we report a 3.9% opt-out rate and will divide the coefficient by 96.1%. For the

interaction group we report an opt-out of 7% and will divide the coefficient by 93%. Summary Statistics are shown in Table 24 and Results are shown in Table 25.

*Table 20:* Summary of Average Hourly Consumption (kWh/h) per Condition for Enhanced Pilot Opt-Outs Included

| | On-Peak Hours 2017 (kWh) | On-Peak Hours 2018 (kWh) | Off-Peak Hours 2017 (kWh) | Off-Peak Hours 2018 (kWh) | All Hours 2017 (kWh) | All Hours 2018 (kWh) |
|---|---|---|---|---|---|---|
| Control | 0.98 | 1.16 | 0.88 | 1.01 | 0.90 | 1.05 |
| Price | 0.99 | 1.16 | 0.87 | 1.01 | 0.90 | 1.05 |
| Nudge Repot | 1.00 | 1.16 | 0.88 | 1.01 | 0.91 | 1.05 |
| Price + Nudge | 1.00 | 1.16 | 0.88 | 1.01 | 0.91 | 1.05 |

*Table 21: ITT Analysis Comparing Impacts between Opt-Outs Included vs. Not Included*

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Enhanced Pricing (Main Effect in %) | | Nudge Report (Main Effect in %) | | Nudge Report * Enhanced Pricing (Interaction Effect in %) | |
| TOU Period | Original Estimate | ITT Coef Adjusted | Original Estimate | ITT Coef Adjusted | Original Estimate | ITT Coef Adjusted |
| On-Peak | +0.17 | -0.01 | **-1.50%*** ** | **-1.43%*** ** | +0.63 | +1.02 |
| Mid-Peak | +0.01 | -0.17 | -0.50† | -0.44 | +0.66 | +0.94 |
| Off-Peak | **+0.64*** | **+0.56*** | -0.23 | -0.18 | -0.22 | -0.06 |
| System-Coincident Peak | -0.41 | -0.56 | -1.01 | -0.98 | +1.11 | +1.47 |
| Monthly Usage | +0.35 | +0.25 | -0.46† | -0.42 | +0.12 | +0.34 |

Based on the data presented in Table 24 and Table 25 we observe *nearly identical results* when estimating for consumption of households who opted-out of the price treatment. Based on this data, we conclude that a small asymmetric bias occurred in the data due to higher opt-out rates in the treatment

vs control rate. However, this asymmetric bias was not strong enough to create a meaningful change in the results and thus, do not affect the conclusions drawn from the experiment.

## 5.5 Overnight Plan Preliminary Results

The number of participants for the Overnight Pilot (N size) is displayed in Table 26. The Overnight Pilot began with 732 participants evenly distributed between the treatment and control groups. As of September 30th, the number of participants was 701. Participant drop off was due to either households moving out of the service territory, households opting out of either treatment, missing data[7] or the household consumption was deemed to be an outlier[8]. Some of the households were recruited to the Overnight Pilot without one full year of historical data. The purpose of allowing these households was to not exclude interested households and analyze their data as part of the final report.

*Table 22*: Number of Participants for Overnight Pilot

| Treatment Group | Starting (N) | Optouts (N) | Moveouts (N) | Outliers[10] (N) | Missing Data[9] | Final (N) |
|---|---|---|---|---|---|---|
| Overnight Pricing | 366 | 18 | 7 | 3 | 0 | 340 |
| Control (Regular Pricing) | 366 | 0 | 0 | 4 | 1 | 361 |
| Total | 732 | 18 | 7 | 7 | 1 | 701* |

*Note: As some households may have been removed for multiple criteria, Final (N) may be greater than the total number of ineligibilities

*Table 23*: Summary of Average Hourly Consumption (kWh/h) per Condition for Overnight Pilot

| | On-Peak Hours 2017 (kWh) | On-Peak Hours 2018 (kWh) | Off-Peak Hours 2017 (kWh) | Off-Peak Hours 2018 (kWh) | All Hours 2017 (kWh) | All Hours 2018 (kWh) |
|---|---|---|---|---|---|---|
| Control | 0.86 | 1.06 | 0.66 | 0.72 | 0.90 | 1.03 |
| Overnight Pricing | 0.84 | 0.94 | 0.71 | 1.11 | 0.92 | 1.12 |

Results for Peak and Off-Peak Impacts are displayed in Table 28. Overall, we observed significant effects for all four peak periods and the System-Coincident Peak for the Overnight Pricing Treatment. The data showed a reduction in both On-Peak consumption and Mid-Peak consumption in the Overnight Treatment group relative to the Control group. These decreases were estimated to be approximately 7.4% and 5.7% for On-Peak and Mid-Peak respectively.

Moreover, the data showed an increase in electricity consumption during Off-Peak and Super Off-Peak hours for the Overnight Treatment group relative to the Control group. We estimated these

[7] Any household who had missing data for any hour throughout the period of analysis was removed; households with missing data amounted to only 0.14% of the sample

[8] An outlier was defined as any household who consumed more than 15kWh per hour or less than 0.05kWh per hour during any hour in the analysis period.

consumption increases at 4.2% and 29.6% for Off-Peak and Super-Off-Peak respectively. Finally, we observed an approximate 7.4% decrease in consumption during the System-Coincident Peak hours in the Overnight Pricing group relative to the Control group.

*Table 24*: Overnight Pilot Average Hourly Consumption per TOU Period (Summer Impacts)

| | Consumption Relative to Control | |
|---|---|---|
| | Overnight Pricing | |
| TOU Period | kWh | % |
| On-Peak Impact | -0.100*** | -7.37%*** |
| Mid-Peak Impact | -0.082*** | -5.71%*** |
| Off-Peak Impact | +0.057*** | +4.17%*** |
| Overnight Off-Peak Impact | +0.346*** | +29.64%*** |
| System-Coincident Peak Impact | -0.114*** | -7.36%* |

**** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1*

Results for the Average Conservation Impact are shown in Table 29. The data showed a statistically significant increase in total summer consumption in the Overnight Pricing group relative to the control group estimated at approximately 5.3%. These results indicate that the increase in consumption during Off-Peak and Super Off-Peak hours was greater than the reduction in consumption during On-Peak and Mid-Peak hours, resulting in a net increase in total consumption.

*Table 25*: Overnight Pilot Average Hourly Consumption per Season

| | Consumption Relative to Control | |
|---|---|---|
| | Overnight Pricing | |
| TOU Period | kWh | % |
| Summer Impact | +0.054** | +5.34%** |
| Winter Impact | NA | NA |
| Year-Round Impact | NA | NA |

**** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1*

Daily and Substitution Elasticities are reported in Table 30. Daily elasticity of demand was estimated at -0.29. The daily elasticity of demand was negative and less than 1, indicating an inelastic daily demand curve. The substitution Elasticity was estimated at -0.26. This indicates an approximately 0.26% decrease in the ratio of on/super Off-Peak consumption relative to a 1% increase in the on/super Off-Peak price.

*Table 26*: Overnight Pilot Daily and Substitution Elasticities of Demand

| TOU Period | Consumption Relative to Control<br>% |
|---|---|
| Daily Elasticity | -0.292*** |
| Substitution Elasticity<br>On/Overnight Off-Peak | -0.263*** |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

In summary, the data indicate that offering Overnight pricing for customers leads to a decrease in On-Peak and Mid-Peak energy consumption and an increase in Off-Peak and Super Off-Peak energy consumption. These shifts accounted for an overall net increase of electricity consumption of approximately 5%.

## 5.6 Dynamic Plan Preliminary Results

The number of participants for the Dynamic Pilot (N size) is displayed in Table 31. The Dynamic Pilot began with 1,540 participants evenly distributed between the four treatment and control groups. Households who were part of the legacy Dynamic group were not included in these results. As the legacy group has been part of Dynamic pricing for over a 1 year period, we cannot compare their results to the same control group as the new participants; therefore legacy Dynamic customers will be required to be analyzed separately. As of September 30th, the number of participants was 1,409. Participant drop off was due to either households moving out of the service territory, households opting out of the program, missing data[9] or the household consumption was deemed to be an outlier[10].

*Table 27*: Number of Participants for Dynamic Pilot

| | Starting N | Opt-Outs | Move-Outs | Outliers[12] | Missing Data[11] | Interim Impact Total |
|---|---|---|---|---|---|---|
| Dynamic Pricing | 385 | 34 | 9 | 5 | 0 | 338 |
| Nudge Reports | 385 | 1 | 17 | 7 | 0 | 362 |
| Dynamic Pricing + Nudge Reports | 385 | 29 | 6 | 6 | 0 | 345 |
| Control | 385 | 0 | 14 | 11 | 0 | 364 |
| Total | 1,540 | 64 | 46 | 29 | 0 | 1,409 |

*Note: As some households may have been removed for multiple criteria, Final (N) may be greater than the total number of ineligibilities

*Table 28*: Summary of Average Hourly Consumption (kWh/h) per Condition for Dynamic Pilot

| | On-Peak 2017 (kWh) | On-Peak 2018 (kWh) | Off-Peak 2017 (kWh) | Off-Peak 2018 (kWh) | Total 2017 (kWh) | Total 2018 (kWh) |
|---|---|---|---|---|---|---|
| Control | 1.19 | 1.97 | 0.85 | 0.97 | 0.90 | 1.04 |
| Dynamic Pricing | 1.23 | 1.80 | 0.90 | 1.02 | 0.95 | 1.07 |
| Nudge Report | 1.25 | 2.07 | 0.89 | 1.02 | 0.94 | 1.09 |
| Dynamic Pricing + Nudge Report | 1.17 | 1.69 | 0.85 | 0.97 | 0.90 | 1.01 |

[9] Any household who had missing data for any hour throughout the period of analysis was removed. There were no households with missing data in the Dynamic Pilot.

[10] An outlier was defined as any household who consumed more than 15kWh per hour or less than 0.05kWh per hour during any hour in the analysis period

For Dynamic Group only, On-Peak and CPP days varied depending on the system load. In Table 33 we report the number of High, Medium, and Low On-Peak days along with the number of CPP days during the pilot period.

*Table 29*: Dynamic On-Peak and CPP Days

| Dynamic On-Peak | Number of Days | % of Total | Prescribed by OEB |
|---|---|---|---|
| High | 26 | 20% | 20% |
| Medium | 35 | 28% | 30% |
| Low | 66 | 52% | 50% |
| CPP | 6 | n/a | |

Days are counted Beginning May 1 2018

The days reported only includes weekdays. Weekends are always Off-peak. There was a slight deviation from the prescribed breakdown of Low, Medium and High days. The way Alectra determines the rate per day is based on the IESO's overall demand forecast – which is highly correlated to the weather forecast – which is variable and hard to predict. Alectra sets a threshold on the demand forecast that will determine if a day is Low, Medium or High. Sometimes, Alectra adjusts the threshold to make more sense when comparing to previous days' rates so that customers have a consistent experience.

