CustomerFirst Regulated Price Plan Pilot Program: Final Report

Final Impact and Process Evaluation Report

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EXECUTIVE SUMMARY

This executive summary provides a high-level overview of CustomerFirst's Regulated Price Plan (RPP) Pilot Program, a brief summary of the methodology and data used to assess the quantitative and qualitative impacts as well as the key findings from the analyses and recommendations for improvement.

Introduction

In 2017, Navigant Consulting, Ltd. (Navigant) was retained by CustomerFirst Inc. (CustomerFirst) as an evaluation partner to support CustomerFirst's efforts to obtain OEB funding to deploy two different experimental Time of Use (TOU) residential electricity pricing plans across various partner Local Distribution Company (LDC) service territories, and develop a comprehensive evaluation, measurement and verification (EM&V) plan consistent with applicable Ontario Energy Board (OEB) requirements. Each Local Distribution Company (LDC) was assigned to test one of the two pricing structures, see Table 1. Program design and management was undertaken by CustomerFirst, while program elements such as implementing the new prices were undertaken by the LDCs. The program period covers the timeframe from October 1, 2018 to August 31, 2019.

Table 1. Partner LDCs and TOU Pricing Assignments

Local Distribution Company	TOU Pilot Pricing Assignment
Greater Sudbury Hydro	Enhanced Status Quo (ESQ)
North Bay Hydro Distribution Ltd.	Enhanced Status Quo (ESQ)
PUC Services Inc.	Enhanced Status Quo (ESQ)
Northern Ontario Wires	Seasonal
Newmarket-Tay Power Distribution Ltd.	Seasonal

Source: CustomerFirst

The two pricing schemes piloted are:

- **Enhanced Status Quo (ESQ)** – Based on the existing RPP TOU structure (two seasons – summer/winter[1], three TOU periods – on-peak/mid-peak/off-peak), but with a greater differential between off-peak, mid-peak and on-peak prices.
- **Seasonal** – eliminates the mid-peak period during the summer and winter seasons, which now span three months each, while offering a flat price during the shoulder, spring and fall, seasons[2]. The hours that would have been in the mid-peak are incorporated into the on-peak period effectively lengthening the duration of the on-peak period.

In total, there were 1,091 participants that enrolled in the pilot across all LDCs, and the two treatment groups – rate only and rate and enabling technology[3], see Table 2. The ESQ and the Seasonal price

[1] For the ESQ pricing scheme, the summer season is from May 1st to end October and the winter season is from November 1st to end April. This is the same definition as used under the regular RPP TOU pricing scheme.

[2] For the Seasonal pricing scheme, the summer extends from June 1st to end August, the winter from December 1st to end February with the remaining months being classified as the shoulder season.

[3] The rate and enabling technology participants were provided with a smart thermostat at the start of the pilot while the rate only participants were provided a smart thermostat at the end of the pilot.

structures had 622 and 469 participants respectively. The total enrollment numbers were notably lower than expected, an uptake of at least four thousand customers was expected in total.[4] In total, 82 customers opted out representing 7.5% of participants.

Table 2. Enrollment Summary

Local Distribution Company	Rate Only Enrollment	Rate & Enabling Technology Enrollment	Total Enrollment
Greater Sudbury Hydro	169	86	255
North Bay Hydro Distribution Ltd.	95	63	158
PUC Services Inc.	143	66	209
Northern Ontario Wires	48	17	65
Newmarket-Tay Power Distribution Ltd.	260	144	404
Total	**715**	**376**	**1,091**

Source: CustomerFirst, Navigant Analysis

Methodology and Data

The OEB Pilot Plan Technical Manual[5] identifies two types of experimental designs that are deemed to deliver acceptable validity[6]: i). Randomized Control Trial (RCT) or ii). Randomized Encouragement Design (RED). The RCT design employs a recruit and deny strategy which caused concerns for CustomerFirst and partner LDCs with regards to customer satisfaction. Hence, an RED design was implemented for this pilot.

The RED involves randomizing the study population (in this case, the residential population for each of the LDCs) into treatment and control groups, see section 2.1 for additional detail. Those in the treatment group are provided encouragement, via direct mail, to enroll in the pilot while the control group received no such encouragement. This pilot involves two treatment groups, a rate only treatment group and a rate and enabling technology treatment group and were incentivized to participate with a smart thermostat at the end and start of the pilot respectively.

Direct mails (encouragement in the context of the RED) were sent out to eighty-five thousand customers across five LDCs that were randomized into the two treatment groups, see section 2.4.1, with a minimum expected enrollment rate of five percent or approximately four thousand participants. The uptake was notably lower than expected with just about five hundred participants, a half a percent acceptance rate.

Given the lower than expected enrollment, a second round of direct mails were sent to the same eighty-five thousand customers across five LDCs that were randomized into the two treatment groups to increase enrollment. This resulted in an additional five hundred participants bring the total enrollment to over a thousand participants, as seen in Table 2, representing an acceptance rate of just over one percent.

[4] At least 2.800 and 1,200 participants for the ESQ and Seasonal pricing schemes respectively.

[5] OEB RPP Pilot Plan Technical Manual (2016) - https://www.oeb.ca/oeb/_Documents/EB-2016-0201/RPP_Roadmap_Pilot_Plan_Technical_Manual.pdf

[6] In the absence of an experimental design, there exists the possibility that program participation is correlated with the error term (omitted variable bias) as the type of customer who would enroll in an opt-in program is, by the very act of enrolling, different than the type of customer who would not. If this difference is related to their energy use in the absence of the program, then the estimator of the program impact is biased (self-selection bias).

The lower than expected enrollment posed potential challenges that impacts from the RED analysis may not be precise enough. However, to be certain, due diligence was conducted to evaluate the RED impacts as part of the interim analysis which confirmed that the estimates were not precise enough. Hence, a quasi-experimental approach that involves the use of a matched control group that was proposed in the EM&V plan as a contingency approach was used in the final analysis.

A quasi-experimental approach, such as matching, can be used as a contingency plan in the event that the randomized experimental design does not yield reasonably precise estimates. The quasi-experimental design yields a matched control for each participant that has a usage pattern that is most similar in the pre-period. The matched controls are selected from the randomized pool of the controls that were created as part of the RED thereby still preserving the element of randomization (i.e., the matched control customers were never exposed to any encouragement to enroll).

Navigant used the following data to estimate price impacts:

- **Tracking Data** – provided by CustomerFirst for the study population for all LDCs which identified which customers were assigned to which treatment groups, opted-in and opted-out and when.

- **Study Population Hourly Consumption Data** – provided by each LDC for the program period as well as for the year immediately prior to the start of the program (also known as pre-program period data). The program period covers the timeframe from October 1, 2018 to August 31, 2019.

- **Weather Data** – purchased from Environment Canada for the weather stations that were mapped to each participant and matched control.

In addition to the impact analysis, a process evaluation was also conducted. High quality process evaluations are based on primary data collection and analysis. Telephone interviews were completed with the program managers from both CustomerFirst and all partner LDCs to gain an understanding of LDC motivations, strengths and weakness of the implementation strategy and challenges encountered and how they were resolved. A survey was deployed to all participants shortly following program initiation and at the end of the pilot to gauge participant motivations and expectations, planned vs. actual behavioural changes and associated benefits and assess marketing and advertising effectiveness.

Results

Energy Impact Results

The energy impacts for both pricing schemes are not statistically distinguishable from zero as can be seen in Figures 1 through Figure 4. The impacts are presented at the hourly level. In general, the confidence bands are wider for the rate and enabling technology treatment group which can be attributed partly to a smaller sample size compared to the rate only treatment group. The results support the hypothesis that participants did not make material behavioural changes. The key to understanding these results lies in understanding three key underlying aspects related to electricity consumption that drive these results:

1. Only a portion of electricity consumption can be reduced or shifted;

Not all electricity consumption is flexible or elastic and hence sensitive to price, meaning that not all consumption can be shifted or reduced. A notable portion of consumption can be considered to be fixed (e.g. baseloads, refrigeration etc.) and hence inelastic, meaning that they are insensitive to price.

2. The base RPP rates already follow a TOU structure; and

Ontario has already made the transition from a tiered rate structure to a TOU pricing structure for almost all residential households during which at least some customers, though admittedly not all, would have reduced or shifted some consumption from the on-peak to off-peak periods. This means that a portion of their elastic consumption has already been shifted or reduced and there is limited potential for further behavioural changes as part of the pilot program compared to the potential that would have been available when starting from a flat or tiered pricing structure.

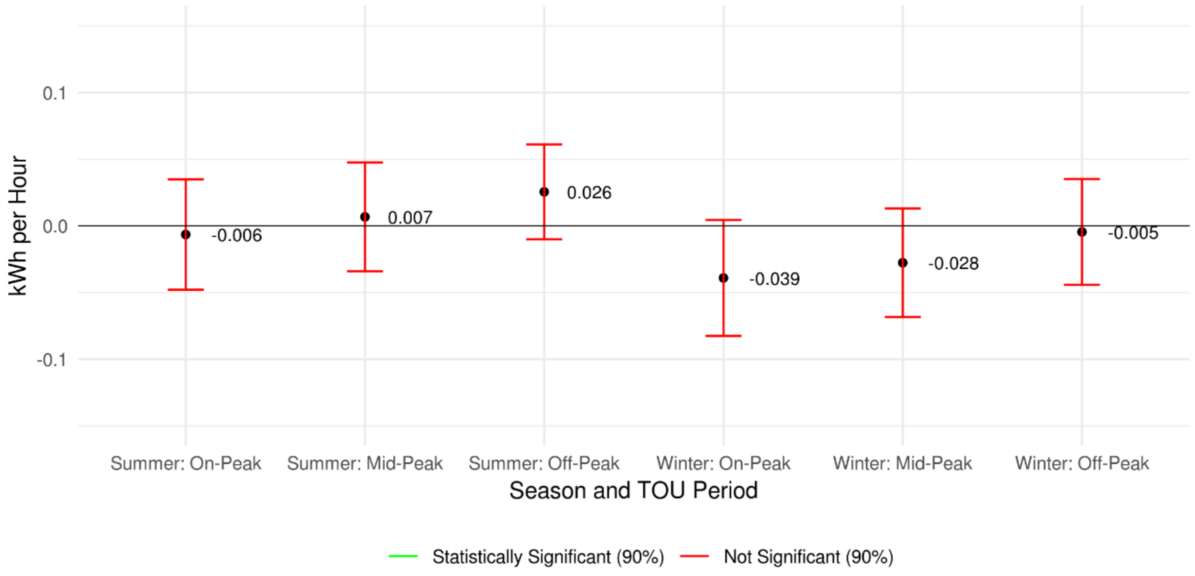
3. The benefits of shifting behaviour, bill savings, vs. the cost, personal discomfort are minimal.

Rounding the average on-peak consumption to 1 kWh and assuming a straight reduction of twenty percent, a customer would save (0.2 kWh times six on-peak hours times twenty weekdays) 24 kWh per month. The maximum price differential between the regular RPP on-peak price vs. a pilot on-peak price is approximately five cents and translating into monthly bill savings of approximately ($0.05 * 24 kWh) $1.2. The savings are minimal compared to the personal discomfort that could be associated with such drastic behavioural changes.

To summarize, even though we may see notable differences between the on-peak and off-peak prices, a 4:1 and 2.5:1 on-peak to off-peak price ratio for ESQ and Seasonal pricing schemes respectively[7], we do not see impacts that are statistically different from zero. The magnitude of the impacts is not very large relative to the uncertainty / variation in the data and the magnitude of the piloted price differential may not be sufficient to incentivize participants to significantly modify their behaviour.

This coupled with the small sample sizes and that the prices only affect a portion of total consumption and the dollar value of significant reductions in energy consumption are minimal (even less for load shifting), might explain why we do not see large impact estimates that are statistically significant.

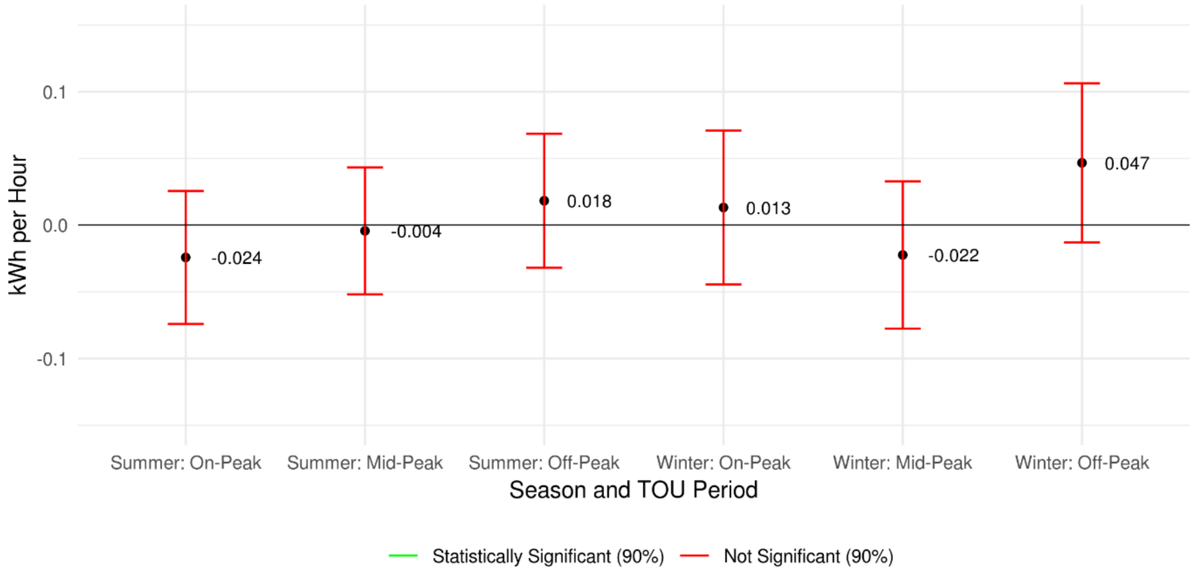
Figure 1. ESQ Price Energy Impacts – Rate Only



Source: Navigant Analysis

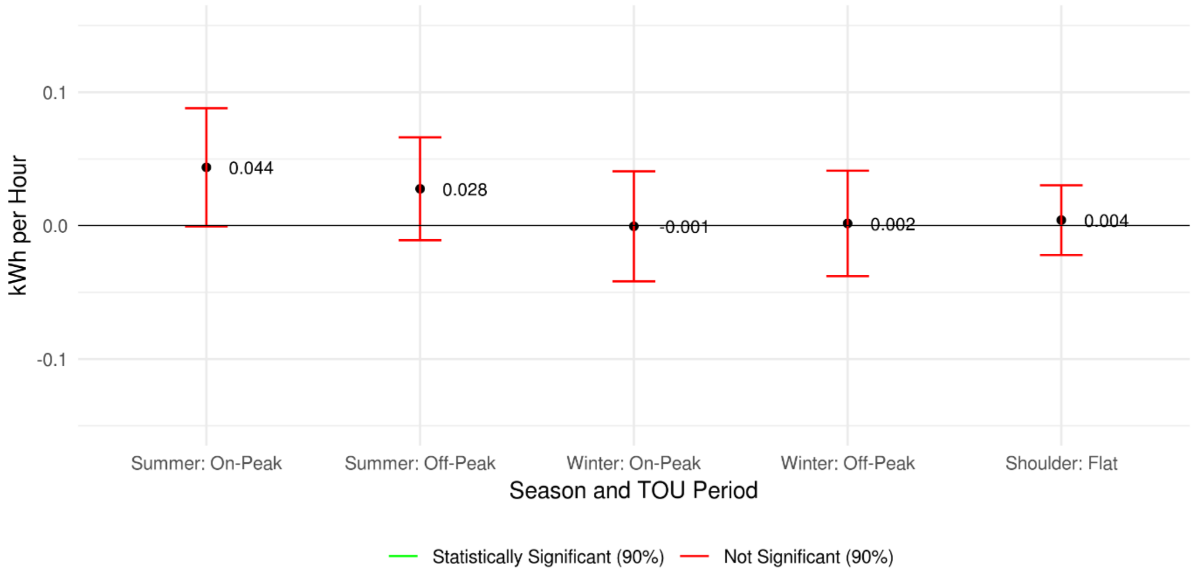
[7] See Table 4 and Table 5 for additional detail for the ESQ and Seasonal pricing schemes respectively.