Results for Peak and Off-Peak Impacts are displayed in Table 34. In the Dynamic pilot, On-Peak hours were sub-divided by High, Medium, and Low On-Peak[11]. For the three On-Peak periods (High, Medium, and Low), we observed a reduction in consumption for participants in the pricing manipulation relative to control of approximately 15.6%, 13.6%, and 6.7% respectively.

In the Nudge Report condition, we observed no effects for the non-price treatment on consumption for any of the peak periods. However, there was an interactive effect significant at the 10% level for households who received both the Nudge Report and Dynamic pricing during High On-Peak hours. These results suggest that the Nudge Report may have successful at reducing energy consumption during Peak Hours when combined with Dynamic Pricing.

During the System-Coincident Peak hours we observed an 11.8% reduction in consumption relative to control for individuals who received Dynamic Pricing. There was no main effect of Nudge Report relative to the Control group.

[11] Each On-Peak period was determined on a daily basis based on the total system load

*Table 30*: Dynamic Pilot Average Hourly Consumption per TOU Period (Summer Impacts)

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Dynamic Pricing (Main Effect) | | Nudge Report (Main Effect) | | Nudge Report * Dynamic Pricing | |
| TOU Period | kWh | % | kWh | % | kWh | % |
| High Peak | -0.260*** | -15.60*** | -0.015 | -1.46 | -0.095* | -5.26† |
| Medium Peak | -0.186*** | -13.55*** | -0.002 | +0.12 | -0.032 | -1.45 |
| Low Peak | -0.069*** | -6.73*** | +0.000 | -0.29 | +0.017 | +0.83 |
| Off-Peak | 0.000 | 0.18 | 0.007 | +0.01 | -0.010 | -2.2 |
| System-Coincident Peak | -0.165*** | -11.84*** | -0.010 | -1.38 | -0.014 | -3.21 |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

The results for Critical Peak Days are shown in Table 35. We observed consistent reductions in electricity consumption during CPP hours for the Pricing Treatment ranging between a 19%-34% decrease relative to control. Households who received the Nudge Report had a further 6% and 15% reduction in energy on CPP Days 3 and 4. The average across the 6 days was a reduction of 26.3% electricity for the Pricing Treatment and a reduction of 3.5% for the Nudge Report Condition. There were no significant interaction effects for CPP hours. However, on CPP Day 4 and Day 5 there was an additional decrease of 11.7% and 11.5% significant at the 10% level. In Appendix F we present consumption differences between Dynamic customers and the Control customers during the six CPP days. In addition, a comparison of consumption during the six CPP days is presented alongside average consumption on High Peak days.

*Table 31*: Dynamic Pilot Average Hourly Consumption per Critical Peak Day

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Dynamic Pricing (Main Effect) | | Nudge Report (Main Effect) | | Nudge Report * Dynamic Pricing | |
| CPP | kWh | % | kWh | % | kWh | % |
| CPP Day 1 | -0.375*** | -33.63*** | -0.026 | -2.74 | +0.118 | +10.17 |
| CPP Day 2 | -0.329*** | -19.31*** | -0.076† | -6.69* | -0.0854 | -10.48 |
| CPP Day 3 | -0.282*** | -19.73*** | -0.136*** | -14.64*** | 0.025 | +8.65 |
| CPP Day 4 | -0.407*** | -29.74*** | +0.083* | +0.06 | -0.153† | -11.65† |
| CPP Day 5 | -0.361*** | -27.11*** | -0.006 | 0.59 | -0.099 | -11.47† |
| CPP Day 6 | -0.365*** | -25.47*** | 0.005 | 2.46 | -0.087 | -1.84 |
| Total | -0.353*** | -25.84*** | -0.026 | -3.49* | -0.047 | -2.76 |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

Results for the Average Conservation Impact are shown in Table 36. Overall, we observed that the main effect of Dynamic Pricing on total summer electricity consumption was a reduction in consumption of approximately 1% however the results were not significant. We observed no interaction effect between Dynamic Pricing and the Nudge Report. Winter and Year-Round impacts will be included at the conclusion of the in-field trial.

*Table 32*: Dynamic Pilot Average Hourly Consumption per Season

| | Consumption Relative to Control | | | | | |
|---|---|---|---|---|---|---|
| | Dynamic Pricing | | Nudge Report | | Enhanced Pricing * Nudge Report | |
| TOU Period | kWh | % | kWh | % | kWh | % |
| Summer Impact | -0.026*** | -0.9 | 0.009 | -0.21 | -0.010 | -1.76 |
| Winter Impact | NA | NA | NA | NA | NA | NA |
| Year-Round Impact | NA | NA | NA | NA | NA | NA |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

Daily and Substitution Elasticities are reported in Table 37. Daily elasticity of demand was estimated at -0.050. The daily elasticity of demand was negative and less than 1, indicating an inelastic daily demand curve. Substitution elasticity of demand was estimated at -0.014 indicating a very inelastic substitution elasticity.

*Table 33*: Dynamic Pilot Daily and Substitution Elasticities of Demand

| Elasticity Estimate | (%) |
|---|---|
| Daily Elasticity | -0.050*** |
| Substitution Elasticity On/Off-Peak | -0.014*** |

*** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.1

Finally, we compare results between households who signed a pledge versus households who didn't. Similar to the Enhanced group, households had the option to sign a pledge to commit to reducing their on-peak energy use. Households who signed and returned the pledge were offered a $5 rebate. While the pledge was not experimentally manipulated, we compare the results of households who signed the pledge versus households who received the nudge report, but didn't sign the pledge see Table 38 and Table 39.

*Table 34: Pledge Numbers – Dynamic Condition*

| Control Pledge Not Signed | Control Pledge Signed | Dynamic Pricing Pledge Not Signed | Dynamic Pricing Pledge Signed |
|---|---|---|---|
| 362 | 0 | 309 | 24* |

**does not include opt-outs and moved outs*

*Table 35 : Pledge Analysis – Dynamic Condition*

| | Year-Year Average Hourly Consumption Change | | | |
|---|---|---|---|---|
| | Control Group (kWh) | No Pledge (kWh) | Signed Pledge (kWh) | P-Value |
| On-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.539 | - | - | - |
| Control - Nudge Report | - | 0.550 | N/A | N/A |
| Dynamic Pricing and Nudge Report | - | 0.371 | 0.252 | 0.053 |
| Mid-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.285 | - | - | - |
| Control -Nudge Report | - | 0.294 | N/A | N/A |
| Dynamic Pricing and Nudge Report | - | 0.155 | 0.098 | 0.241 |
| Off-Peak Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.124 | - | - | - |
| Control -Nudge Report | - | 0.135 | N/A | N/A |
| Dynamic Pricing and Nudge Report | - | 0.126 | 0.153 | 0.282 |
| Monthly Consumption | | | | |
| Base Line (Control - No Nudge Report) | 0.140 | - | - | - |
| Control -Nudge Report | - | 0.145 | N/A | N/A |
| Dynamic Pricing and Nudge Report | - | 0.115 | 0.182 | 0.040 |

Overall, results from Table 38 and 39 show that households who signed the pledge showed lower On-Peak consumption relative to households who have not signed the pledge; however this effect was marginally significant at the 0.05 and 0.04 levels. Furthermore, Mid-Peak and Off-Peak consumption were not different between the two groups. In addition, there were no households in the Dynamic Control group who signed the pledge which prevented us from comparing this group. As this pledge was

not experimentally manipulated and served as an aspect of the nudge report, we cannot make a causal inference that the pledge created energy savings or if is the case that households who were already more motivated to save were more likely to sign the pledge.

We found that offering Dynamic pricing for customers leads to a significant decrease in consumption during all three (High, Medium, and Low) On-Peak periods and the System-Coincident Period. Furthermore, there was evidence that customers who received Dynamic Pricing and the Nudge Report displayed a further 5.3% reduction in consumption during the High On-Peak hours. These shifts resulted in a total summer energy reduction of approximately 1% for households who received Dynamic Pricing. Finally, during CPP hours Dynamic Pricing reduced consumption by 26% and the Nudge Report reduced consumption by 3.5%. These results indicate that the pilot was successful at reducing On-Peak consumption, and there was evidence that the Nudge Report further increased these savings.

### 5.7 Revenue Analysis

A core policy goal for the Regulated Price Plan is that the prices charged recover the costs of consumption over time. Accordingly, APP rates were designed to be revenue neutral, meaning that the rates charged under each price plan are revenue neutral assuming no behavioural response from participants. This helps to ensure the integrity of the prices charged and minimizes the risk of cross subsidies between plans.

To assess each plan's performance with regard to revenue adequacy, average plan revenues are compared to revenues under status quo TOU prices in Table 36. Overall, the plans, in combination, appear to be effective at collecting expected revenues when compared to status quo rates. Dynamic and Enhanced plans are recovering costs effectively (<1% deviation from target revenues). However, the apparent rate of under-collection in the Overnight plan suggests that, with current prices and levels of load shifting, it might not be effective at recovering plan costs over time. Each of these findings will be further investigated in the final report.

The slight under-collection overall is expected, given the aggregate rates of demand response and conservation behaviours seen in all the plans in combination.

*Table 36: Average Revenues (TOU and APP)*

| | Average Revenues (TOU) | Average Revenues (APP) | Change |
|---|---|---|---|
| | $/kWh | $/kWh | % |
| Dynamic | 0.0822 | 0.0819 | -0.4 |
| Enhanced | 0.0819 | 0.0822 | 0.5 |
| Overnight | 0.0778 | 0.0710 | -8.7 |
| Total | 0.0816 | 0.0814 | -0.3 |

## 6. Lessons Learned from Program Implementation

There are a number of lessons learned that Alectra would like to share. Some of them will be captured in the Process Evaluation report to be submitted around the same time as the Final Report submission. In the Process Evaluation, we are looking at what went well, what did not work, and what we could have done better. It will also include a review of all the materials we used in the program (e.g., marketing materials, web portal, customer letters), the data flow efficiency and quality, and the communications between all the parties/vendors involved in the program implementation. Most especially, the Process Evaluation will capture customer feedback and perception on the pilot (e.g., customer satisfaction, customer understanding of the program). Alectra engaged BEworks to conduct the Process Evaluation on our behalf.

Here are a number of lessons learned from the operational perspective to date:

**Customer service and care:**

- Alectra hired a third party to provide call centre services. The initial training and tools provided to them were all related to program recruitment and how the program works. They were not trained on the Alectra billing process and the details of how the billing adjustments were to be applied. Typically, billing related inquiries are taken care of by Alectra's own call centre. At the same time, Alectra's own call centre was informed to transfer all calls to the third party call centre. It would be ideal to have one call centre that could answer all of the customers' inquiries.
- The automatic enrolment of customers to the Enhanced plan caused dissatisfaction to some customers. This could not have been completely avoided, but there are ways to reduce the number of dissatisfied customers. Really good and simple communication regarding the program is a key, as well as training to call centre staff on how to answer these types of concerns. Explaining why Alectra is doing this and how they were selected and how they can opt out of the program will eliminate majority of the customer inquiries. Using multiple media to communicate this information is also recommended. The opportunity to have all billing adjustments associated with their participation in APP addressed most, but not all, of customers' dissatisfaction.