Figure 2. ESQ Price Energy Impacts – Rate and Enabling Technology



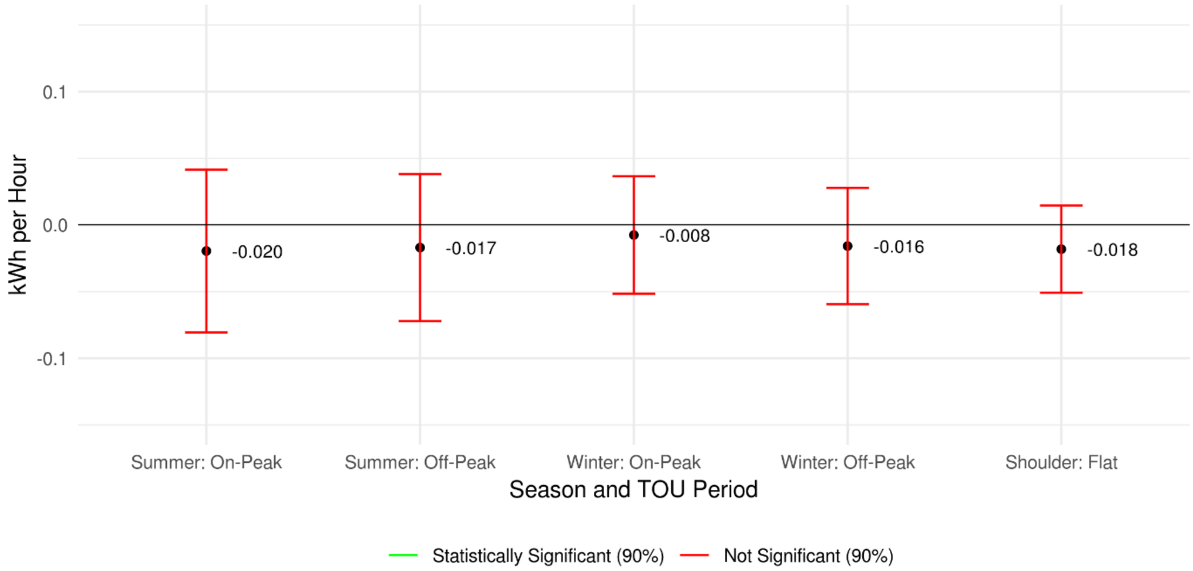
Source: Navigant Analysis

Figure 3. Seasonal Price Energy Impacts – Rate Only



Source: Navigant Analysis

Figure 4. Seasonal Price Energy Impacts – Rate and Enabling Technology



Source: Navigant Analysis

Price Elasticity Results

To estimate a robust set of own price elasticities generally requires more than one set pricing schemes (e.g. multiple versions of the ESQ pricing scheme, namely ESQ_1 … ESQ_n). The daily own price elasticity[8] estimates are presented in section 3.1.3.1 for the sake of completeness, but the key takeaway is that the own price elasticity estimates are not robust. The elasticities are very small in magnitude and are not statistically different from zero (slightly positive in some cases which is counterintuitive).

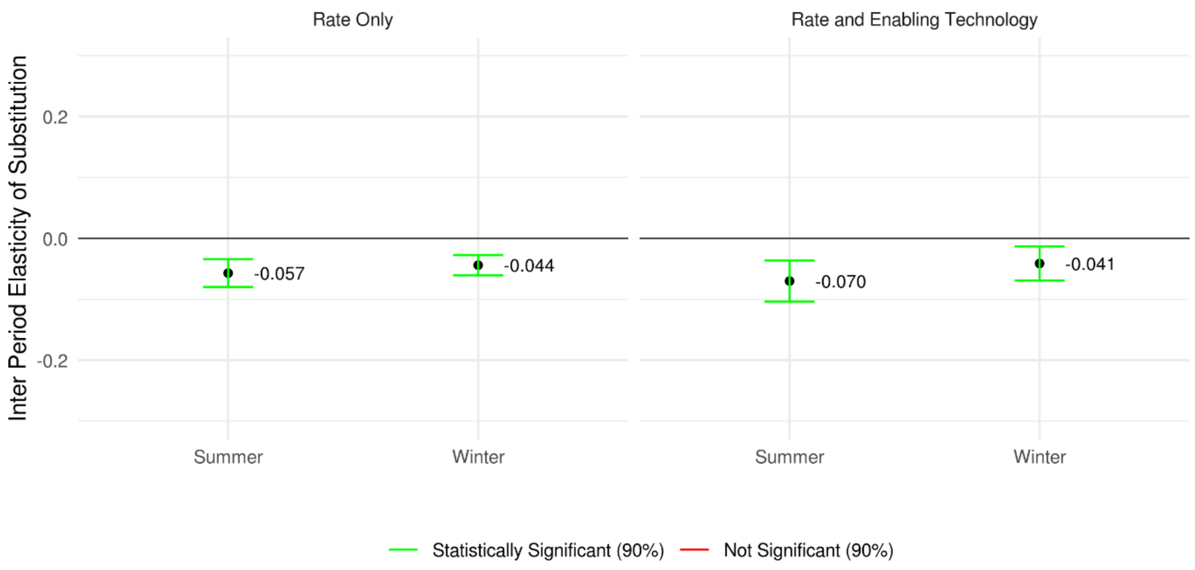
With regards to the inter-period elasticity of substitution[9], the on-peak to off-peak price elasticity of substitution is higher for the ESQ pricing scheme in comparison to the Seasonal pricing scheme which is consistent with the higher on to off-peak price ratio being statistically significant and the confidence bands being tighter. The Seasonal price elasticities are not statistically different from zero and have wider confidence bands. The summer elasticities are slightly higher than the winter elasticities in absolute value which could be due to electric space heating loads that are relatively inelastic.

The magnitude of the on-peak to off-peak price elasticity of substitution is small. A one-hundred percent increase in the ratio of the on-peak to off-peak price would result in a shift in electricity consumption of at most seven percent and is consistent with the small and highly uncertain energy impact findings. The statistically significant ESQ inter-period elasticities would suggest the presence of some load shifting but the magnitude is too small to obtain a robust estimate.

[8] The own price elasticity of demand represents the responsiveness of the change in quantity demanded given a change in price and is calculated as the percentage change in quantity demanded divided by the percentage change in price.

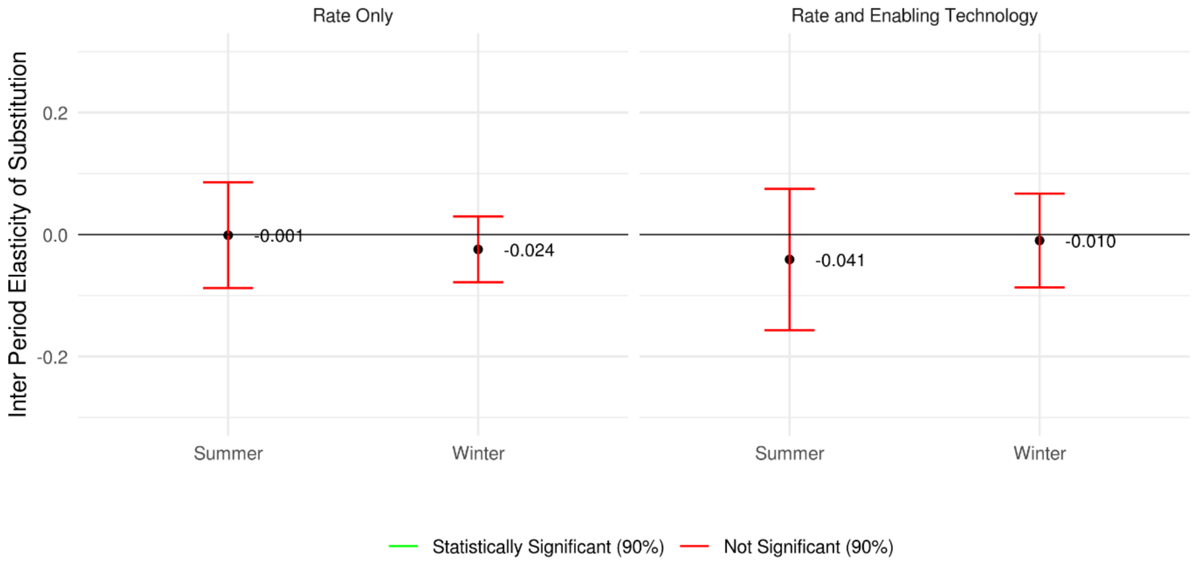
[9] The inter-period elasticity of substitution provides insights into whether electricity consumption in one time period can be substituted for consumption in another time period, e.g. shift consumption from the on-peak to off-peak periods. This is calculated as the change in the ratio of the percentage change in electricity consumption in each time period with respect to the ratio of their prices.

Figure 5. Inter-Period Elasticity of Substitution – ESQ Price



Source: Navigant Analysis

Figure 6. Inter-Period Elasticity of Substitution – Seasonal Price

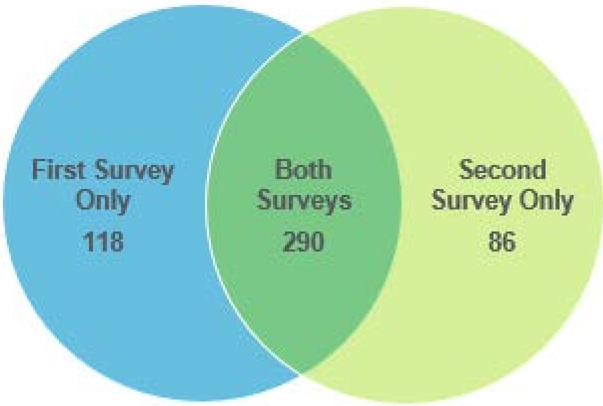


Source: Navigant Analysis

Process Evaluation Results

Navigant conducted two surveys throughout the pilot, one pre-pilot and one post-pilot. Navigant received 408 and 376 complete responses respectively, with 290 participating in both surveys, see Figure 7. The first and second surveys had a response rate of thirty seven percent and thirty four percent respectively. Navigant also conducted interviews with each of the participating LDCs as well as with CustomerFirst staff. Differing response rates across surveys are inevitable but there is a good overlap and hence the focus is on the results of the final survey with key pieces from the first survey as appropriate. The overlap between the two surveys is important since certain questions aim to track changes in behaviour before and after the pilot. The summary statistics presented in this section pertain to the survey respondents.

Figure 7. Survey Responses



Source: Navigant Analysis

On average there are approximately 2.9 people per household. Nineteen percent of all homes identified that they had an annual household income of less than $50,000[10]. The average age was forty-five to fifty-four years with a four-year college degree being the most common education level. Those working full or part time or going to school represent fifty two percent of respondents while those at home all day (retired, working from home or staying home with dependents) represent forty-one percent of respondents.

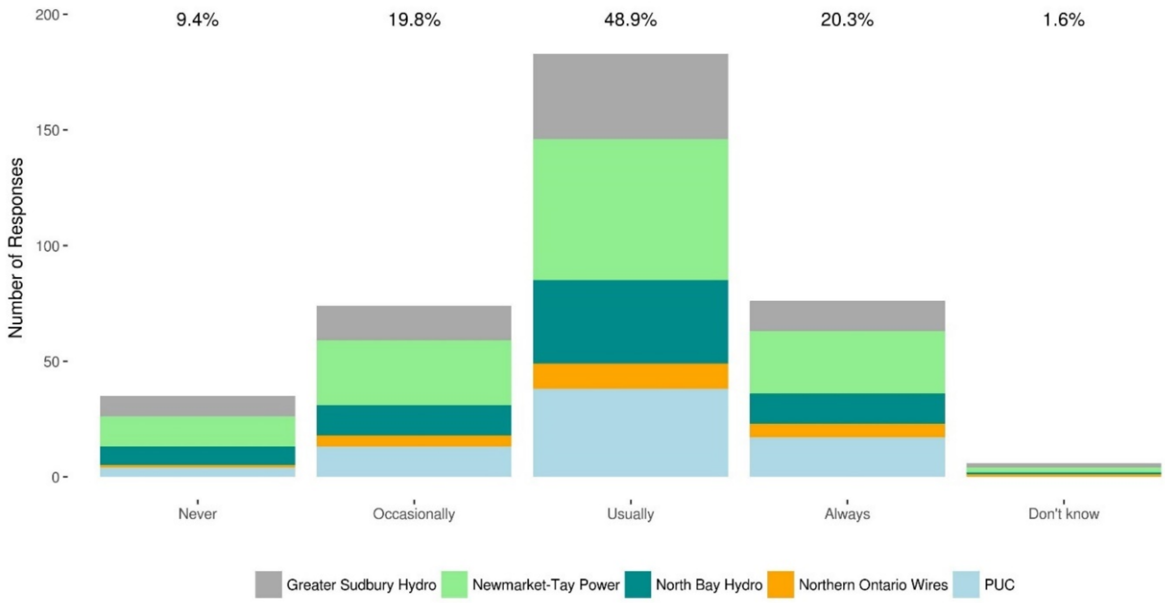
Interviews with LDC and CustomerFirst program managers revealed that prior to enrolling in the pilot, some customers inquired whether the pilot prices would be beneficial to them given their historical bills and system types. Overall, sixty-five percent of survey respondents indicated that their primary motivation to participate in the pilot was to reduce their electricity bill, while twenty-two percent wanted to receive a free thermostat.