**Shadow billing:**

- The shadow billing seems to be effective to inform customers of their benefits being in a different rate plan. The challenges with shadow billing are:
  - It is relatively difficult to implement and more prone to errors compared to full billing integration;
  - There is an added time lag between consumption period and when the customers receive their billing information which creates customer confusion; and
  - It is relatively expensive to implement (from developing the shadow bills, to printing and creating a separate mailing to the customers).

Fully integrating the rate plans to the utility billing system should avoid or reduce these challenges. There will be a simpler and more positive customer experience and it might also be more cost-effective to implement, since the billing system upgrade/changes will only be done once and weekly shadow billing will not be required. However, there would be more up-front costs that would be required to make the changes to the billing system, test and then deploy them. Full billing integration was not possible during the term of this project due to Alectra's concurrent billing system upgrades and integration work that precluded development of capability as part of the RPP Roadmap pilot project.

**Customer Recruitment:**

- Customer recruitment was made more difficult on account of the requirement to exclude customers participating in related conservation behaviour projects. Since Alectra had already

launched a Home Energy Report project to the targeted population group, this project had only a relatively small subset of the overall population eligible to target for recruitment. This meant that a smaller number of customers were available to bring in while maintaining the same target sample sizes, and also precluded mass-market marketing initiatives that would have resulted in a large number of interested participants being rejected on account of their eligibility.

- A longer recruitment period would have resulted in more participation – both to give customers more time to respond, and to give staff more opportunity to develop marketing channels. This was evident when the OEB allowed Alectra to extend the recruitment period for Overnight for an additional month.
- A more comprehensive marketing strategy that included both mass market as well as targeted engagement to reach customers multiple times would have resulted in a higher participation rate.
- The Overnight plan may not be appealing to most customers since it appeals to a niche of customers who can take advantage of the low rate in the 12am-6am period. It is ideal for EV owners and shift workers. Alectra tried to promote the plan by leveraging car dealerships and employers of shift workers, but there was little incentive for these organizations to promote the plan. Alectra would recommend a more comprehensive and sophisticated marketing strategy be conducted if the Overnight plan is promoted again. Historical consumption data could be analyzed to see if EV loads could be detected. Working with various industry organizations to locate EV owners would also be desirable moving forward. As for shift workers, designing a package that would make it easier for companies that have large number of shift workers to promote this plan to employees would also be helpful.

**Design and development work:**

- Scoping all potential requirements/options upfront (functional requirements, reporting requirements, future roadmap "wish list" items, etc.) when engaging a vendor allows the vendor to plan more effectively and provide suggestions and feedback for creating a more valuable service.
- Ensure that sufficient time is allocated for development and testing to maintain confidence that systems are functioning correctly.
- Detailed business process sessions and diagrams completed/updated each time a major change is required/requested.
- Clearly define settlement reporting requirements at the start of the project so it could have been incorporated into the billing system design initially. During the design phase, it was not clear if bill adjustments would be settled with IESO or provided through the project budget.

**Eligibility:**

- Additional manual processes are required when applying bill adjustments to customers enrolled in pre-authorized plan and budget billing plan. It is also arguable that these customers may not be the ideal customers to target for a rate plan behavioral pilot since their preference may imply not paying close attention to monthly electricity bills – the reason why they signed up for budget billing and pre-authorized payments.

**Staff resourcing:**

- Ensure that there are enough capacity and capability to work on all the project requirements. Project activity was delayed during certain points because the limited staff resources were not able to carry out all scheduled work activities at the same time.

**Data quality:**

- Process automation – the more automation that can be put in place the better – manual manipulation of data and spreadsheets leaves room for human error and uneven data quality. These processes should be rigorously designed and audited once implemented to ensure that automated processes are generating correct outcomes.

**Focus group insights:**

In addition to the above learnings, here are some highlights of the focus group sessions. Please note that this is just one set of information gathered (from 30 participants and 10 non-participants) and should be treated as indicative but perhaps not a reflection of the whole APP community. These findings were shared with OEB staff in previous reports.

- Awareness of the macro or overarching reasons for the pilot, and the benefits both to the electricity system in Ontario and to consumers, were very poorly understood. While there was some awareness of benefits to the grid, there was also some cynicism and skepticism as to why the pilot is in place – those with these views generally feel that they may in the end "lose out" in the form of higher electricity bills in the future.
- Many participants in the pilot program are familiar with how it works, and the various rates and peak times, in particular in the Dynamic and Overnight groups. However, there was some confusion in the Enhanced group about how this program works a) because of the similarities to regular TOU pricing – in particular, the rate design graphic and b) because they were automatically added to the pilot and not opt-ins, and so were generally less informed about the program.
- Most who are currently on an Advantage Power Pricing plan changed their electricity consumption behaviour in some form as a result. Those who opted into the program were generally more literate and engaged with the energy sector to begin with, and their participation in the plans contributed to this.
- Because the savings realized from the plans are lower than expected and lack "wow", many are on the fence about their continued participation in the plans, particularly if they have made significant lifestyle changes in order to align their behaviour with off-peak times.
- The idea of having Alectra use its available data to the benefit of its customers, and allowing customers to view, understand, and track their own consumption was of great interest. In particular, making recommendations on the best program to be on and providing information on usage and savings that tie into various peak periods would be interesting and relevant to hear about.
- Most program materials are positively perceived as being memorable and helpful, but channels for communication need to evolve to reflect changing behaviour. Furthermore, many would like and expect their smartphones to be their hub (namely via an App) for managing and tracking their energy consumption.

- Perceptions of how useful and relevant the tools were, were mixed. While some found the tools to be helpful in managing their electricity use, such as being able to view their use online through the Alectra customer website or portal, others were less useful such as the emails about Critical Peak pricing, in that they arrived too late for customers to take any action about their electricity use.
- Communications specific to the programs were generally thought to be informative and effective when they reached program customers; however the issue for many was they do not receive communications about the program from Alectra for various reasons.
- Most of those who are not currently on APP, or opted out, had little interest in the program for various reasons: some felt that the realized or potential cost savings were too low, or they were reluctant to change their behaviour. However, providing information to optimize participation and savings was of interest to a few if it were simple and/or customized.

# 7. Conclusions

In summary, this project, in its first half of the term, successfully tested three separate pilot pricing programs in combination with a Nudge Report. To date, the first eight months of the unprotected pilot period have been completed, and this report covers the six months of the Summer RPP period (May-October). With the results seen so far, it appears that both Dynamic Pricing and Overnight Pricing have yielded reductions in On-Peak consumption and customer bill savings. At this time, no effect from of the Enhanced Pricing on On-Peak consumption has been seen; however, an increase in Off-Peak consumption was observed. Furthermore, the Nudge Report was consistent at reducing On-Peak consumption by approximately 1.5%-3.5% for all customer groups. The results/effects associated with the legacy dynamic customers, thermostats and in-home technology, and energy literacy will be included in an addendum to this report later in Spring 2019.

There are two potential causes for why savings were observed in the Dynamic and Overnight plans and not in the Enhanced plan. The first possibility is that the Enhanced plan did not offer a large enough price differential between On-Peak and Off-Peak prices to motivate customers to change their behavior. The Enhanced plan offers customers moderately lower Off-Peak rates (6.5¢/kWh to 4.4¢/kWh) and moderately higher On-Peak rates (13.2¢/kWh to 17.6¢/kWh). In contrast, the Overnight plan offered a considerable discount on the Overnight Off-Peak Rate from to 2¢/kWh, with higher On-peak prices of 18.3¢/kWh. Dynamic pricing incorporated a considerably higher On-Peak rate at 39.7¢/kWh and 49.8¢/kWh during Critical Peak Pricing. These substantial rate differences may have been enough to encourage households to make substantive technological changes or shift their energy consumption behavior.

A second possibility is that both Dynamic and Overnight plans required customers to volunteer and opt-in to the pilot pricing initiatives. This is in contrast to Enhanced Pricing where customers were selected at random to participate. It is possible therefore that there are intrinsic differences between customers on Enhanced pricing and those customers who volunteered for Dynamic or Overnight. Specifically, it is possible that the latter group chose these programs because they intended to change their consumption behavior to save money. Nonetheless, the observed interim impacts observed for the Dynamic and Overnight pilots are externally valid, provided the program is also offered on an opt-in basis. The same is true of the Enhanced pilot interim findings, assuming this program was rolled out Province-wide on an opt-out basis.

With respect to the Nudge Report, we observed consistent reductions in On-Peak consumption of approximately 1.5%. These reductions occurred regardless of whether the households received Enhanced or Regular TOU pricing. Similarly, in the Dynamic Pilot we observed a reduction in the High On-Peak of 1.46%, a reduction in the System-Coincident Peak hours of 1.38%, and reduction during CPP hours of 3.5%; these were consistent across households with Dynamic or Regular TOU pricing. One caveat to these findings was that only reductions which occurred during CPP hours were statistically significant. This is potentially due to the reduced power of the Dynamic Pilot in comparison to the Enhanced Pilot; however, a larger experiment would need to be done to confirm this hypothesis.

Based on the summer interim pilot data, our findings suggest that there is no evidence yet that the Enhanced plan was able to successfully reduce consumption during either On-Peak or System-Coincident Peak hours or reduce total consumption. There was strong evidence that the Dynamic and Overnight plans were successful in reducing consumption during On-Peak and System-Coincident Peak hours.

The sizeable impacts of CPP days on peak consumption reduction for Dynamic pricing participants are noteworthy. The number of CPP days for the Summer months included in this report was capped at six, however it would be advantageous for future pilots to experimentally manipulate the frequency and/or duration of CPP events in order to determine whether even greater consumption reductions can be realized. By subjecting different groups of program participants to different frequencies of CPP events (e.g., 6, 10, 14) within each of the Summer and Winter TOU months, peak consumption reductions relative to Control participants could be assessed as a function of CPP event frequency. The research question of interest is whether there is a limit to participant responsiveness to CPP events. It is likely that if CPP events occur too frequently, participants will be unable (or unwilling) to curb consumption behaviours during CPP event hours. Determining the frequency of CPP events at which diminished responsiveness occurs would allow the OEB to maximize on-peak consumption reductions resulting from CPP events. The role of technology (e.g., smart thermostats able to respond to CPP events) in helping to reduce consumption during CPP periods) will also be illuminating. This topic will be covered in the Addendum, to be submitted later in March 2019.

Alectra is looking forward to completing the 12-month pilot of its RPP pilots, with a focus on seeing how the effects of the price plans and Nudge Report change during the winter RPP period, and if Enhanced customers achieve greater savings over an extended pilot period. As well, it will be interesting to see the impact associated with the use of home energy management technology (e.g., thermostats) in both the heating and cooling seasons.

In addition to completing the initial pilot term, **Alectra strongly recommends extending the pilot by another year (to April 2020), taking advantage of the investment in participant recruitment and program infrastructure to obtain additional valuable insight that can provide a more complete set of policy recommendations to the OEB.**

There are several areas which the Alectra team believes would benefit from further exploration.

- **Test the two hypotheses to explain the results of the Enhanced Plan.** First off, results to date suggest that additional study of the Enhanced group to identify the reason for the low impact of the change of pricing would be beneficial to the implementation of future changes to the RPP. This price plan was designed to have a bigger price differential than the standard TOU pricing. Alectra believes that there would be value to determining if it is true that the Enhanced price differential is still not enough to convince customers to change the way they use electricity at home, or if it is the recruitment method that is driving the low levels of behaviour change.
    - This could be done by offering the program on an opt-in program.

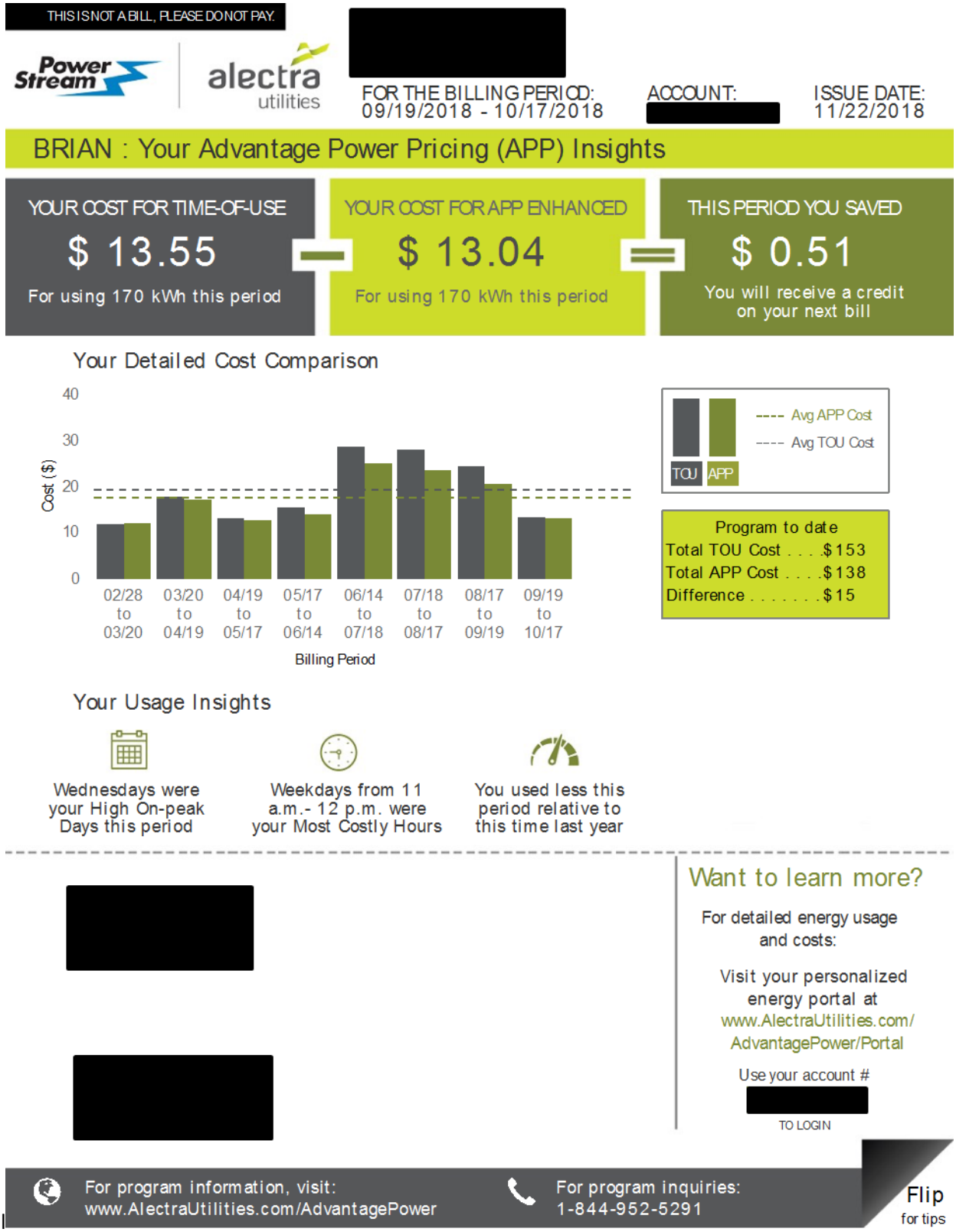
- Secondly, the program could incorporate a different price differential while maintaining the same rate structure, to see if a change in pricing will lead to greater behaviour change.

The expected result would be to collect more data to establish the degree to which the price differential or the recruitment method is driving low levels of customer behaviour change. This would provide insight to the OEB whether, in the future, customers should ideally be offered a choice of rate plan, or if it is more important to set appropriate prices.

- **Collect more data to inform EV Initiatives.** There are insights from the Overnight and Dynamic plans that could be leveraged to inform how rate structures can be used as a tool to influence the charging behavior of electric vehicle (EV) drivers. The growth rate of EVs has been exponential for 5+ years, and there are now over 30,000 EVs on Ontario's roads, with an annual growth rate of 120% from 2017-2018. Stakeholders, including utilities, are concerned that these large loads could pose a threat to the operation of the electricity system, especially where they are clustered on the same electrical infrastructure (especially on neighborhood transformers). Rate structures could be a cost-effective way of mitigating the impact of EV adoption by encouraging vehicle charging during system off-peak periods. Alectra has been approached by a partner that has been awarded funding through the Ontario Smart Grid Fund that would allow vehicle data to be provided from APP participants with EVs to understand customers' charging and driving behaviors, and how they compare to drivers on standard TOU rates.
- **Obtain more statistically powerful impacts.** Given that most customers are unlikely to change their rate structure on a regular basis, the long term impacts of alternative rates on customer behaviour would be valuable to see if impacts persist on a longer term basis. A second year of study would provide an opportunity to obtain these data.

Alectra believes that extending the APP pilot study will enable it to provide additional insight to the OEB, which in turn can be used to influence the future of electricity pricing in Ontario for the benefit of all Ontarians. Alectra also believes that these benefits would far outweigh the costs to extend the program for an additional year. Alectra, with its partner BEworks, will provide a recommended scope of work to the OEB for additional study of the customer response to alternative rates through this pilot initiative.

*Appendix A – Shadow Bill*



Power Stream | alectra utilities

## YOUR HOUSEHOLD POWER INSIGHTS:

### YOU MAINTAINED THE **SAME OR LESS** ON-PEAK USAGE THAN USUAL.

Maintain or increase your savings by reducing usage during On-peak hours.

*Feedback based on your On-peak usage this period relative to your historical On-peak usage this time last year*

### Here's your personalized saving strategy:

**Adjust your thermostat**

**Tennis, anyone?**

ng through the clothes, absorb moisture, and reduce drying time.

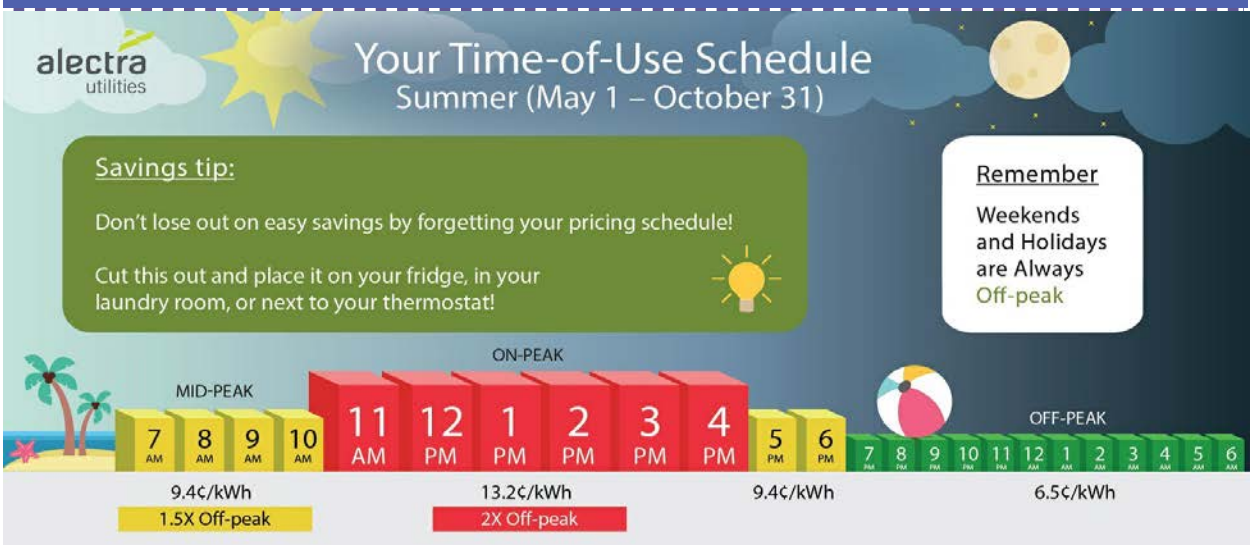
**Use an advanced power bar and save electricity!**

Electronic devices left plugged in, even when turned off, still draw power. Use advanced power bars to combat "Always On" power.