Consistent with respondent motives to reduce electricity bills, most respondents expected that the pilot would help them achieve this goal. Approximately seventy percent of respondents in the first survey expected to see a decrease, while just eight percent expected an increase and eleven percent expected no impacts.

Prior to enrolling in the pilot, ninety-one percent of respondents reported that they had shifted their consumption patterns in varying degrees and ninety-four percent planned to shift their electricity consumption during the pilot. At the end of the pilot, in the final survey, forty-nine percent of respondents stated they usually changed their behaviour and only twenty percent of respondents always changed their behaviour (see Figure 8), which differs from responses gathered in the first survey where a larger proportion, forty-two percent, indicated that they planned to ‘always’ shift their behaviour.

[10] Statistics Canada defines low income as households with a pre-tax income of approximately CAD 50,000 for a household of four persons - https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/tab/t4_2-eng.cfm.

Figure 8. Frequency of Electricity Consumption Behaviour Changes During the Pilot



Source: Navigant Analysis

All participants in the rate and enabling technology treatment group received the same smart thermostat. Approximately thirty-six percent of thermostats were installed within two weeks of enrollment, however approximately thirty percent of respondents waited a month or more before their thermostat was installed.

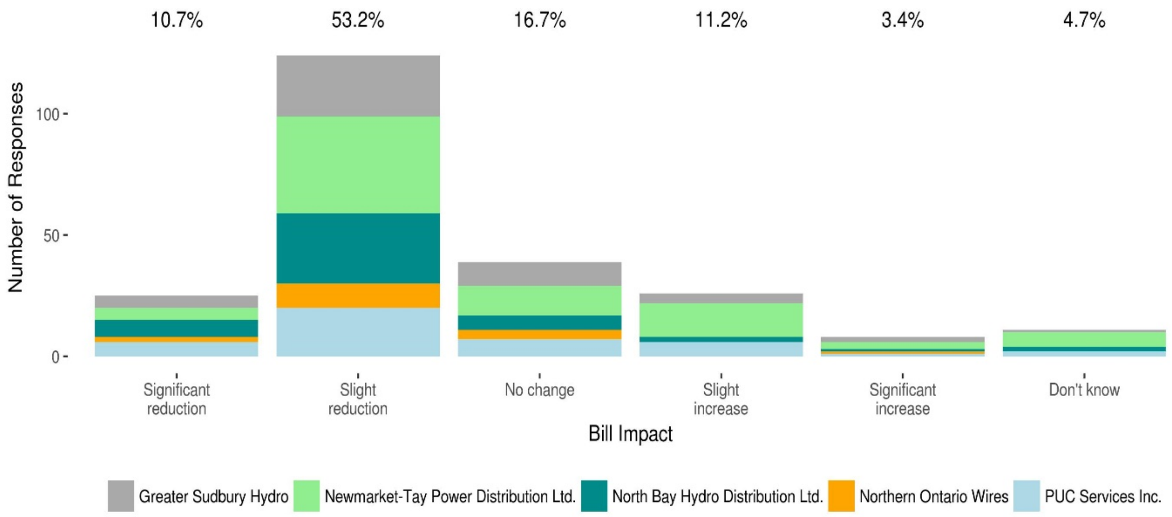
Approximately eighty-eight percent of respondents received instructions on how to program and/or use their new thermostat of which ninety-three percent found helpful. Of the remaining twelve percent of respondents that did not receive instructions, sixty percent would have valued receiving them.

Approximately eighty-two percent of respondents programmed their thermostat[11] of which sixty nine percent did so on the same day it was installed, while seven percent did so the next day and twenty percent within the first week. Approximately fifty-five percent of respondents stated that their thermostats were either easy or very easy to program.

Approximately sixty-four percent of respondents in the final survey monitored the impact of the new TOU prices on their electricity bill with most monitored them three to five times over the course of the pilot. A breakdown of bill impacts for those who did monitor their bills is shown in Figure 9. Of the respondents that did not actively monitor their bills, approximately thirty-seven percent perceived that their bills saw a slight reduction, while twenty-six percent perceived no change and approximately fifteen percent perceived a bill increase.

[11] Information on whether the respondents had any sort of thermostat prior to enrolling in the pilot and whether they programmed it was not gathered.

Figure 9. Bill Impacts

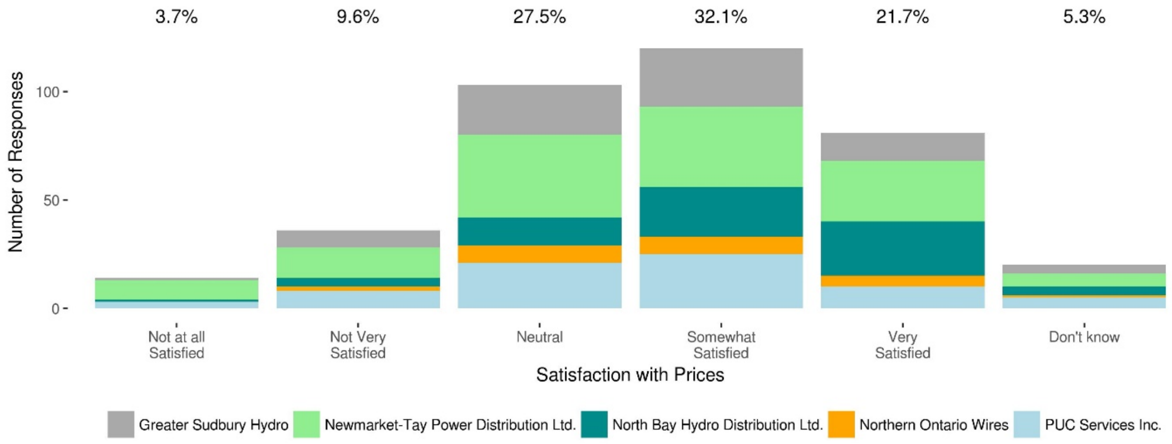


Source: Navigant Analysis

The registration or sign-up process required for the RPP pilot was well received by respondents with over seventy one percent of respondents being satisfied and only ten percent not satisfied, The registration process was conducted by phone and LDC program managers reported that some customers experienced delays in call backs of up to four or five days. The LDC program managers also held the view that the registration window was quite narrow

Initial impressions of the alternate price structures were received relatively well. Thirty-five percent of respondents reported being somewhat satisfied, seventeen percent being very satisfied and less than ten percent being unsatisfied. As seen in Figure 10, post pilot satisfaction with the pricing schemes is closely aligned with initial perceptions.

Figure 10. Post Pilot Satisfaction with TOU Prices



Source: Navigant Analysis

Overall, sixty-five percent of respondents were satisfied with the pilot while twenty-four percent remained neutral and less than ten percent were not satisfied. Approximately eighty-four percent of respondents stated they would recommend the pilot program to a friend and eighty-eight percent of recommended the pilot pricing schemes be rolled out province wide.

Ninety two percent of respondents first learned of the RPP pilot through the direct mail which is consistent with experimental design (RED). The first set of direct mails were sent out in July with the plan to close enrollments by the end of August[12] which LDC program managers believed was too narrow a time frame especially when coupled with the constrained marketing due to the nature of the experimental design. Due to lower than expected enrollment, a second round of enrollment was conducted in August through September to the same set of customers. This did increase total enrollment but still fell short of initial expectations.

Conclusion and Recommendations

Neither the ESQ nor the Seasonal pricing schemes have yielded statistically significant savings, at a reasonable level of confidence (ninety percent), in either season. This result is driven by three key factors. Not all electricity consumption can be shifted or conserved and hence the price affects only a portion of total consumption. Since the starting point is a TOU pricing scheme, participants have less flexibility to further shift or conserve electricity as compared to starting from a flat or tiered pricing structure. Finally, even substantial conservation during the on-peak periods would result in insignificant bill savings, a few dollars per month at most.

There could potentially be some savings (impacts) for some customers as seen by some negative estimates and negative parts of the confidence bands and some impacts being more significant than others but this cannot be broadly generalized given the reasons described in the paragraph above.

The overall impact results are also consistent with participant expectations and behaviours over the course of the pilot. Prior to the start of the pilot, most participants expected to see a slight reduction in their bills and some actually expected an increase. Over the course of the pilot, ten percent of survey respondents stated that they had not changed their behaviour over the course of the pilot and twenty percent reported that they occasionally changed their behaviour. Effectively, thirty percent of the respondents did not modify their behaviours in any significant way which would also have a notable effect on the impact estimates.

However, approximately seventy percent of survey respondents self-reported making behavioural changes over the course of the pilot. Most were satisfied with the pilot prices, across both pricing schemes, and recommended a broader provide wide rollout. While at first glance, this may appear to be a contradiction to the statistically insignificant impact findings, the explanation lies in a cautious interpretation of the results.

Even though survey respondents may have modified their behaviour in some ways during the pilot, it may not be significant enough to manifest in the form of statistically significant impact estimates. Prior to enrolling in the pilot, ninety-one percent of respondents reported that they had shifted their consumption patterns in varying degrees, see Figure 44, and the incremental behavioural changes undertaken during the pilot may not be as significant as the respondents may perceive. Hence, the interpretation requires caution when comparing the survey and impact results.

The following key takeaways could also be of value to the design and implementation of future pilots:

1. **The Piloted On-Peak to Off-Peak Price Differentials, for both Pricing Schemes, May Not Be Sufficient on their Own to Encourage Load Shifting or Conservation when Starting from TOU Prices**

As demonstrated in the results section, even significant further conservation in consumption during the on-peak period (twenty percent in the example provided) would result in minimal bill savings (a few dollars at most) under the piloted pricing schemes compared to the relative discomfort that one may have to endure to conserve so much energy during the on-peak period. This is further substantiated by the very small magnitude of the inter-period elasticities of substitution.

[12] The direct mails were intended to be sent out in June 2018 but due to challenges with the printers and Canada Post, mailers were sent out in July.

If a jurisdiction has already made the transition from a flat or tiered rate structure to a TOU pricing structure for almost all residential households, it is reasonable to expect that some customers, though admittedly not all, would have made some behavioural changes that would have resulted in shifting some consumption from the on-peak to off-peak periods and or some reductions in overall consumption. This is also consistent with survey findings where ninety-one percent of respondents reported that they shifted their consumption patterns in varying degrees prior to enrolling in the pilot, see Figure 44. This would limit their ability to further adjust behaviours as part of the pilot program.

2. **Future TOU Pilots that Start from TOU Prices and Pilot Similar TOU Structures with Different Prices may require Larger Sample Sizes than those Starting from Flat or Tiered Structures.**

Future TOU pilot programs could consider planning for larger sample sizes when starting from TOU prices than they normally would if they were starting from a flat or tiered pricing, as the impacts that one would expect to see would be smaller in comparison. The purpose of any such pilot is to be able to state for a statistical fact, with a high degree of confidence and precision that the impacts of the proposed pricing scheme are significant as this lends credibility to future decisions that may be based on such pilots (for example a province wide rollout of the prices).

While some of the impacts estimated as part of the pilot may be negative, indicating savings, the confidence bands are fairly wide, straddling zero, and the relative precision is low. Larger sample sizes could aid in achieving more precise estimates thereby supporting more definitive statements and future decision making.

3. **Survey Respondents Reported Positive Impressions with Pilot Enrollment but There Is Potential to Improve Response Time and Mitigate Confusion**

The registration process to enroll in the pilot was well received by respondents with over seventy-one percent being satisfied. The registration process was conducted by phone and all calls for the pilot were directed to a dedicated CustomerFirst call center which prevented additional load on the LDC call centers that they were not equipped for.

However, some confusion was created when customers called the utility call centers and were simply re-directed to the dedicated CustomerFirst line. A simple explanation from the LDC call center representatives of why customers were being transferred would greatly aid in easing customer concerns. Additional clarifications could also be provided in the marketing materials.

Interviews with LDC program managers also revealed that some customers experienced delays in call backs of up to four or five days. Ensuring adequate resources for call centers could reduce the response time and positively impact enrollment numbers. This could potentially be a key contributor to the low enrollment seen in this pilot.

4. **Increasing the Enrollment Window Could Increase Enrollment Numbers**

The first set of direct mails were sent out in July with the plan to close enrollments by the end of August. Due to lower than expected enrollment, a second round of enrollment was conducted in August through September to the same set of customers, see section 3.2.6 for additional detail. For future pilots, the enrollment window could be increased which would aid in achieving higher enrollment numbers. This would not interfere with any experimental design; for example, in the case of an RED customers can simply be provided a longer timeframe to respond to the encouragement provided.

5. **Provide Instructions for Enabling Technology**

Twelve percent of respondents reported that they did not receive instructions, see Figure 49, of which sixty percent would have valued receiving them, see Figure 51.[13] Instructions for any enabling

[13] See section 3.2.3.1 for additional detail.

technology, such as smart thermostats, should be provided to all participants by default. Some additional tips for usage and savings could also be provided within the context of the pilot to make them easier to digest. This could potentially reduce the number of participants that do not program the technology at all and or reduce the time taken by participants to program the technology.

6. Account for Distributor Billing System Limitations

LDC program managers noted that the billing system updates were a labour intensive manual process and required training for staff on how to prepare participant bills. While this is beyond the scope of control of CustomerFirst or the OEB, consideration could be given to the costs associated with program management as the costs associated with manual intervention can increase exponentially as enrollment and billing complexity increase. While billing system upgrades are often complex and expensive, future programs should consider whether the billing systems provide the needed flexibility, and ease of use, to be able to test more complex rate structures.

1. INTRODUCTION

In 2017, Navigant Consulting, Ltd. (Navigant) was retained by CustomerFirst Inc. (CustomerFirst) as an evaluation partner to support CustomerFirst's efforts to obtain OEB funding to deploy two different experimental Time of Use (TOU) residential electricity pricing plans across various partner Local Distribution Company (LDC) service territories.

The research methodology adopted by Navigant aligns with the accepted methodologies described within the IESO's Evaluation Protocols and Requirements document as well as those defined within the OEB Pilot Plan: Technical Manual. Navigant has also provided advice to CustomerFirst and partner utilities on key program design decisions that require consideration from an EM&V perspective to ensure that the evaluation remains in compliance with the OEB's RPP EM&V requirements.