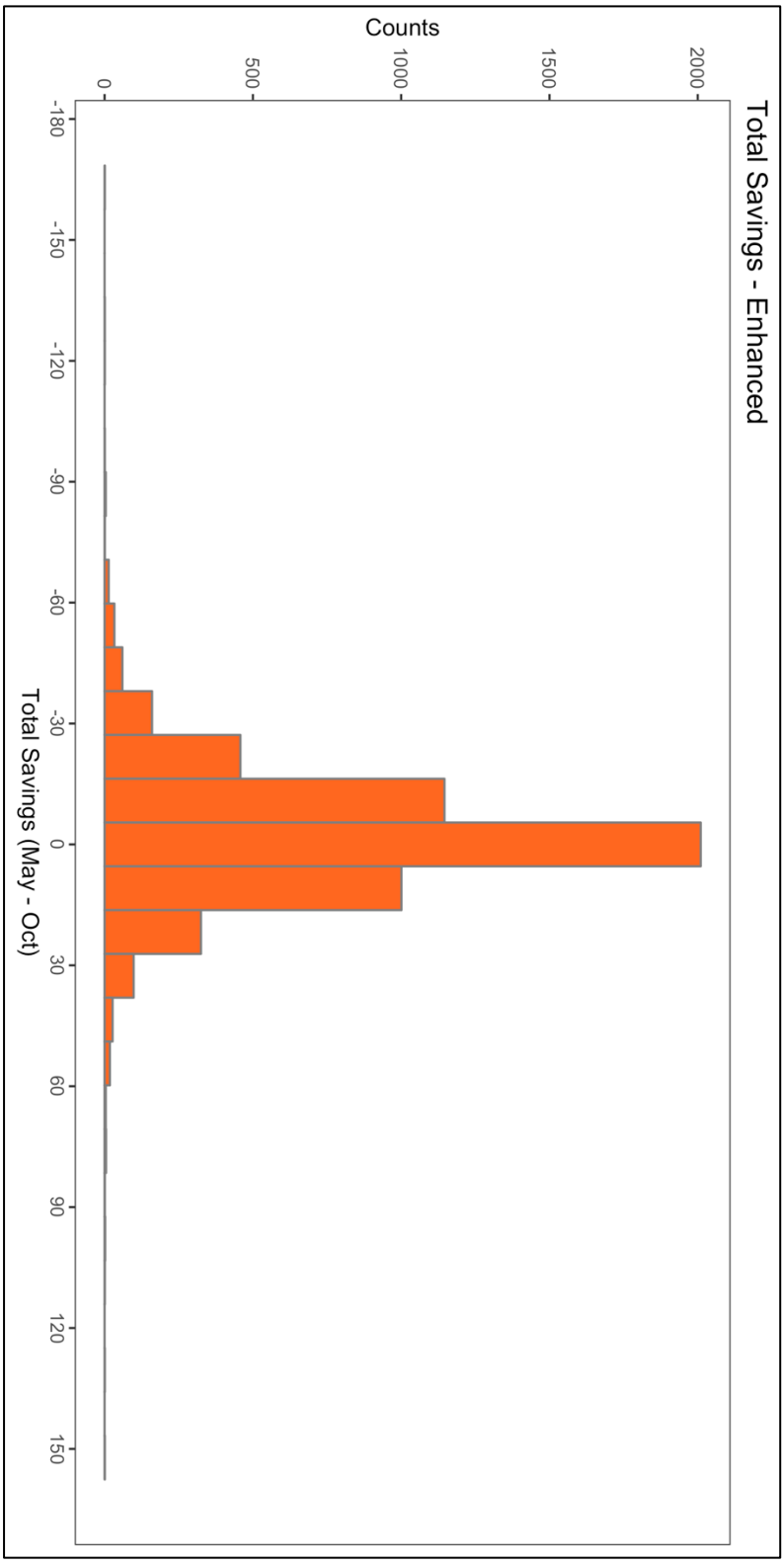

I, _____ pledge to save On-peak by reducing my weekday usage from **11 a.m. to 5 p.m.**

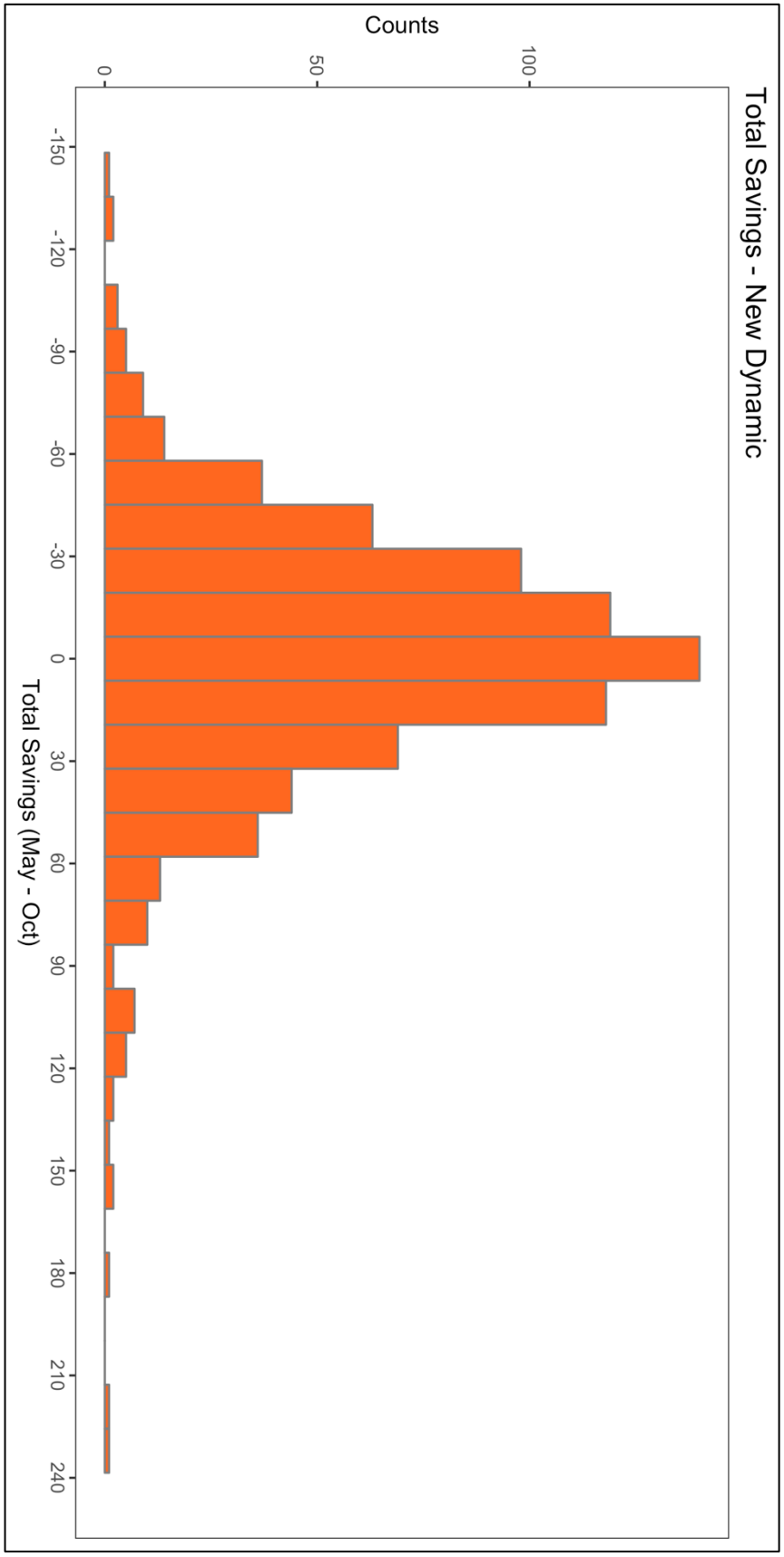
- **Text* SAVE2018 to 76000**
- **Receive a $5 credit on your next bill**

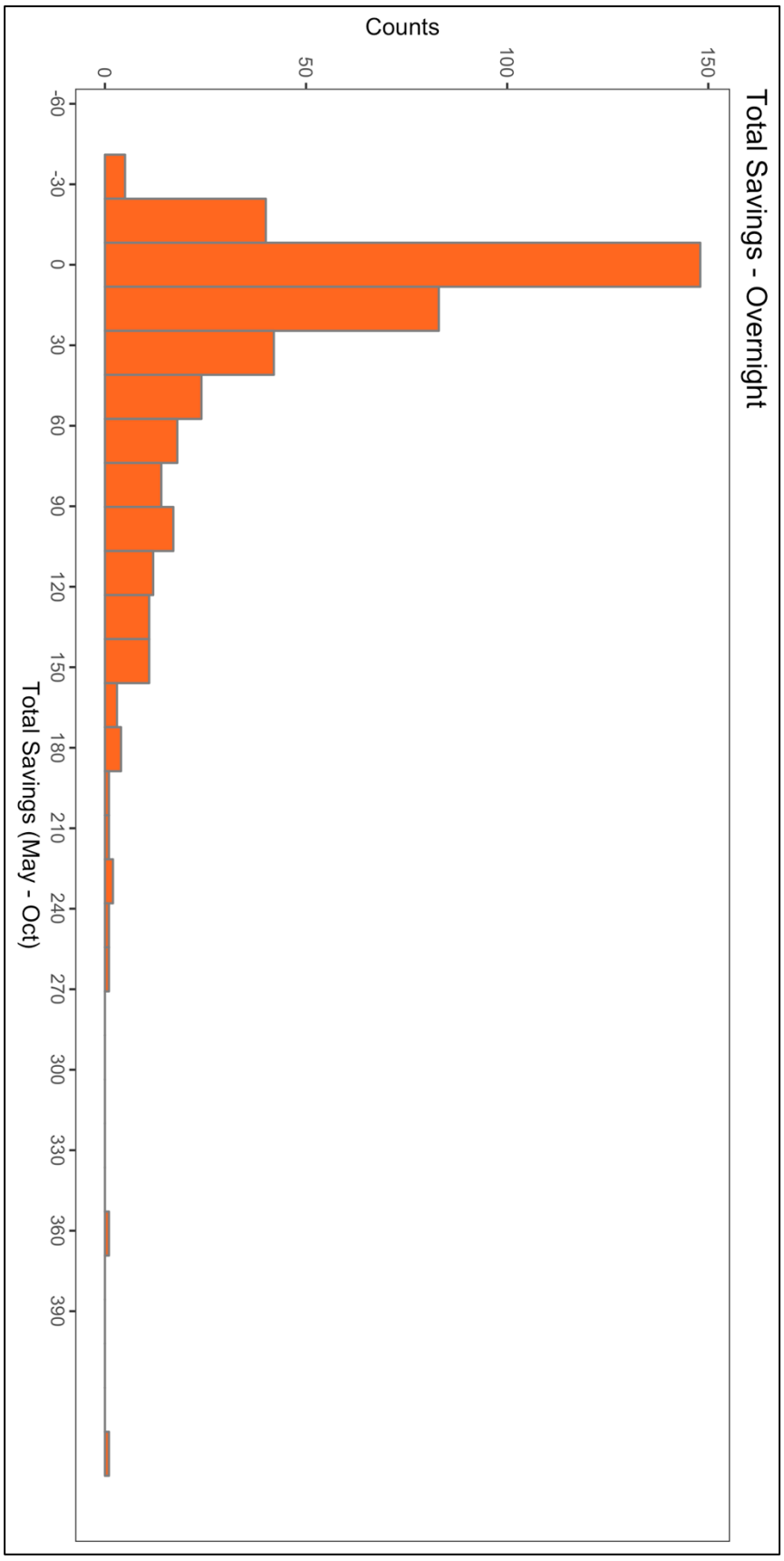
* Message and data rates may apply. We may send you text message responses to complete the pledge process. www.alectrautilities.com/pledge and www.alectrautilities.com/privacy apply.



## *Appendix C – Savings per Pricing Pilot*




Total Savings - New Dynamic
Counts
0
50
100
-150
-120
-90
-60
-30
0
30
60
90
120
150
180
210
240
Total Savings (May - Oct)


Total Savings - Overnight
Counts
0
50
100
150
-60
-30
0
30
60
90
120
150
180
210
240
270
300
330
360
390
Total Savings (May - Oct)

## *Appendix D – Deviations from EMV Report*

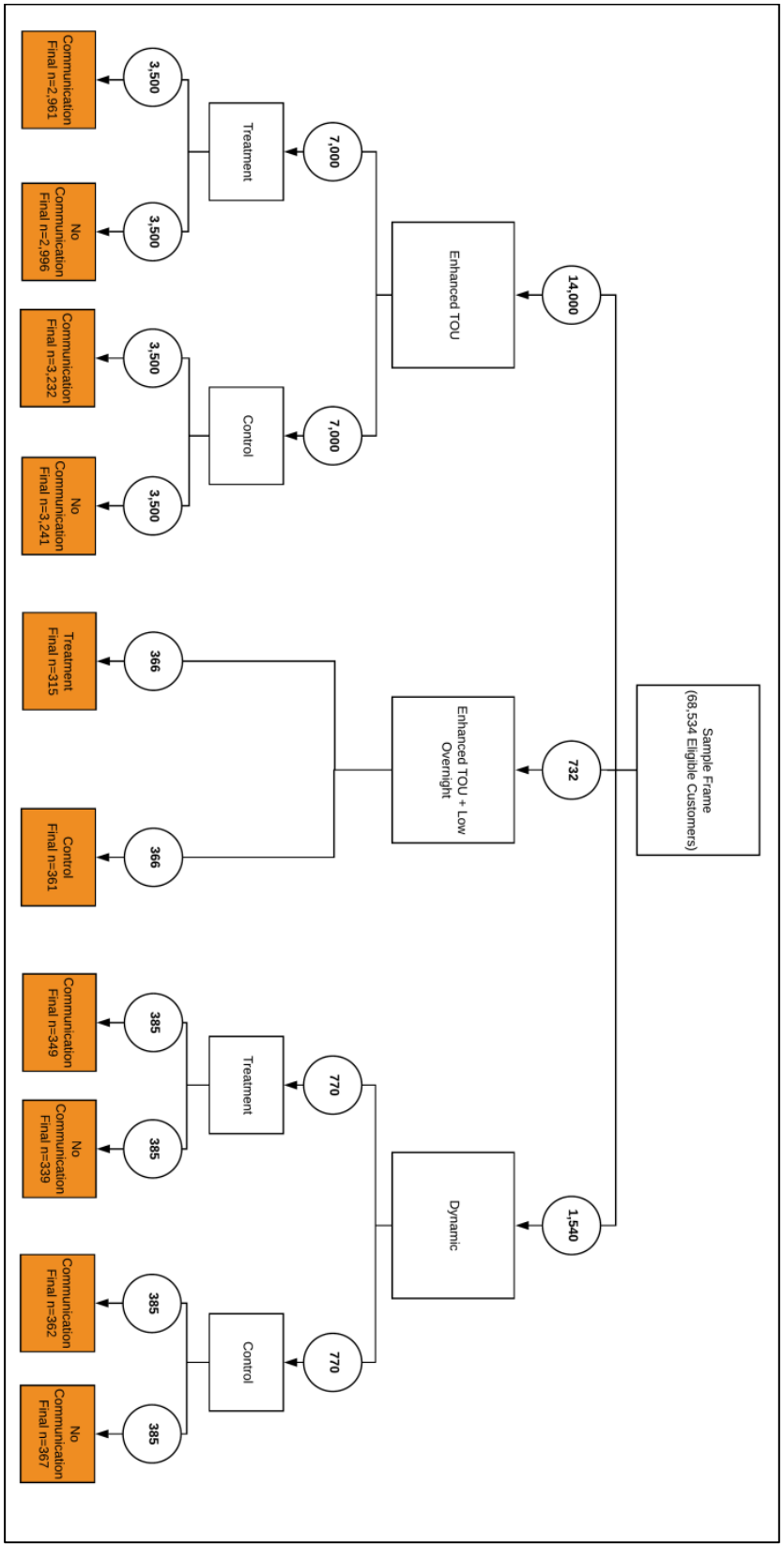
| Intent as per EMV Plan | Deviation and Rationale |
|---|---|
| Target sample sizes | Target sample sizes for recruitment of new participants into the opt-in treatment groups as laid out in the EMV plan were as follows: 1,000 Dynamic and 500 Overnight. Due to lower than expected uptake of the APP program by eligible customers, actual enrolment rates into the treatment conditions were as follows: 688 Dynamic and 315 Overnight. Power analyses were conducted to confirm that these samples were sufficient to proceed. |
| Distribution of Nudge Reports | Nudge reports containing customized conservation tips were intended to be distributed to selected customers beginning in May 2018. As a result of delays associated with integrating customer disaggregation data with the Nudge reports, these customized tips did not appear on the Nudge reports until July. |
| Impact Analysis | In order to control for selection bias introduced into the Enhanced pricing Treatment group due to opt-outs, an Intent to Treat analysis was conducted. This analysis was not specified in the EMV plan. |

### Sample Size Explanation

For our sample size calculation we used an ANOVA repeated measures between factors power analysis. In this power estimation we looked at the required sample size to achieve an effect size of 0.1 with a 90% power. For the Enhanced and Dynamic samples which were a 2X2 design and 6 repeated measures, a conservative power analysis would yield an approximate requirement of 832 participants or 208 per cell. For the Overnight analysis which had 2 groups, this was number estimated at a total of 700 participants, or 350 per cell.

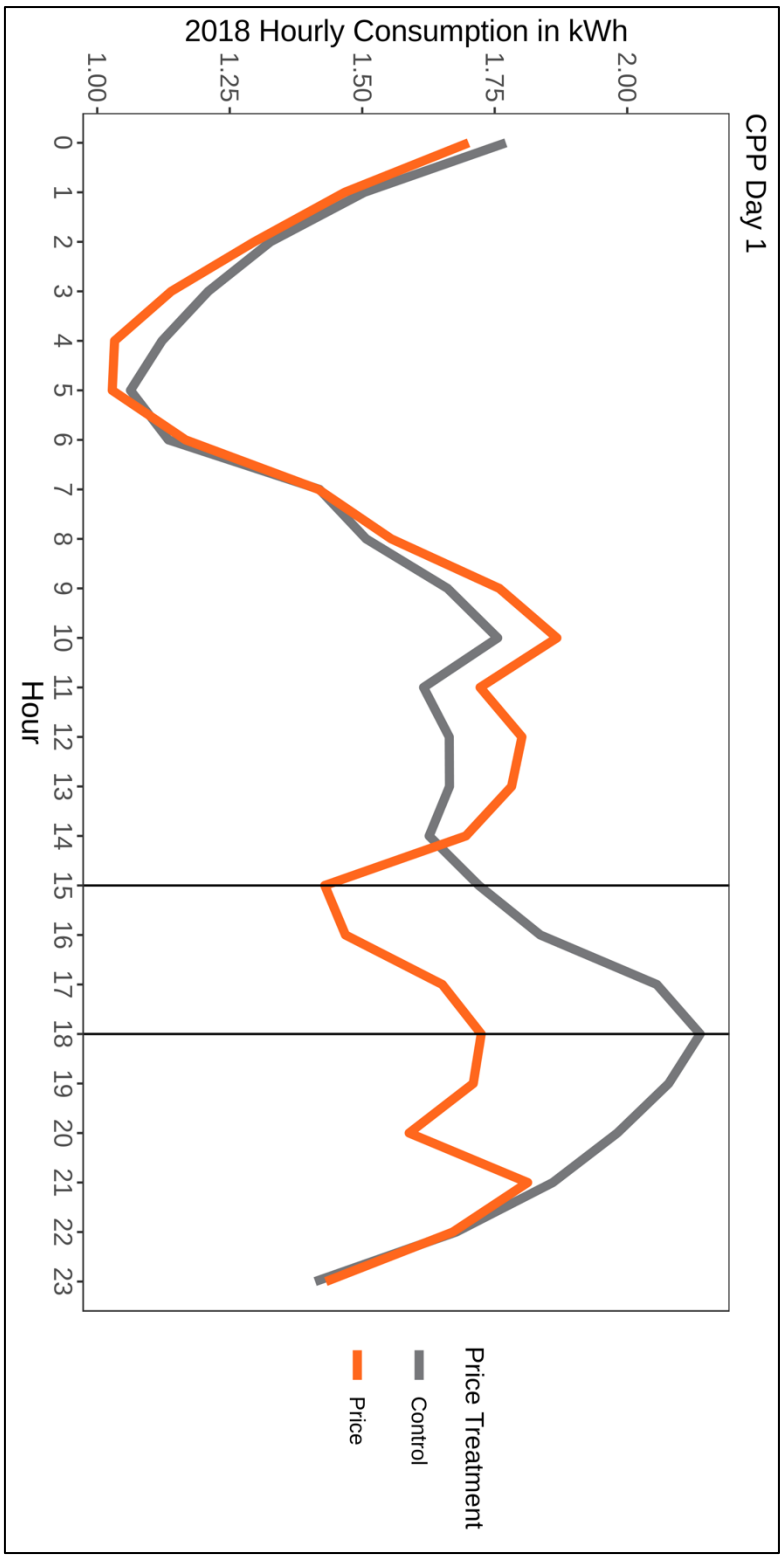
We reiterate that a power analyses allows us to state that given these sample sizes are met, we can conclude that if an effect of 0.1 exists, we would detect the effect 90% of the time. We conclude that given the conservative assumptions made in the power analysis and that sample sizes were met in all three experimental pilots, the three experimental pilots were sufficiently large to draw meaningful conclusions about the data without the concern of being underpowered.