The remainder of this chapter is divided into the following sections:

- **Pilot Overview** – provides an overview of the pilot program, the utilities involved, and the pilot prices being tested by each utility.
- **RPP Pilot Pricing Schemes** – describes the pilot TOU prices being tested and how they compare to the regular RPP rates.
- **Enrollment Summary** – provides a summary of the number of customers who enrolled in the pilot.
- **Evaluation Goals and Objectives** – describes the goals and objectives of the evaluation from a price impact and process evaluation standpoint.

1.1 Pilot Overview

CustomerFirst partnered with five utilities in Ontario to pilot two Time-of-Use (TOU) pricing structures for residential customers which are described below. Each Local Distribution Company (LDC) was assigned to test one of the two pricing structures, see Table 3. Program design and management was undertaken by CustomerFirst, while program elements such as implementing the new prices were undertaken by the LDCs. The program period covers the timeframe from October 1, 2018 to August 31, 2019.

Table 3. Partner LDCs and TOU Pricing Assignments

Local Distribution Company	TOU Pilot Pricing Assignment
Greater Sudbury Hydro	Enhanced Status Quo (ESQ)
North Bay Hydro Distribution Ltd.	Enhanced Status Quo (ESQ)
PUC Services Inc.	Enhanced Status Quo (ESQ)
Northern Ontario Wires	Seasonal
Newmarket-Tay Power Distribution Ltd.	Seasonal

Source: CustomerFirst

A sixth distributor was initially included in Customer First's project proposal. Espanola Regional Hydro Distribution Corp. was eventually excluded from the pilot due to the high fixed costs related to the billing system upgrades coupled with the low enrollment potential. Only 2,861 customers served by Espanola were set to be targeted for enrolment.

1.2 RPP Pilot TOU Pricing Schemes

The section describes the two experimental prices tested in this pilot:

- Enhanced Status Quo (ESQ) Pricing Scheme
- Seasonal Pricing Scheme

1.2.1 Enhanced Status Quo (ESQ) Price

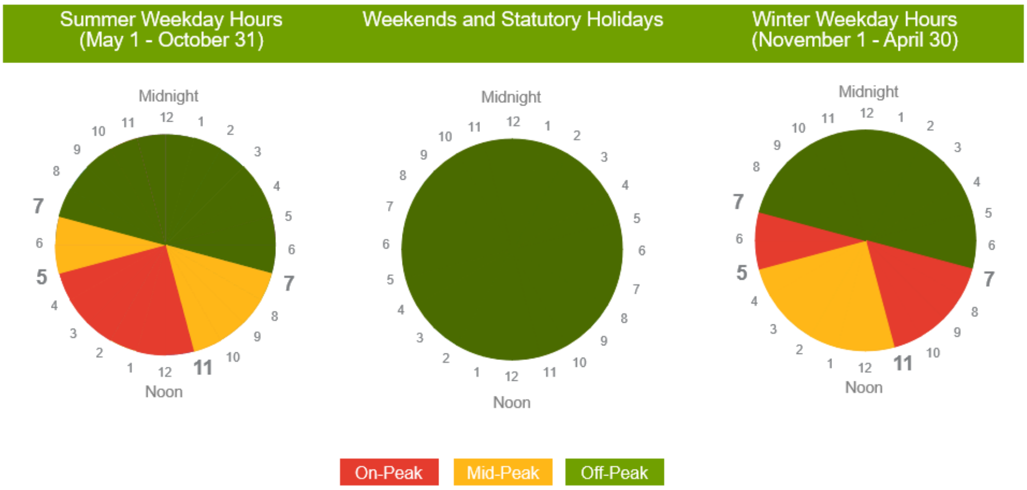
The ESQ price is based on the existing TOU structure (two seasons – summer/winter, three TOU periods – on-peak/mid-peak/off-peak), but with a greater differential between off-peak, mid-peak and on-peak prices, see Table 4. The ESQ price offers participants a lower off-peak price as compared to the existing TOU prices, but higher mid-peak and on-peak prices. The definitions of the TOU periods remain the same, see Figure 11.

Table 4. Enhanced Status Quo (ESQ) Price Comparison

Effective Date	Time of Use Period	Standard RPP TOU Price (c/kWh)	ESQ Pilot TOU Price (c/kWh)	Price Difference
May 1, 2018	On-Peak	13.2	17.5	32.5% ⇧
	Mid-Peak	9.4	13.2	40.4% ⇧
	Off-Peak	6.5	4.4	32.3% ⇩
May 1, 2019	On-Peak	13.4	17.6	31.3% ⇧
	Mid-Peak	9.4	13.2	40.4% ⇧
	Off-Peak	6.5	4.4	32.3% ⇩

Source: Ontario Energy Board[14], Navigant Analysis

Figure 11. Enhanced Status Quo (ESQ) TOU Period Definitions



Source: Navigant Analysis

[14] https://www.oeb.ca/industry/policy-initiatives-and-consultations/rpp-roadmap

1.2.2 Seasonal TOU Price

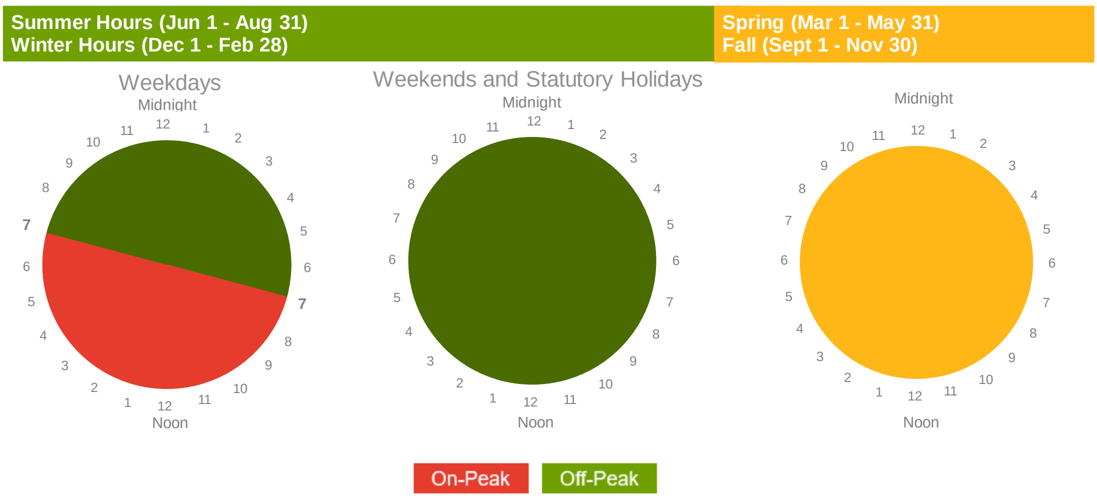
The Seasonal TOU price eliminates the mid-peak period during the summer and winter seasons while offering a flat price during the spring and fall seasons. The hours that would have been in the mid-peak are incorporated into the on-peak period effectively lengthening the duration of the on-peak period. The Seasonal summer period now includes the months of June, July and August, the Seasonal winter December, January and February with the remaining months placed in the shoulder season. The new TOU period and season definitions and pilot prices are shown below in Figure 12 and Table 5 respectively.

Table 5. Seasonal TOU Price Comparison

Effective Date	Time of Use Period	Standard RPP TOU Price (c/kWh)	Summer / Winter Pilot TOU Price (c/kWh)	Percent Difference	Spring / Fall Flat Price
May 1, 2018	On-Peak	13.2	13.5	2.3% ⇧	8.1
	Mid-Peak	9.4	N/A	N/A	
	Off-Peak	6.5	5.4	16.9% ⇩	
May 1, 2019	On-Peak	13.4	13.6	1.5% ⇧	8.2
	Mid-Peak	9.4	N/A	N/A	
	Off-Peak	6.5	5.4	16.9% ⇩	

Source: Ontario Energy Board[15], Navigant Analysis

Figure 12. Seasonal TOU Period Definitions



Source: Navigant Analysis

15 https://www.oeb.ca/industry/policy-initiatives-and-consultations/rpp-roadmap

1.3 Enrollment Summary

In total, there were 1,091 participants that enrolled in the pilot across all LDCs, and the two treatment groups, see Table 6. This represents an overall acceptance rate[16] of 1.26%. The ESQ and the Seasonal price structures had 622 and 469 participants, an acceptance rate of one and two percent respectively.[17]

Customers were incentivized to participate by offering a thermostat at the end of the pilot - rate only treatment, or at the start of the pilot – rate and enabling technology treatment. The total enrollment numbers were notably lower than expected, an uptake of at least four thousand customers was expected in total[18]. The associated challenges with estimating the impacts given the low enrollment and recommendations for improvement are discussed in the sections that follow. In total, 82 customers have opted out, representing 7.5% of participants, see Table 7.[19]

Table 6. Enrollment Summary[20]

Local Distribution Company	Rate Only Enrollment (Acceptance Rate)	Rate & Enabling Technology Enrollment (Acceptance Rate)	Total Enrollment
Greater Sudbury Hydro	169 (1.18%)	86 (0.59%)	255
North Bay Hydro Distribution Ltd.	95 (1.33%)	63 (0.85%)	158
PUC Services Inc.	143 (1.42%)	66 (0.65%)	209
Northern Ontario Wires	48 (2.42%)	17 (0.98%)	65
Newmarket-Tay Power Distribution Ltd.	260 (2.71%)	144 (1.49%)	404
Total	**715**	**376**	**1,091**

Source: CustomerFirst, Navigant Analysis

[16] The acceptance rate refers to the percent of customers that were encouraged and accepted the encouragement.

[17] Northern Ontario Wires and Newmarket-Tay Power were the two LDCs assigned to the Seasonal pricing scheme and have less customers in total compared to other LDCs assigned to the ESQ pricing scheme, see Table 12.

[18] At least 2.800 and 1,200 participants for the ESQ and Seasonal pricing schemes respectively.

[19] Some insight into attrition is provided in section 3.2.

[20] Some customers from the rate and enabling technology treatment were allowed to shift to the rate only treatment due to thermostat installation issues and were offered the thermostat at the end of the pilot. This decision was made based on discussions with the OEB to maximize the sample size given the low enrollment. A few customers from the control group found out about the pilot and were allowed to opt-in the pilot and constitute approximately 2% of the participants.

Table 7. Opt-Out Summary

Local Distribution Company	Rate Only Opt-Outs	Rate & Enabling Technology Opt-Outs
Greater Sudbury Hydro	24	9
North Bay Hydro Distribution Ltd.	10	4
PUC Services Inc.	11	3
Northern Ontario Wires	5	0
Newmarket-Tay Power Distribution Ltd.	12	4
Total	**62**	**20**

Source: CustomerFirst, Navigant Analysis

1.4 Evaluation Goals and Objectives

In accordance with the approved evaluation plan submitted to the OEB, Navigant estimated the Ex-Post Energy Impacts, i.e. the estimated impacts of historical pricing treatments, for each of the pilot rates. Impacts were estimated for each of the pilot pricing schemes, which involved pooling the LDCs assigned to the same pilot pricing scheme, to increase the sample size and thereby improve the precision of the estimates.

1. ESQ Price Ex-Post Impacts by season and TOU Period for:
    a. Rate Only Treatment Group
    b. Rate and Enabling Technology Treatment Group
2. Seasonal Price Ex-Post Impacts by season and TOU Period for:
    a. Rate Only Treatment Group
    b. Rate and Enabling Technology Treatment Group

In addition to the price impacts, a process evaluation was conducted to determine the qualitative impacts of the pilot and combine them with the results of the impact evaluation to provide a comprehensive understanding of the overall effectiveness of the pilot. The objectives of the process evaluation are to:

- assess participant motivations for enrolling in the pilot and their satisfaction with various aspects of the pilot;
- gauge how customers planned to modify their behaviour through participation in the pilot, including use of technology, and as well as how these behaviours actually changed during the pilot period;
- identify participant demographics and characteristics; and
- from the perspective of partner LDCs and CustomerFirst, identify program design challenges and limitations as well as lessons learned that can be used to inform future RPP programs;

The approach used to estimate the price and process impacts are discussed in section 2 and the associated findings in section 3.

2. METHODOLOGY AND DATA

This chapter provides a high-level description of the approach used to conduct both the price impact and process evaluations. Appendix A provides additional technical detail regarding the approach. The remainder of this chapter is divided into the following sections:

- **Experimental Design** – describes the experimental design used for the price impact evaluation
- **Estimating Energy Impacts** – describes the econometric approach used to estimate price impacts.
- **Estimating Price Elasticities of Demand** – describes the econometric approach used to estimate own price and inter-period elasticities of substitution.
- **Data Used to Estimate Price Impacts** – describes the data used to estimate price impacts.
- **Outlier Analysis** – describes the approach used to identify and exclude outliers.
- **Process Evaluation Methodology** – describes the approach used to evaluate qualitative aspects of the program.

2.1 Experimental Design

The OEB Pilot Plan Technical Manual[21] identifies two types of experimental designs that are deemed to deliver acceptable validity[22]: i). Randomized Control Trial (RCT) or ii). Randomized Encouragement Design (RED).

The RCT design employs a recruit and deny strategy which caused concerns for CustomerFirst and partner LDCs with regards to customer satisfaction. There were concerns that after expending the effort to recruit customers for a pilot, denying them participation to create the control group, as required by RCT design, would not be well received by the customer base and potentially impact customers' perception of their LDC in a negative way.

Due to concerns with the recruit and deny aspect of the RCT, an RED design was proposed for the purpose of this pilot as that is the other experimental design deemed to deliver acceptable validity in accordance with the OEB Pilot Plan Technical Manual. The RED involves randomizing the study population into treatment and control groups and providing encouragement to only the treatment group to enroll in the pliot.a A more detailed overview is presented in section 2.1.1 and specifics related to this pilot are discussed in section 2.1.2.

As part of the EM&V plan, a quasi-experimental approach that involves the use of a matched control group was also proposed as a contingency plan in the event that the RED results are not precise enough. A quasi-experimental approach, such as matching, can be used as a contingency plan in the event that the randomized experimental design does not yield reasonably precise estimates. The quasi-experimental design yields a matched control for each participant that has a usage pattern that is most similar in the pre-period.

The matched controls are selected from the randomized pool of the controls that were created as part of the RED thereby still preserving the element of randomization. This approach can potentially reduce the variation in the data as we no longer include the entire residential population and balance

[21] OEB RPP Pilot Plan Technical Manual (2016) - https://www.oeb.ca/oeb/_Documents/EB-2016-0201/RPP_Roadmap_Pilot_Plan_Technical_Manual.pdf

[22] In the absence of an experimental design, there exists the possibility that program participation is correlated with the error term (omitted variable bias) as the type of customer who would enroll in an opt-in program is, by the very act of enrolling, different than the type of customer who would not. If this difference is related to their energy use in the absence of the program, then the estimator of the program impact is biased (self-selection bias).

the participant and control groups based on observable characteristics (i.e. pre-period consumption) which can potentially yield narrower confidence bands and more precise estimates.

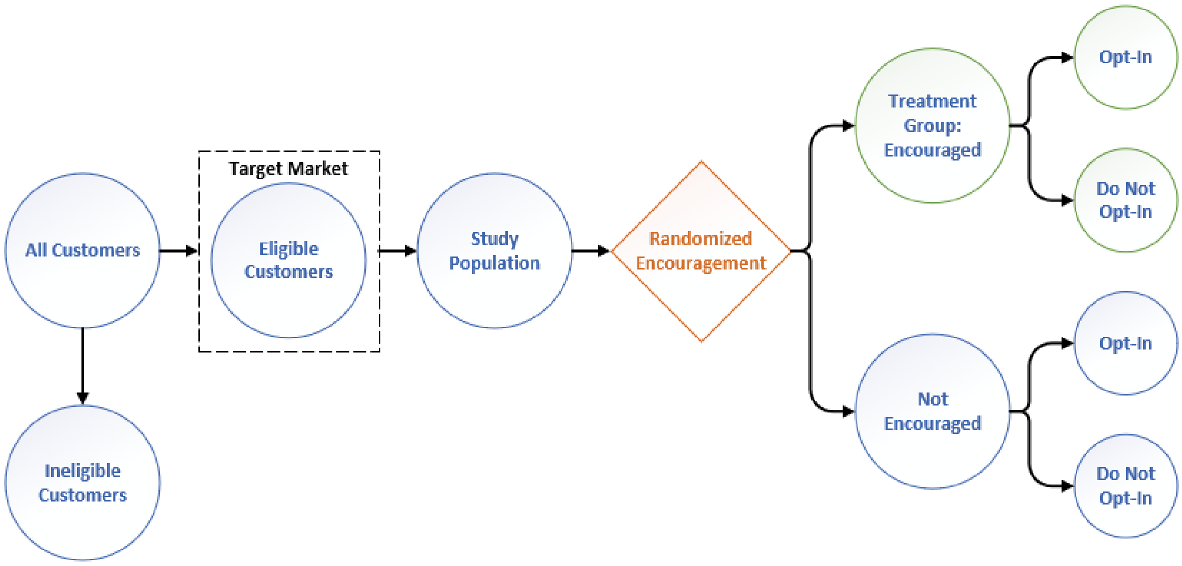
Customers who were randomized into the treatment groups were encouraged to enroll via direct mails. In total, eighty-five thousand direct mails across five LDCs were sent out, see section 2.4.1 Table 12, with a minimum expected enrollment rate of five percent or approximately four thousand participants. The uptake was notably lower than expected with just about five hundred customers who accepted the encouragement and enrolled in the pilot, a half a percent acceptance rate.

Due to the total enrollment numbers being notably lower than expected, a second round of direct mails were sent to the same eighty-five thousand customers across five LDCs that were randomized into the two treatment groups to increase enrollment. The second round resulted in an additional five hundred participants bring the total enrollment to over a thousand participants, as seen in Table 6[23], representing an acceptance rate of just over one percent. However, the total enrollment was still lower than original expectations. A key contributing factor is that the RED design imposes limitations on the types of marketing that can be conducted to encourage customers to participate in the pilot which is discussed further in section 3.2.6.

As part of the interim analysis, Navigant conducted its due diligence and evaluated the RED which confirmed that the confidence bands were too wide to yield meaningful insights.[24] Hence, Navigant and CustomerFirst proposed, and received approval from the OEB, that the contingency approach (matched controls) be the focus for the final analysis as adding a few extra months of data to the RED analysis was extremely unlikely to yield any real value. Hence, the results presented in section 3.1 will focus on the quasi-experimental design only. The following subsections will explain the true experimental design, the RED, for context followed by the quasi-experimental approach.

2.1.1 Overview of a Randomized Encouragement Design

Figure 13. General Illustration of an RED



Source: Navigant Analysis

Figure 13 provides a graphical illustration of an RED. The first step is to determine the study population. Any customers that are not eligible are screened out and the rest are screened into the

[23] See section 1.3

[24] As part of the interim report, an opt-in analysis was conducted to see if those who chose to opt in had significantly different load profiles. This analysis is presented in Appendix C.

study population. The study population is then randomly assigned in equal proportions to either the Treatment or Control group. Customers in the treatment group are encouraged[25] to participate in the program and those in the control group are not. Hence, in the context of an RED the treatment group does not refer to those customers who opted-in but those who were encouraged to participate in the pilot.

Those in the treatment group can choose to either accept the encouragement and opt-in to the program or not opt-in to the program. Although the control group customers are not sent any form of encouragement or communication, some may hear about it from friends or family and may contact their utility and could be allowed to enroll in the program.

In an RED, the encouragement alone does not affect energy consumption. Only those customers who opt-in would receive the intervention, the pilot TOU prices in this case, and therefore only their energy consumption would be impacted. Hence, an RED provides an unbiased estimate of the effect of encouragement on energy use, commonly referred to as the Intent to Treat (ITT) impacts, and can also provide an unbiased estimate of the intervention for those customers who opt-in, commonly referred to as the Treatment Effect on the Treated (TOT) impacts.

To illustrate this, we can divide the study population into three distinct groups:

1. **Always Takers**: those who would accept the intervention whether encouraged or not;

2. **Never Takers**: those who would never accept the intervention even if encouraged; and

3. **Compliers**: those who would accept the intervention only if encouraged.

Since eligible customers are randomly assigned to the treatment or control group, both groups are expected to have equal frequencies of always takers, never takers, and compliers. After treatment (i.e. encouragement), the only difference is that compliers in the treatment group accept the intervention while those in the control group do not. In both groups, always takers accept the intervention and never takers always refuse. Hence, the difference in energy use between the treatment and control groups reflects the impact of encouragement on compliers (ITT) and the customers who accept the intervention and opt in vs. those who do not reflect the impact of intervention (TOT).

A key advantage of an RED is that its structure provides the opportunity to address omitted variable bias and self-selection bias. This is because the encouragement is an instrumental variable for participation that is correlated with program participation (the more effective the encouragement, the higher the correlation) and is not correlated with unobservable variables affecting participation.

It is also important to note that for an RED to be successful, i.e. be able to provide a robust estimate of the impacts, it requires a larger sample size as compared to an RCT and that compliers constitute a relatively high percentage of the encouraged population meaning that there is notable potential for enrollment.

2.1.2 Randomized Encouragement Design

For the purpose of this pilot, each partner Local Distribution Company (LDC) was assigned to test one of the two pricing structures, see Table 8.[26] For each LDC the study population was determined by screening out the residential customers on a retail contract and screening the remaining residential customers in to the study population. Residential customers on a retail contract do not pay the regular

[25] Encouragement can take any form, e.g. financial incentive, free technology.

[26] The assignments of the LDCs to the pilot pricing treatments are from CustomerFirst's application to the OEB and were determined by trying to achieve a reasonable number of participants in each pilot pricing scheme and also factoring in distributor preferences. Espanola was excluded from the pilot due to the high fixed costs related to the billing system upgrades coupled with the low enrollment potential. The customer base that the direct mailout would have been sent to was only 2,861 customers and were removed prior to the start of the direct mail marketing.

RPP rates and are charged using a different rate structure (usually a flat rate[27]) by their retailer and hence were screened out.

Table 8. Partner LDCs and TOU Pricing Assignments

Local Distribution Company	TOU Pricing Assignment
Greater Sudbury Hydro	Enhanced Status Quo (ESQ)
North Bay Hydro Distribution Ltd.	Enhanced Status Quo (ESQ)
PUC Services Inc.	Enhanced Status Quo (ESQ)
Newmarket-Tay Power Distribution Ltd.	Seasonal
Northern Ontario Wires	Seasonal

Source: CustomerFirst

The study population for each LDC was split into three equally sized, but randomly assigned, groups. Two of these groups were presented with encouragement, in the form of direct mails, to participate in the pilot price program assigned to their LDC, while a third group received no encouragement:

1. **Group A – Rate Only Treatment**:

Group A customers were mailed literature that encouraged them to participate in the program and must opt-in to participate. As a thank you for program participation, participants would receive a thermostat at the end of the pilot and hence were encouraged to participate in the price only treatment group.

2. **Group B – Rate and Enabling Technology Treatment**:

Group B customers were also mailed literature that encouraged them to participate in the program and had to opt-in to participate. In addition, Group B participants were incentivized with a smart thermostat at the beginning of the program and hence were encouraged to participate in the price and enabling technology treatment group.

3. **Group C – Control Group**:

Group C customers received no information about the program and were not encouraged to participate and constitute the control group. If customers heard about the program (for example, from their neighbours) and contacted their LDC to asked to be part of the program, they were allowed opt-in.

2.1.3 Quasi-Experimental Design

The quasi-experimental design involves selecting a matched control for each participant that has a usage pattern that is most similar in the pre-period. The matched controls are selected from the randomized pool of the controls that were created as part of the RED thereby still preserving the element of randomization. Effectively, if customers were encouraged to participate in the pilot, they are not eligible to be part of the control group even if they did not accept the encouragement.

The process of finding matched controls can be thought of as a pre-processing step for the impact analysis. This is because the act of selecting matched controls is aimed at reducing the variation in the data as we no longer include the entire residential population and balance the participant and

[27] Retailers offer customers a flat rate to shield them from the higher prices in the on-peak and mid-peak periods.

control groups based on observable characteristics, namely pre-period consumption, which can potentially yield narrower confidence bands and more precise estimates.

This is a key aspect that must be borne in mind. Matching cannot be expected to yield a perfect matched control for every participant and there are bound to be some differences in consumption even during the matching period. The goal is to reduce the variation in the pre-period as much as possible, given the pool of controls, such that the regression has to do less '*work*' to control for these differences which would aid in yielding narrower confidence bands and more precise estimates. Any remaining differences will be controlled for by the regression model.

The process of finding a matched control for each participant was conducted in two phases:

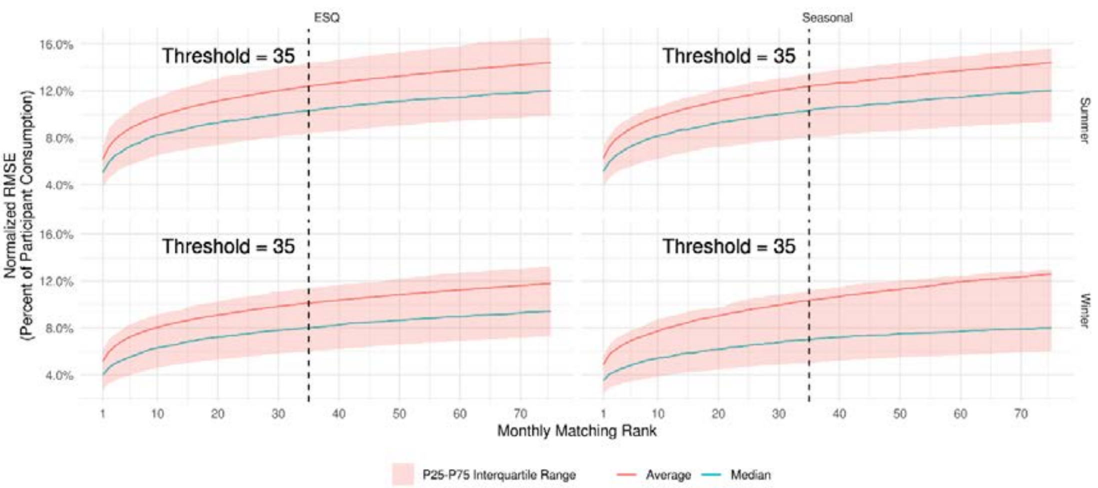
- Phase 1: Monthly Matching

This phase can be thought of as a pre-processing step for the hourly matching. The goal of this phase is to narrow down the potential pool of controls for each participant for each season (as seasonal load profiles can vary) such that their monthly profiles are similar. Matching based on Euclidean distance was conducted within each LDC to select a subset of the top monthly matches for each participant for the summer and winter seasons respectively[28]. The matching period used was the twelve-month period that immediately preceded the start of the marketing – July 2017 through end June 2018 as marketing begin in July 2018.

Figure 14 shows that the monthly distances (root mean squared error, RMSE) plateau quickly as you move further down the ranks allowing for the flexibility to have a reasonable threshold at which to narrow down the pool of controls for each participant. This also provides a decent sized pool for each participant for phase 2: hourly matching. If the curves in Figure 14 were significantly steeper, the threshold would likely have to be lower so as to filter out the monthly matches that have a much higher RMSE.

There is no scientific algorithm to be applied in selecting the threshold for the top monthly matches but rather a determination based on reviewing the distribution in Figure 14 coupled with professional judgement to ensure a sufficient pool for the hourly matching. The distributions are similar for both price treatments in both seasons and hence a threshold of the top thirty-five monthly matches was selected as the threshold for both pricing schemes and seasons.

Figure 14. Monthly Matches RMSE Distribution by Rank



Source: Navigant Analysis

[28] The seasonal definitions are aligned with the OEB's definitions for the regular RPP prices wherein:
Summer: May to end October
Winter: November to end April

In summary, this first phase generates thirty-five matches for each participant for each season, summer and winter respectively, within their own LDC with similar monthly load profiles that can be passed to phase 2 for further refinement at the hourly level.

- Phase 2: Hourly Matching

Given that the impacts are estimated using an hourly regression model, it is important to ensure that the hourly load profiles are as close as possible. The top thirty-five monthly matches for each participant (in each season) from phase one were used as inputs to select the matched control with the most similar hourly profile for each participant in each season. The matching period used was same as that used in phase 1: the twelve-month period that immediately preceded the start of the marketing – July 2017 through end June 2018 as marketing begin in July 2018.

For the purpose of hourly matching, the TOU Periods were defined as seen in Table 9. The weekend off-peak period was separated from the weekday off-peak period as the weekend load profiles are usually different from the weekday. The weights assigned to each period correspond to the number of hours they span in the week, i.e. they are the natural weights.

However, the TOU periods span many hours and hence the day was further broken down into six *day-periods* to further refine the analysis, see Table 10. The buckets were defined such that they fall within a particular TOU period only and are based on the local (Eastern) prevailing time.