## *Appendix E - Experimental Design*

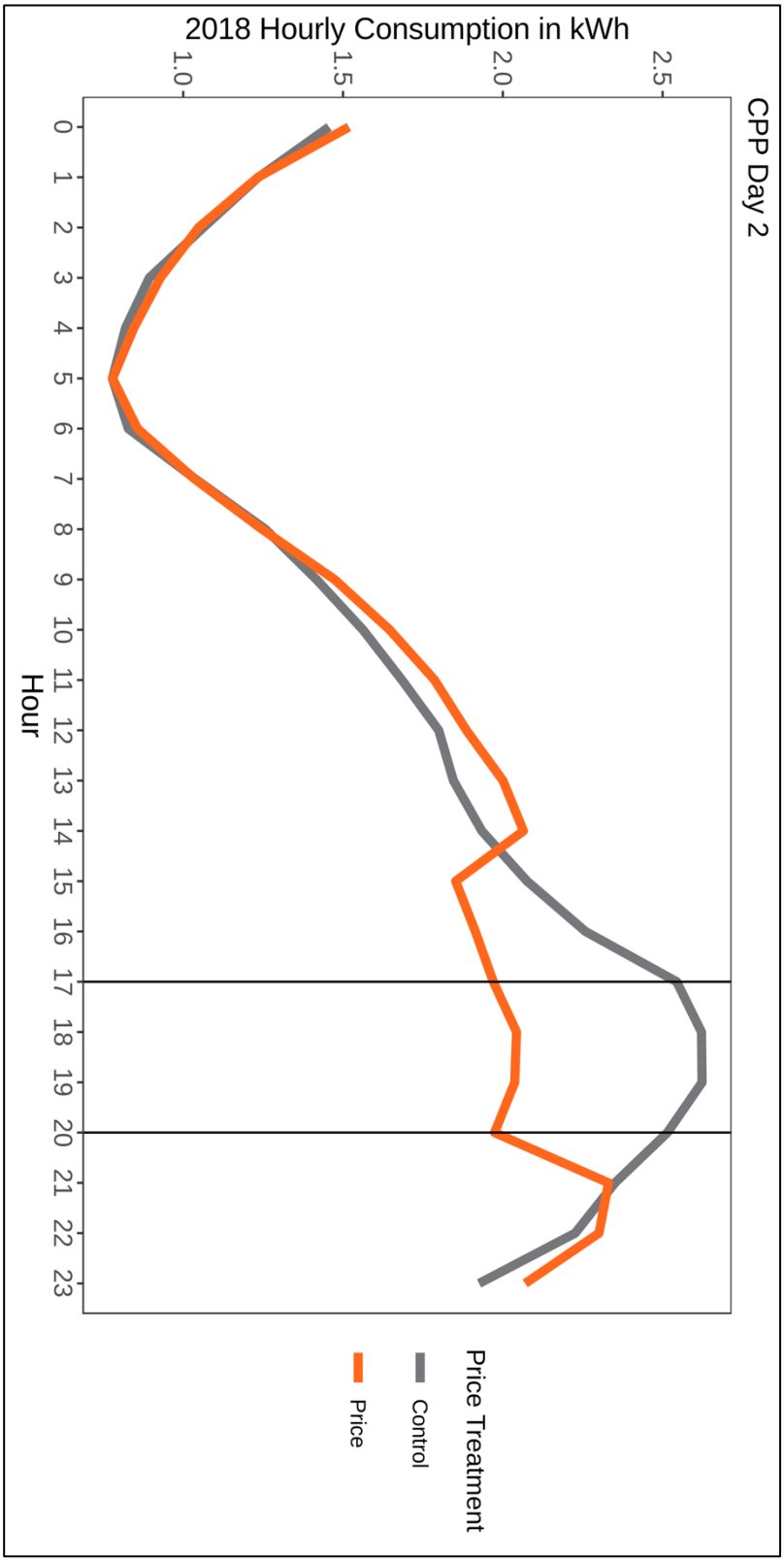


## *Appendix F: CPP Days*

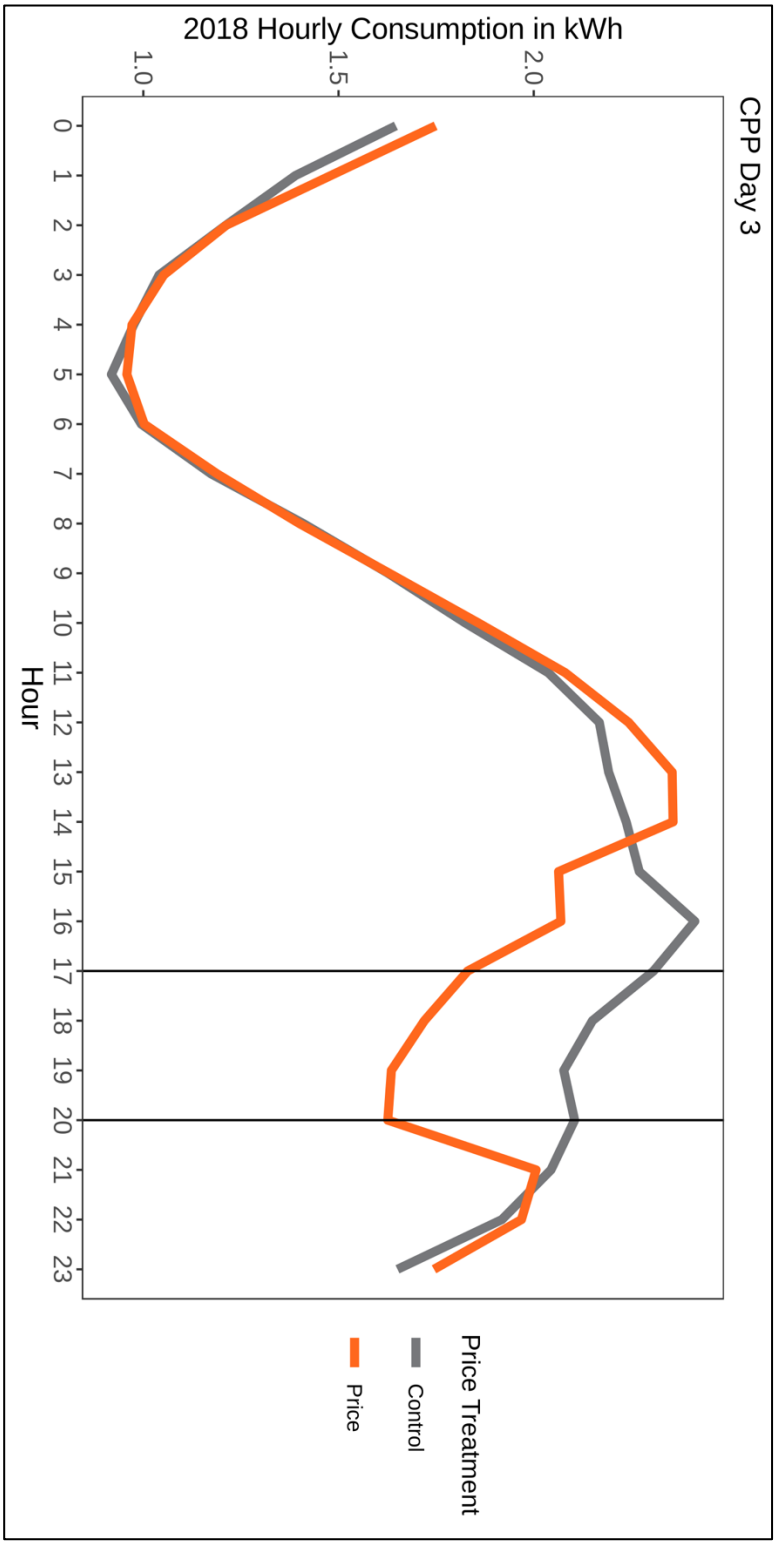
CPP Day 1



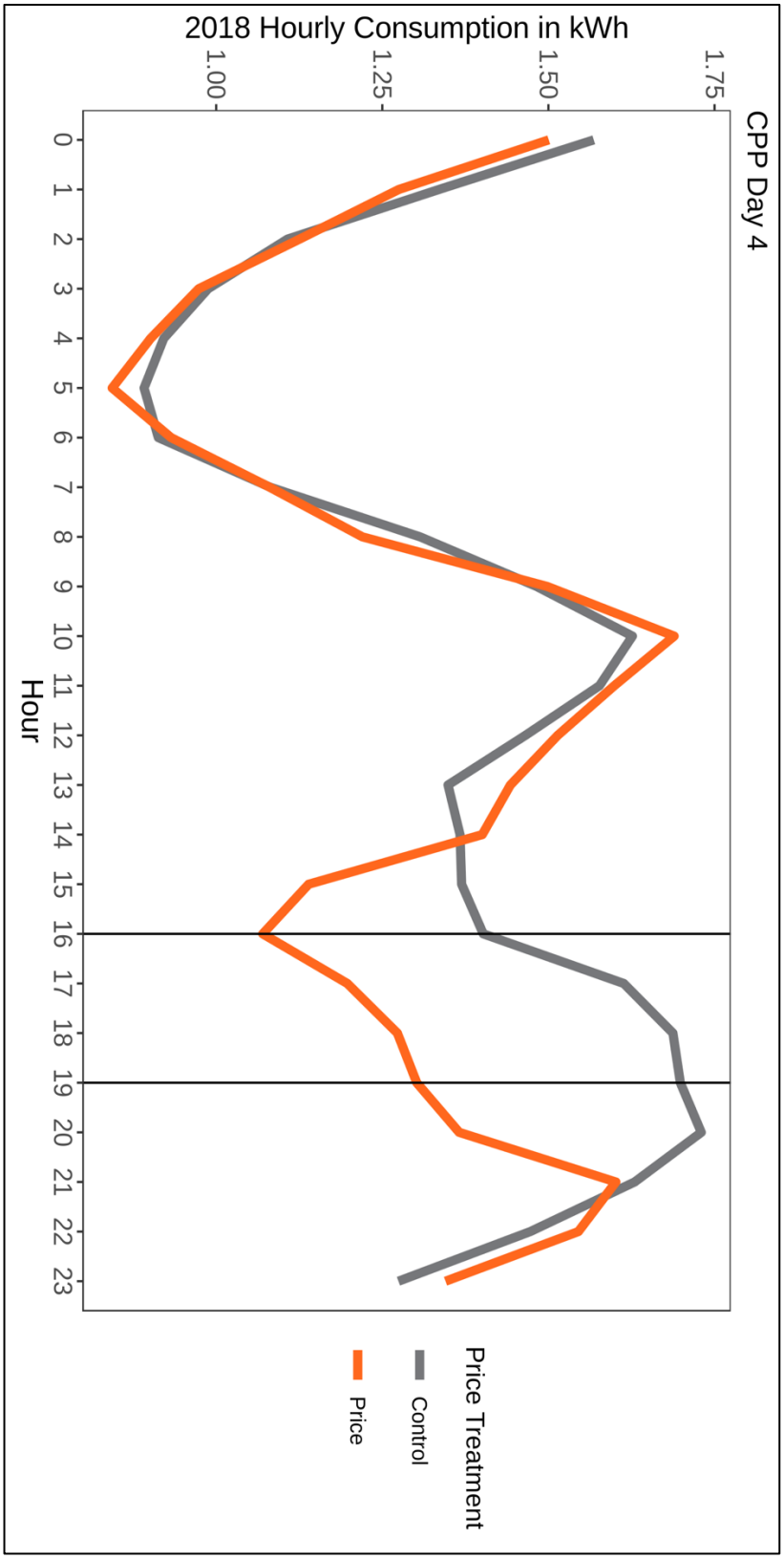
CPP Day 2


CPP Day 2
2018 Hourly Consumption in kWh
1.0
1.5
2.0
2.5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour
Price Treatment
Control
Price

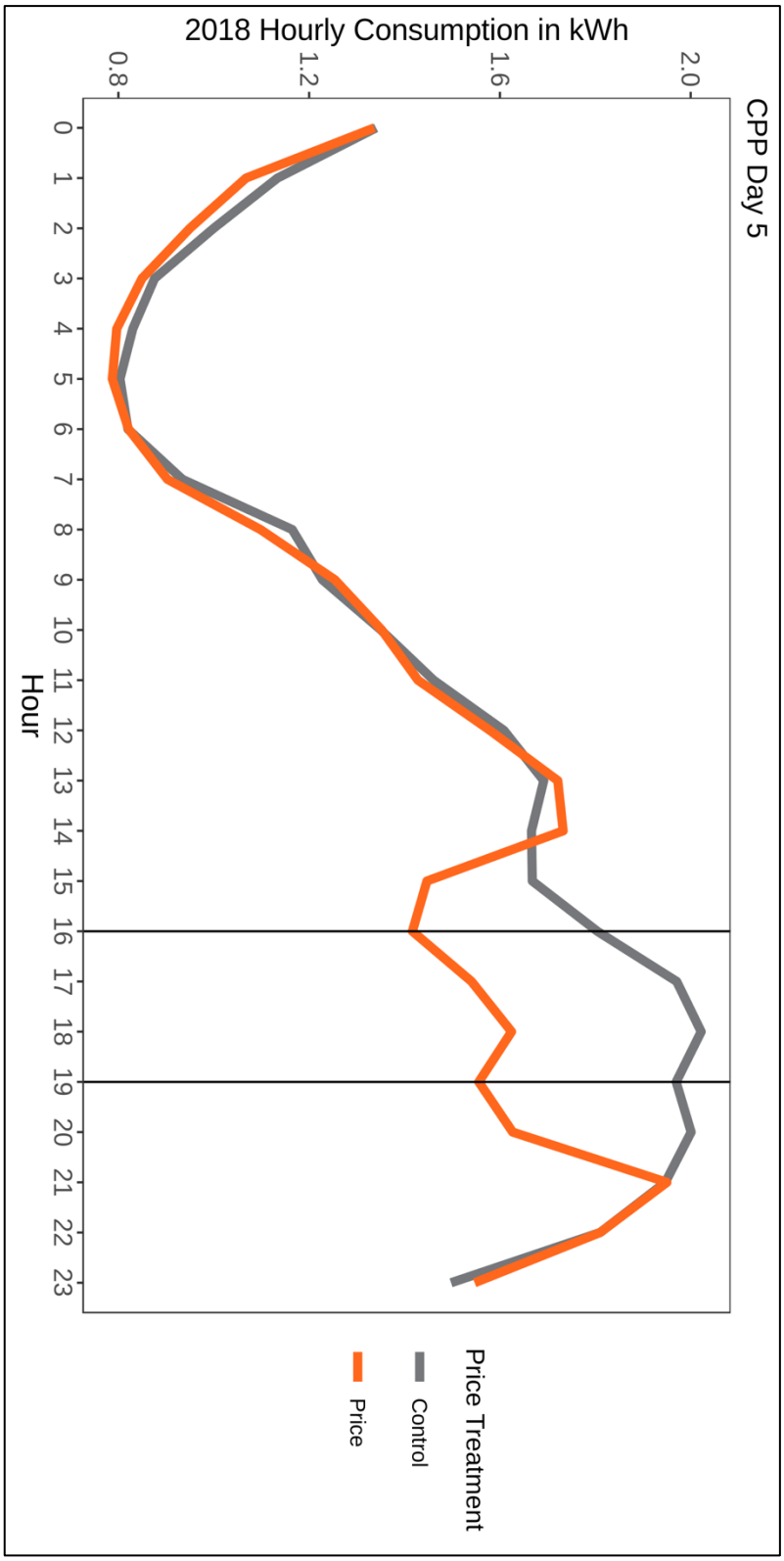
CPP Day 3


CPP Day 3
2018 Hourly Consumption in kWh
1.0
1.5
2.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour
Price Treatment
Control
Price

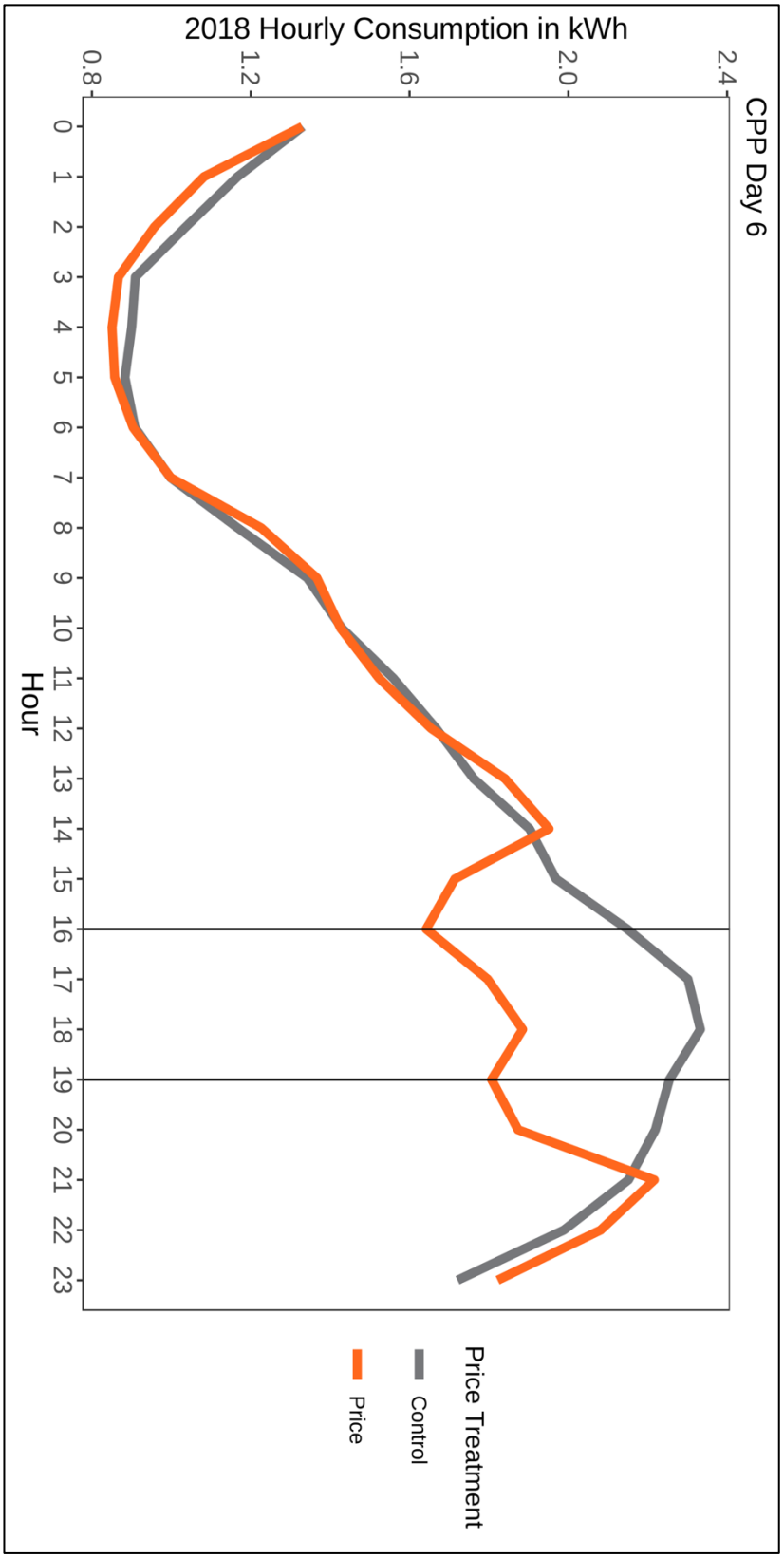
CPP Day 4


CPP Day 4
2018 Hourly Consumption in kWh
1.75
1.50
1.25
1.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour
Price Treatment
Control
Price

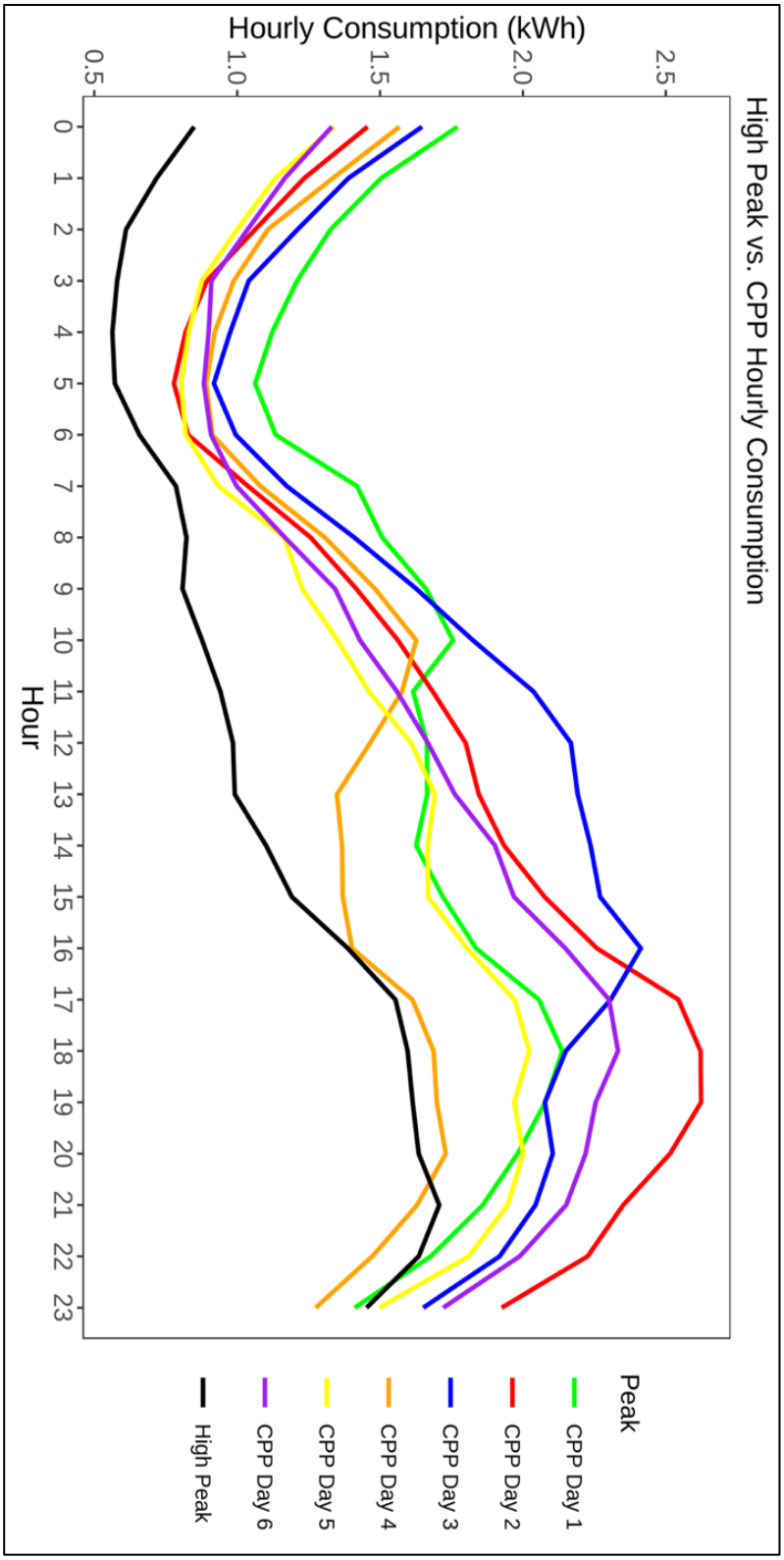
CPP Day 5


CPP Day 5
2018 Hourly Consumption in kWh
0.8
1.2
1.6
2.0
Hour
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Price Treatment
Control
Price

CPP Day 6


CPP Day 6
2018 Hourly Consumption in kWh
0.8
1.2
1.6
2.0
2.4
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour
Price Treatment
Control
Price

High Peak vs CPP Hourly Consumption



## How to contact us

To learn more about Alectra, please visit **https://alectrautilities.com**

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