Table 9. TOU Period Definitions and Weights

Day Type	TOU Period	TOU Period Hours / Week	Total Hours / Week	Weight
Weekday	On-Peak	30	168	18%
Weekday	Mid-Peak	30	168	18%
Weekday	Off-Peak	60	168	36%
Weekend	Off-Peak	48	168	29%

Source: Navigant Analysis

Table 10. Day Period Breakdowns

Bucket	Definition
1-Wee-Morning	Midnight to 7 am
2-Early-Morning	7 am to 11 am
3-Afternoon	11 am to 5 pm
4-Early-Evening	5 pm to 7 pm
5-Late-Evening	7 pm to 10 pm
6-Twilight	10 pm to Midnight

Source: Navigant Analysis

Conducting the hourly matching with a full twenty-four-hour load profile for the weekday vs. the weekend resulted in too many dimensions for each month to match on whereas just using the TOU buckets resulted in too few. The use of the TOU periods in conjunction with the buckets, see Table

11, help to achieve a better set of matches.[29] Effectively, for each month of each season we have twelve dimensions to match on for each participant, six for the weekday and six for the weekend.

Table 11. Weights by TOU Period and Bucket

Season	Day Type	TOU Period	Bucket	Hours / Day	Hours / Week	Total Hours / Week	Natural Weight
Summer	Weekday	On-Peak	3-Afternoon	6	30	168	18%
		Mid-Peak	2-Early-Morning	4	20	168	12%
			4-Early-Evening	2	10	168	6%
		Off-Peak	1-Wee-Morning	7	35	168	21%
			5-Late-Evening	3	15	168	9%
			6-Twilight	2	10	168	6%
	Weekend	Off-Peak	1-Wee-Morning	7	14	168	8%
			2-Early-Morning	4	8	168	5%
			3-Afternoon	6	12	168	7%
			4-Early-Evening	2	4	168	2%
			5-Late-Evening	3	6	168	4%
			6-Twilight	2	4	168	2%
Winter	Weekday	Mid-Peak	3-Afternoon	6	30	168	18%
		On-Peak	2-Early-Morning	4	20	168	12%
			4-Early-Evening	2	10	168	6%
		Off-Peak	1-Wee-Morning	7	35	168	21%
			5-Late-Evening	3	15	168	9%
			6-Twilight	2	10	168	6%
	Weekend	Off-Peak	1-Wee-Morning	7	14	168	8%
			2-Early-Morning	4	8	168	5%
			3-Afternoon	6	12	168	7%
			4-Early-Evening	2	4	168	2%

[29] Navigant did experiment with assigning higher weights to the on-peak and mid-peak periods as well as higher weights to the late evening hours but did not note a significant improvement and hence opted to keep the natural weights.

Season	Day Type	TOU Period	Bucket	Hours / Day	Hours / Week	Total Hours / Week	Natural Weight
			5-Late-Evening	3	6	168	4%
			6-Twilight	2	4	168	2%

Source: Navigant Analysis

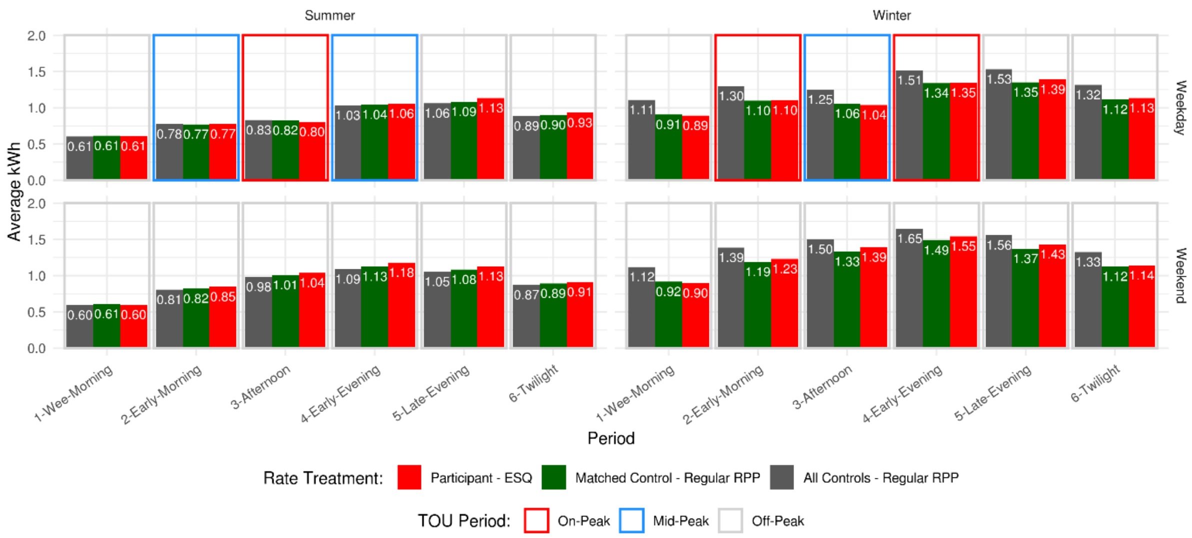
2.1.3.1 Review of Matched Controls

The approach described above yielded a good set of matched controls for both pricing schemes as seen in the figures below. Figure 15 through Figure 20 present the comparison of the participants and matched controls over the matching period. Some participants were excluded from the analysis and the graphs shown below as their RMSE was too high, see Appendix A.1.

The figures also demonstrate how the matched controls compare to all the controls for each pricing scheme. In most cases, we can see that the entire pool of control customers has a notably higher load profile as compared to the participants and the matched control, especially in the winter. Hence, we can conclude that the pre-processing step of finding a matched control was successful and can proceed with the impact analysis.

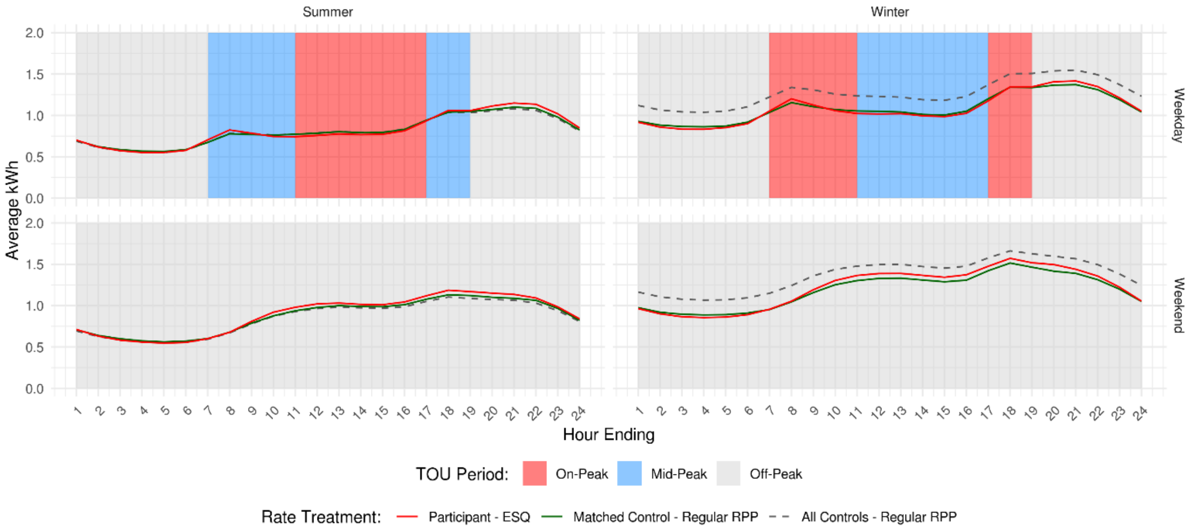
The findings hold true by for each treatment group (rate only and rate and enabling technology) as well and are presented in Appendix A.2. Furthermore, the quality of the matches is consistent over the course of the marketing period as well, see Appendix A.3.

Figure 15. Matched Control by TOU Period and Day Period – ESQ Price



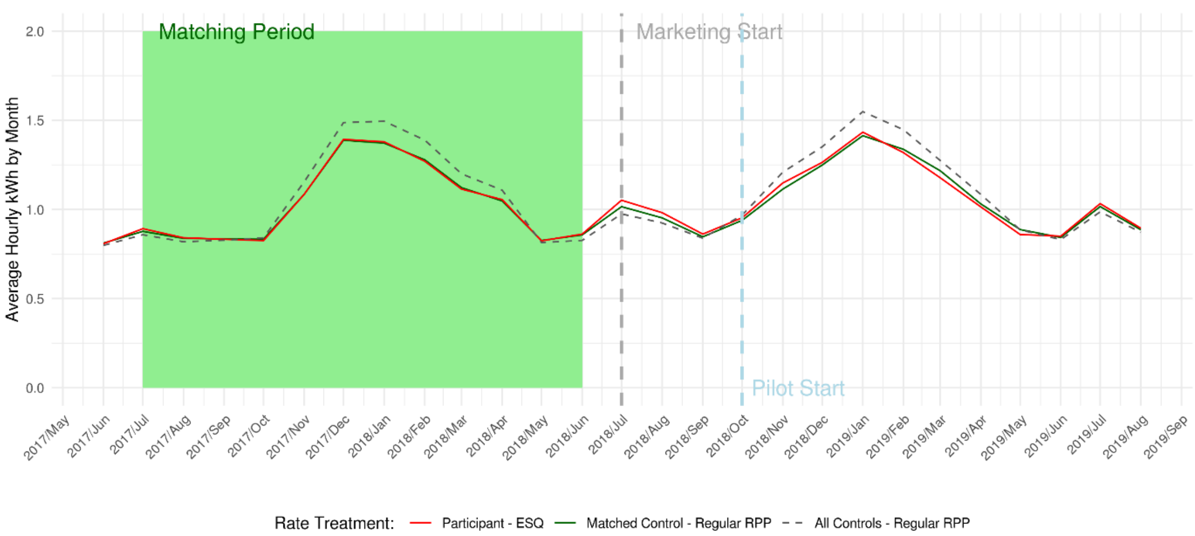
Source: Navigant Analysis

Figure 16. Matched Control Hourly Load Profiles – ESQ Price



Source: Navigant Analysis

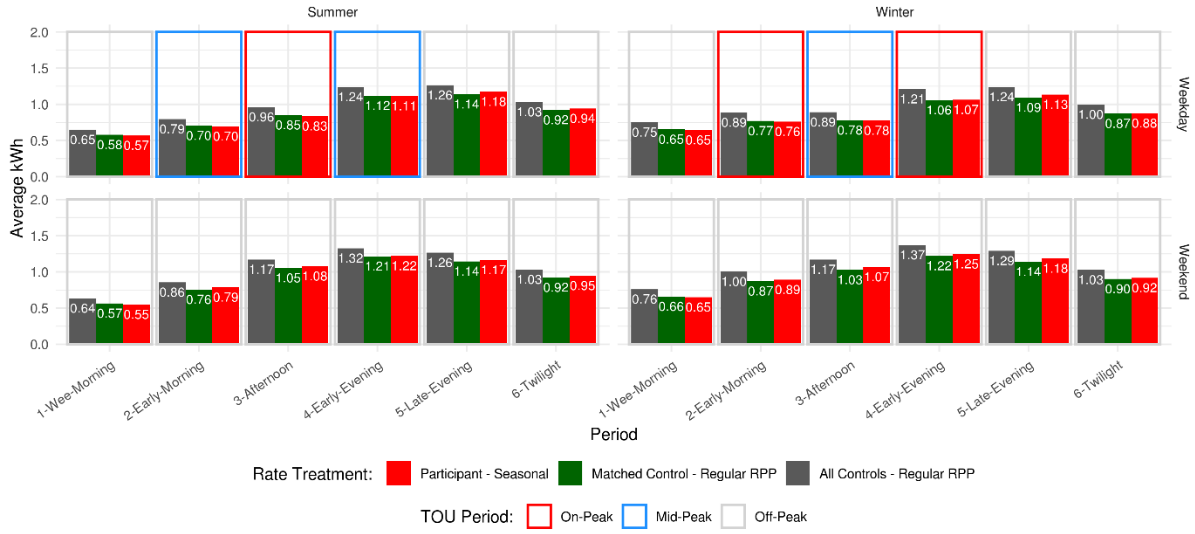
Figure 17. Matched Control Monthly Load Profiles – ESQ Price[30]



Source: Navigant Analysis

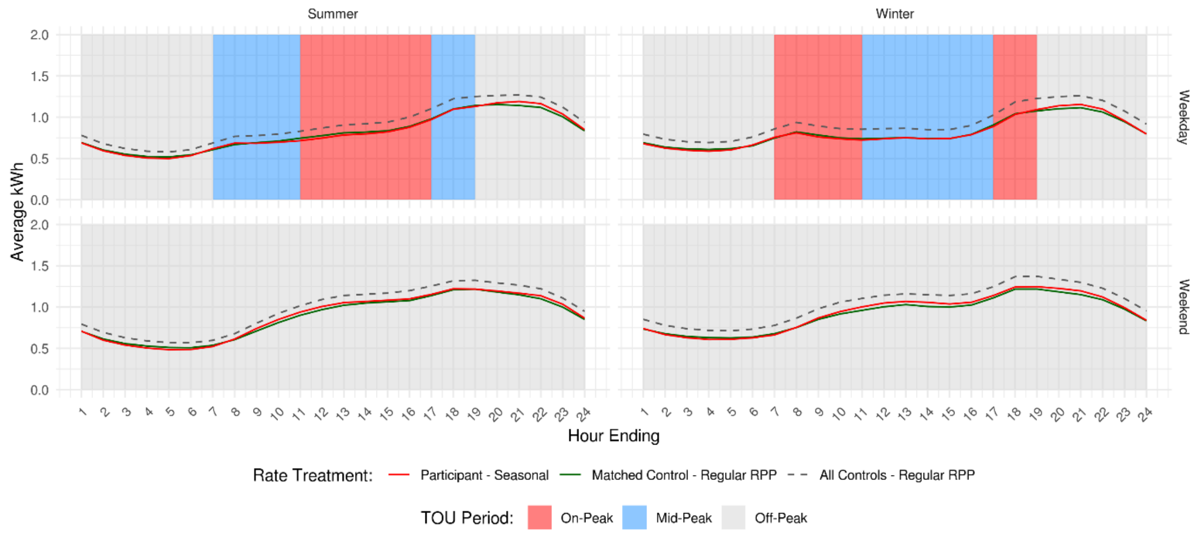
[30] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

Figure 18. Matched Control by TOU Period and Day Period – Seasonal Price



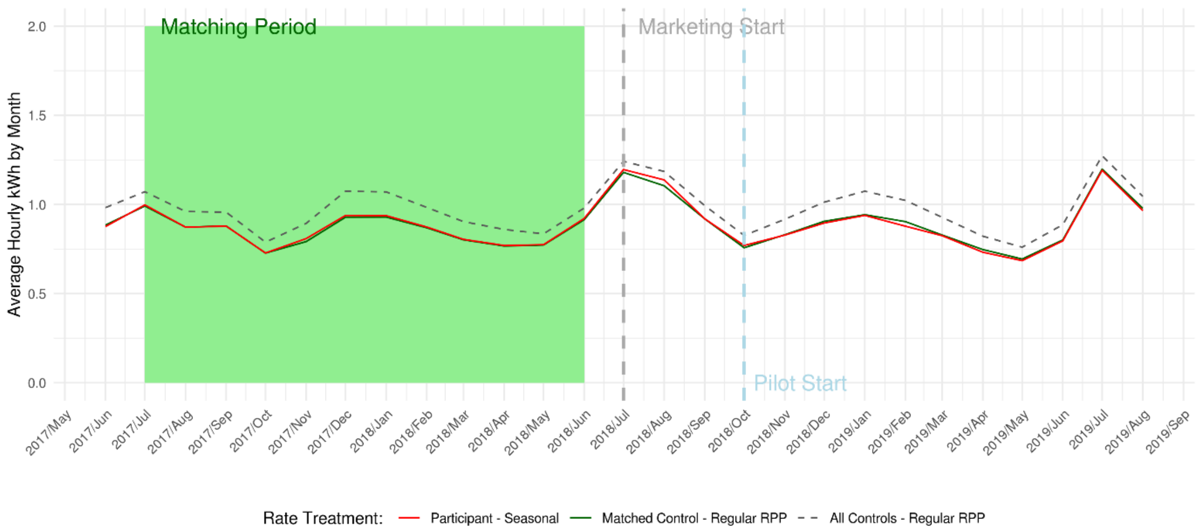
Source: Navigant Analysis

Figure 19. Matched Control Hourly Load Profiles – Seasonal Price



Source: Navigant Analysis

Figure 20. Matched Control Monthly Load Profiles – Seasonal Price[31]



Source: Navigant Analysis

2.2 Estimating Energy Impacts

This section presents the approach adopted by Navigant to estimate impacts under the quasi-experimental design. A post program lagged dependent variable model was applied to a panel dataset. The model effectively compares the hourly consumption during the post-period for customers in the treatment and matched control groups to estimate savings. Any remaining differences in usage prior to enrollment are controlled for via the lagged dependent variable. A separate regression was run for each pilot pricing scheme, treatment group and season; see Equation 1.

Equation 1. Post Program Regression Model under Quasi Experimental Design

$$
\begin{aligned}
kWh_{i,t} = {} & \sum_{w=1}^{W}\sum_{h=1}^{24}\alpha_{w,h}\bullet WeekOfYr_{w,i,t}\bullet Hour_{h,i,t} + \sum_{w=1}^{W}\sum_{d=1}^{7}\beta_{w,d}\bullet WeekOfYr_{w,i,t}\bullet DOW_{d,i,t} + \\
& \sum_{w=1}^{W}\theta_{w}\bullet WeekOfYr_{w,i,t}\bullet kWhLag_{i,t} + \sum_{n=1}^{TOU}\tau_{n}\bullet TOUPeriod_{n,i,t} + \\
& \sum_{w=1}^{W}\eta_{w}\bullet WeekOfYr_{w,i,t}\bullet THI_{i,t} + \sum_{w=1}^{W}\phi_{w}\bullet WeekOfYr_{w,i,t}\bullet THI\_Buildup_{i,t} + \\
& \sum_{n=1}^{TOU}\gamma_{n}\bullet Participant_{i,t}\bullet TOUPeriod_{n,i,t} + \varepsilon_{i,t}
\end{aligned}
$$

Where:

i:	subscript to indicate an individual customer.
t:	subscript to indicate the time period (year, month, day and hour).

[31] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

$kWh_{i,t}$: hourly consumption in the post period for a customer.

$WeekOfYr_{w,i,t}$: a set of binary variables taking a value of 1 when $week\ of\ year(t) = w$ and 0 otherwise.

$Hour_{h,i,t}$: a set of binary variables taking a value of 1 when $hour(t) = h$ and 0 otherwise.

$DOW_{d,i,t}$: a set of binary variables taking a value of 1 when $day\ of\ week(t) = d$ and 0 otherwise.

$TOUPeriod_{n,i,t}$: a set of binary variables taking a value of 1 when $TOU\ Period(t) = n$ and 0 otherwise.

$kWhlag_{i,t}$: The average energy consumption for customer i during hour t in the same week the prior year (the same pre-period timeframe used for the matching analysis). Lags were taken separately for weekdays and weekends as the consumption profiles can be different.[32]

$THI_{i,t}$: temperature humidity index defined as $17.5 + 0.55 \bullet DryBulb + 0.2 \bullet DewPoint$. The dry bulb and dew point temperatures are in degrees Celsius.

$THI\_Buildup_{i,t}$: average THI across the last seventy hours.

$Participant_{i,t}$: a binary variable taking the value of 1 if a customer was a participant, i.e. they were assigned to group A or B and 0 otherwise.

$\varepsilon_{i,t}$: error term.

2.3 Estimating Price Elasticities of Demand

2.3.1 Estimating Own Price Elasticities

To estimate a robust set of own price elasticities more than one set of pricing schemes is usually required as seen the literature[33]. In the case of this pilot, we have only one set of treatment prices and hence obtaining a reliable estimate of the own price elasticity is challenging. To illustrate, if we had more than one variation for each of the pricing schemes (e.g. ESQ_1 … ESQ_n), a more robust estimate of the daily own price elasticities could be estimated.

However, given the requirement to estimate own-price elasticities, Navigant used a functional form similar to the model used to estimate energy impacts, see Equation 1, and applied a log-log

[32] Navigant believes that a weekly average is a reasonable timeframe for the purpose of accounting for the prior year's energy usage. This addresses issues with variability that may arise in one particular hour in the previous year that may not be indicative of typical consumption patterns.

[33] Alcott 2011, Rethinking real-time electricity pricing, Resource and Energy Economics 33, 820–842.

Caves and Christensen 1980, Econometric Analysis of Residential Time-of-Use Pricing, Journal of Econometrics 14-3, 287-306;

Jessoe and Rapson 2013, Commercial and Industrial Demand Response Under Mandatory Time-of-Use Electricity Pricing, UC Center for Energy and Environmental Economics.

transformation to dependent variable, consumption, and price. A separate regression at the daily level was run for each pricing scheme, treatment group and season; see Equation 2. Given that there is only one price change, the model may not yield reliable estimates; for example, it may potentially yield estimates of the "wrong" sign (i.e. positive price elasticities which would imply that demand increases as prices increase which is counter-intuitive to the inverse relation between demand and price) or elasticities that are statistically indistinguishable from zero.[34]

Equation 2. Post Program Regression Model to estimate Own Price Elasticities

$$\begin{aligned}\ln(kWh_{i,t}) = &\sum_{w=1}^{W}\sum_{d=1}^{7}\beta_{w,d}\bullet WeekOfYr_{w,i,t}\bullet DOW_{d,i,t} + \\ &\sum_{w=1}^{W}\theta_{w}\bullet WeekOfYr_{w,i,t}\bullet kWhLag_{i,t} + \\ &\sum_{w=1}^{W}\eta_{w}\bullet WeekOfYr_{w,i,t}\bullet THI_{i,t} + \sum_{w=1}^{W}\phi_{w}\bullet WeekOfYr_{w,i,t}\bullet THI\_Buildup_{i,t} + \\ &\gamma\bullet\ln(P_{i,t}) + \varepsilon_{i,t}\end{aligned}$$

Where:

i: subscript to indicate an individual customer.

t: subscript to indicate the time period (year, month and day).

$\ln(kWh_{i,t})$: natural log of the hourly consumption in the post period for a customer.

$WeekOfYr_{w,i,t}$: a set of binary variables taking a value of 1 when $week\ of\ year(t) = w$ and 0 otherwise.

$DOW_{d,i,t}$: a set of binary variables taking a value of 1 when $day\ of\ week(t) = d$ and 0 otherwise.

$kWhlag_{i,t}$: The average energy consumption for customer i during hour t in the same week the prior year (the same pre-period timeframe used for the matching analysis). Lags were taken separately for weekdays and weekends as the consumption profiles can be different.[35]

$THI_{i,t}$: temperature humidity index defined as $17.5 + 0.55 \bullet DryBulb + 0.2 \bullet DewPoint$. The dry bulb and dew point temperatures are in degrees Celsius.

$THI\_Buildup_{i,t}$: average THI across the last seventy-two hours.

$\ln(P_{i,t})$: natural log of the average TOU price in $day(t)$ for customer i.

[34] Navigant did experiment with excluding all dummy variables and did obtain own price elasticities of the correct sign. However, Navigant does not believe that these estimates are robust as there are other unobservable effects that that the dummy variables control for and therefore have a purpose in the model specification, similar to estimating the energy impacts. Hence, excluding them may incorrectly attribute other effects to the price variable. Navigant also experimented with a reduced set of dummy variables, but they did not yield a more robust set of estimates.

[35] Navigant believes that a weekly average is a reasonable timeframe for the purpose of accounting for the prior year's energy usage. This addresses issues with variability that may arise in one particular hour in the previous year that may not be indicative of typical consumption patterns.

$\varepsilon_{i,t}$: error term.

2.3.2 Estimating Inter-Period Price Elasticity of Substitution

To estimate inter-period price elasticity of substitution between the on-peak and off-peak period, Navigant used a functional form that is similar to the model used to estimate energy impacts, see Equation 1. Navigant used a daily regression model that models the natural log of the ratio of the on-peak to off-peak consumption to the natural log of the ratio of the on-peak to off-peak price, see Equation 3. The other variables control for other factors as they did in Equation 1.

One would expect to see an inverse relationship between the on-peak to off-peak price differential vs. consumption. Effectively, as the on-peak to off-peak price ratio is increased, we would expect to see a decline in the ratio of the on-peak to off-peak consumption meaning that more consumption would be shifted form the on-peak to the off-peak period. This would be indicated by a negative gamma coefficient when the model is estimated.

Equation 3. Post Program Regression Model to estimate Inter-Period Price Elasticity of Substitution[36]

$$
\begin{aligned}
\ln\left(\frac{kWh\_OnPeak_{i,t}}{kWh\_OffPeak_{i,t}}\right) = & \sum_{w=1}^{W}\sum_{d=1}^{5}\beta_{w,d}\bullet WeekOfYr_{w,i,t}\bullet DOW_{d,i,t} + \\
& \sum_{w=1}^{W}\theta_{w}\bullet WeekOfYr_{w,i,t}\bullet\left(\frac{kWhLag\_OnPeak_{i,t}}{kWhLag\_OffPeak_{i,t}}\right) + \\
& \sum_{w=1}^{W}\eta_{w}\bullet WeekOfYr_{w,i,t}\bullet\left(\frac{THI\_OnPeak_{i,t}}{THI\_OffPeak_{i,t}}\right) + \\
& \sum_{w=1}^{W}\phi_{w}\bullet WeekOfYr_{w,i,t}\bullet\left(\frac{THI\_Buildup\_OnPeak_{i,t}}{THI\_Buildup\_OffPeak_{i,t}}\right) + \\
& \gamma\bullet\ln\left(\frac{P\_OnPeak_{i,t}}{P\_OffPeak_{i,t}}\right) + \varepsilon_{i,t}
\end{aligned}
$$

Where:

i: subscript to indicate an individual customer.

t: subscript to indicate the time period (year, month and day).

$kWh\_OnPeak_{i,t}$: the average hourly consumption during the on-peak hours in a day in the post period for a customer.

$kWh\_OffPeak_{i,t}$: the average hourly consumption during the off-peak hours in a day in the post period for a customer.

[36] Similar to the own price elasticity, Navigant did experiment with excluding any dummy variables as well as reduced set of dummy variables and noted that the results were fairly stable. Hence, the inter-period price elasticity of substitution model includes a set of dummy variables to control for other unobservable factors and the results are presented in section 3.1.3.

$WeekOfYr_{w,i,t}$: a set of binary variables taking a value of 1 when $week\ of\ year(t) = w$ and 0 otherwise.

$DOW_{d,i,t}$: a set of binary variables taking a value of 1 when $day\ of\ week(t) = d$ and 0 otherwise.

$kWhlag_{i,t}$: The average energy consumption for customer i during hour t in the same week the prior year. Lags were taken separately for weekdays and weekends as the consumption profiles can be different.[37]

$THI\_OnPeak_{i,t}$: average of the temperature humidity index during the on-peak hours of the day in the post period for a customer.[38]

$THI\_OffPeak_{i,t}$: average of the temperature humidity index during the off-peak hours of the day in the post period for a customer.[39]

$THI\_Buildup\_OnPeak_{i,t}$: average of the THI buildup[40] across the on-peak hours of the day in the post period for a customer.

$THI\_Buildup\_OffPeak_{i,t}$: average of the THI buildup[41] across the off-peak hours of the day in the post period for a customer.

$P\_OnPeak_{i,t}$: average on-peak TOU price in $day(t)$ for customer i.

$P\_OffPeak_{i,t}$: average off-peak TOU price in $day(t)$ for customer i.

$\varepsilon_{i,t}$: error term.

2.4 Data Used to Estimate Price Impacts

Navigant used the following data to estimate price impacts:

- Tracking Data
- Study Population Hourly Consumption Data
- Weather Data

[37] Navigant believes that a weekly average is a reasonable timeframe for the purpose of accounting for the prior year's energy usage. This addresses issues with variability that may arise in one particular hour in the previous year that may not be indicative of typical consumption patterns.

[38] THI is defined as $17.5 + 0.55 \bullet DryBulb + 0.2 \bullet DewPoint$. The dry bulb and dew point temperatures are in degrees Celsius.

[39] THI is defined as $17.5 + 0.55 \bullet DryBulb + 0.2 \bullet DewPoint$. The dry bulb and dew point temperatures are in degrees Celsius.

[40] THI buildup is calculated as the average of the THI over the past seventy-two hours.

[41] THI buildup is calculated as the average of the THI over the past seventy-two hours.

2.4.1 Tracking Data

Tracking data was provided by CustomerFirst for each LDC which included:

- the study population and their assignments to the randomized groups (A, B and C);
- customer start and end dates and address information;
- identifying customers who opted in and the dates on which their pilot rates took effect (which was the start of their next billing cycle in October 2018);
- the dates on which the smart thermostats were installed for the rate and enabling technology treatment group (group B); and
- customers who opted out and the dates on which they opted out.

Table 12 shows the randomized assignments of each LDC's study population to either one of the two treatment groups to receive encouragement or to the control groups. Each group has an equal number of customers assigned to it as required by the experimental design.

Table 12. Study Population by LDC

Local Distribution Company	Randomized Group	Study Population
Greater Sudbury Hydro	A – Rate Only	14,075
	B – Rate & Enabling Technology	14,082
	C – Control	14,072
North Bay Hydro Distribution Ltd.	A – Rate Only	7,017
	B – Rate & Enabling Technology	7,068
	C – Control	7,056
PUC Services Inc.	A – Rate Only	9,880
	B – Rate & Enabling Technology	9,877
	C – Control	9,886
Northern Ontario Wires	A – Rate Only	1,737
	B – Rate & Enabling Technology	1,743
	C – Control	1,742
Newmarket-Tay Power Distribution Ltd.	A – Rate Only	9,472
	B – Rate & Enabling Technology	9,458
	C – Control	9,437

Source: CustomerFirst

In total, there were 1,091 participants that enrolled in the pilot across all LDCs and the two enrollment groups. This represents an overall acceptance rate[42] of 1.26%. The ESQ and the Seasonal price structures had 622 and 469 participants respectively. The total enrollment numbers were notably lower than expected. The associated challenges with estimating the impacts given the low enrollment are discussed in the sections that follow. In total, 82 customers have opted out representing 7.5% of participants.

2.4.2 Study Population Hourly Consumption Data

Each LDC provided Navigant the hourly consumption data for their respective study populations for the program period as well as for the year immediately prior to the start of the program (also known as pre-program period or pre-period data). The program period covers the time from October 1, 2018 to August 31, 2019.

The pre-period data also provides insight with regards to the success of the randomization process. When the study population is randomly assigned to one of three groups as described above, in section 2.1.2, one would expect the load profiles for each of these groups to be similar. Upon investigating the average load shapes for each of the three groups for each LDC by season, Navigant noted that the load shapes were very similar and concluded that the randomization process was successful. The load shapes are presented in Appendix B.

For some participants, a matched control was not found for a particular season due to insufficient pre-period data. For each season in the matching year, a customer was required to have at least three months data to find a reliable match. Table 13 and Table 14 show how many participants were excluded from the analysis as a result of not having at least three full months of data in the pre-period for either the summer or winter seasons for the rate only and rate and enabling technology groups respectively.

[42] The acceptance rate refers to the percent of customers that were encouraged and accepted the encouragement.

Table 13. Matched Control Summary – Rate Only

Season	Pilot Pricing Scheme	Local Distribution Company	Total Enrolled Participants	Participants with Matched Controls	Unmatched Participants	Unmatched Percent
Summer	ESQ	Greater Sudbury Hydro	169	159	10	5.92%
		North Bay Hydro Distribution Ltd.	95	74	21	22.11%
		PUC Services Inc.	143	132	11	7.69%
		Total	**407**	**365**	**42**	**10.32%**
	Seasonal	Northern Ontario Wires	48	43	5	10.42%
		Newmarket-Tay Power Distribution Ltd.	260	229	31	11.92%
		Total	**308**	**272**	**36**	**11.69%**
Winter	ESQ	Greater Sudbury Hydro	169	160	9	5.33%
		North Bay Hydro Distribution Ltd.	95	77	18	18.95%
		PUC Services Inc.	143	134	9	6.29%
		Total	**407**	**371**	**36**	**8.85%**
	Seasonal	Northern Ontario Wires	48	46	2	4.17%
		Newmarket-Tay Power Distribution Ltd.	260	239	21	8.08%
		Total	**308**	**285**	**23**	**7.47%**

Source: Navigant Analysis

Table 14. Matched Control Summary – Rate and Enabling Technology

Season	Pilot Pricing Scheme	Local Distribution Company	Total Enrolled Participants	Participants with Matched Controls	Unmatched Participants	Unmatched Percent
Summer	ESQ	Greater Sudbury Hydro	86	82	4	4.65%
		North Bay Hydro Distribution Ltd.	63	48	15	23.81%
		PUC Services Inc.	66	62	4	6.06%
		Total	**215**	**192**	**23**	**10.70%**
	Seasonal	Northern Ontario Wires	17	17	0	0.00%
		Newmarket-Tay Power Distribution Ltd.	144	128	16	11.11%
		Total	**161**	**145**	**16**	**9.94%**
Winter	ESQ	Greater Sudbury Hydro	86	83	3	3.49%
		North Bay Hydro Distribution Ltd.	63	47	16	25.40%
		PUC Services Inc.	66	64	2	3.03%
		Total	**215**	**194**	**21**	**9.77%**
	Seasonal	Northern Ontario Wires	17	17	0	0.00%
		Newmarket-Tay Power Distribution Ltd.	144	135	9	6.25%
		Total	**161**	**152**	**9**	**5.59%**

Source: Navigant Analysis

2.4.3 Weather Data

Navigant purchased hourly weather data from Environment Canada. Each participant and matched control was mapped to the closest Environment Canada weather station.[43] The weather stations used for each distributor are presented in Table 15. The weather stations listed below have a complete set of hourly data for the pilot period.

[43] The address information for each customer was used to geocode their location (i.e. obtain latitude and longitude) which was then used to find the closest Environment Canada weather station.

Table 15. Weather Stations

Local Distribution Company	Weather Stations
Greater Sudbury Hydro	North Bay Airport
	Sudbury Climate
North Bay Hydro Distribution Ltd.	North Bay Airport
PUC Services Inc.	Sault Ste Marie A
Northern Ontario Wires	Kapuskasing CDA ON
	Timmins A
Newmarket-Tay Power Distribution Ltd.	Toronto Buttonville A
	Uxbridge West

Source: Navigant Analysis, Environment Canada

2.5 Outlier Analysis

To ensure a robust set of impact estimates, Navigant analyzed the consumption of participants as well as the quality of their matches to identify any outliers that should be excluded from the analysis. The purpose of this step is to exclude only those participants who have noticeably different consumption patterns compared to the remainder of the participant population. Participants were considered outliers if they had:

- an average kWh greater than 3 or less than 0.1 kWh;
- peak demand greater than fifteen kW; or
- the RMSE of their hourly matches was greater than 0.5.

Additional detail with regards to the distribution of participant consumption is provided in appendix A.4 while the RMSE distribution of the matched controls is provided in appendix A.1. Table 16 and Table 17 show the number of participants excluded for the rate only and rate and enabling technology treatment groups respectively. The outlier analysis excludes approximately five percent of participants on average, higher for the ESQ pricing scheme in the winter and lower in the summer.

Table 16. Outlier Summary – Rate Only

Season	Pilot Pricing Scheme	Local Distribution Company	Participants with Matched Controls	Outlier Participants	Outlier Percent	Participants Analyzed
Summer	ESQ	Greater Sudbury Hydro	159	10	6.29%	149
		North Bay Hydro Distribution Ltd.	74	2	2.70%	72
		PUC Services Inc.	132	2	1.52%	130
		Total	**365**	**14**	**3.84%**	**351**
	Seasonal	Northern Ontario Wires	43	2	4.65%	41
		Newmarket-Tay Power Distribution Ltd.	229	9	3.93%	220
		Total	**272**	**11**	**4.04%**	**261**
Winter	ESQ	Greater Sudbury Hydro	160	14	8.75%	146
		North Bay Hydro Distribution Ltd.	77	6	7.79%	71
		PUC Services Inc.	134	17	12.69%	117
		Total	**371**	**37**	**9.97%**	**334**
	Seasonal	Northern Ontario Wires	46	4	8.70%	42
		Newmarket-Tay Power Distribution Ltd.	239	8	3.35%	231
		Total	**285**	**12**	**4.21%**	**273**

Source: Navigant Analysis

Table 17. Outlier Summary – Rate and Enabling Technology

Season	Pilot Pricing Scheme	Local Distribution Company	Participants with Matched Controls	Outlier Participants	Outlier Percent	Participants Analyzed
Summer	ESQ	Greater Sudbury Hydro	82	3	3.66%	79
		North Bay Hydro Distribution Ltd.	48	0	0.00%	48
		PUC Services Inc.	62	2	3.23%	60
		Total	**192**	**5**	**2.60%**	**187**
	Seasonal	Northern Ontario Wires	17	1	5.88%	16
		Newmarket-Tay Power Distribution Ltd.	128	5	3.91%	123
		Total	**145**	**6**	**4.14%**	**139**
Winter	ESQ	Greater Sudbury Hydro	83	9	10.84%	74
		North Bay Hydro Distribution Ltd.	47	2	4.26%	45
		PUC Services Inc.	64	11	17.19%	53
		Total	**194**	**22**	**11.34%**	**172**
	Seasonal	Northern Ontario Wires	17	1	5.88%	16
		Newmarket-Tay Power Distribution Ltd.	135	3	2.22%	132
		Total	**152**	**4**	**2.63%**	**148**

Source: Navigant Analysis

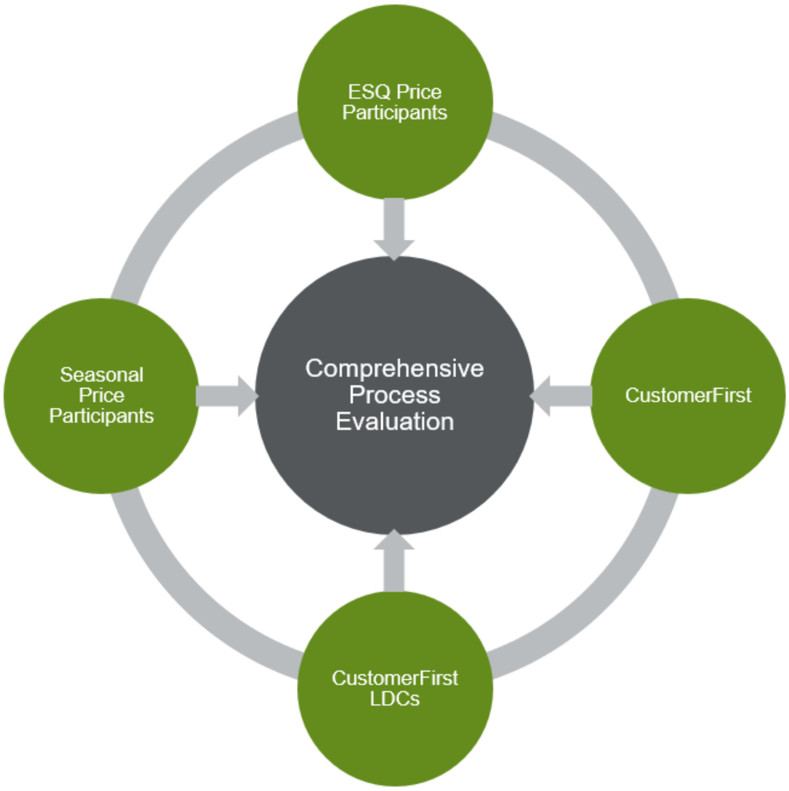
2.6 Process Evaluation Methodology

Process evaluations shed light on the qualitative impacts of the pilot and when combined with the results of impact evaluations, provide a comprehensive understanding of the overall effectiveness of an initiative. The focus of the process evaluation is to develop actionable recommendations that can help improve program delivery.

2.6.1 Research Approach

High quality process evaluations are based on primary data collection and analysis. The most common primary research tools employed by evaluators are interviews and/or surveys. These are effective in collecting the necessary feedback from the participant group to inform an understanding of non-quantitative programmatic impacts. Figure 21 describes the primary research targets from which Navigant collected the information necessary to understand these programmatic impacts.

Figure 21. Process Evaluation – Primary Research Targets



Source: Navigant

To collect the information from all program stakeholders, as demonstrated in Table 18, Navigant conducted both online surveys and interviews. The results of the interviews and both participant surveys are presented in section 3.2.

In order to complete the primary research efforts described in Table 18, a comprehensive interview guide and survey questionnaire was developed while considering:

1. **Survey/Interview length**: ensuring the critical link between survey/interview length and the ability of a survey instrument to solicit high-quality responses is not lost.

2. **Leveraging Past Survey/Interview Learnings**: basing survey/interview instrument design on the cumulative learning experiences drawn from past projects for similar purposes. These proven tools were customized by Navigant's expert market research staff specifically for this engagement to ensure that they extract the most valuable and useful information from interviewees and survey participants.

The survey questionnaire and interview guide were reviewed with CustomerFirst staff and the OEB. All feedback received by Navigant was incorporated before the surveys / interviews were released / conducted.

Table 18. Primary Research

Stakeholder Group	Primary Research Type	Research Timing
CustomerFirst	Telephone interview	- Telephone interview with the CustomerFirst RPP Project Manager. o Interview completed in November 2018.
CustomerFirst LDCs	Telephone interviews	- Telephone interviews completed with Program Managers[44] from all LDCs participating in the RPP pilot. o Interviews completed in January 2019.
Seasonal and ESQ Price Participants	Online survey	- Online surveys that all RPP pilot participants enrolled in Seasonal and ESQ were requested to complete. o First survey completed in December 2018 shortly after the pilot was rolled out. o Final survey completed in September 2019 at the end of the pilot.

Source: Navigant

2.6.2 CustomerFirst and LDC Interviews

Telephone interviews were completed with the program managers from CustomerFirst and all partner LDCs to gain the following range of understandings:

- assess partner LDC motivations for program/project support as well as any barriers that may have inhibited interest,
- from the perspective of the participating LDCs and CustomerFirst, develop an understanding of the strengths and weaknesses of the program as well as the strategy created to support deployment,
- identify any factors that impacted participation within their service territory as well as how and if these limitations were overcome,
- determine key best practices and lessons learned from each LDC and CustomerFirst's perspective,
- identify potential enhancements to the implementation and communication strategies that have been implemented.

The program managers were the individuals overseeing the execution of the pilot at the LDC level and can provide context on any challenges the utility may have in scaling the pilot or in implementation of additional pilots.

2.6.3 Participant Surveys

To capture customer feedback on the effectiveness of the pilot, Navigant developed two online surveys for all participants. Figure 22 below highlights the various aspects of the pilot assessed through participant surveys to gain:

1. A greater understanding of the program's effectiveness; and,

[44] The program managers from the LDCs are the most knowledgeable about the pilot and hence they were selected for interviews.

2. Actionable recommendations that can be used to inform successful future RPP initiatives.

Figure 22. Participant Survey Overview

Source: Navigant

The first survey was deployed in December 2018 to the entire participant base, those who opted-in, shortly following program initiation to:

- gauge participant expectations of the initiative prior to engagement,
- gain insight into the value or benefit that customers anticipate achieving as a result of participation,
- explore the range of motivations for participation to gain an understanding of the types of customers attracted to the RPP program's offering, and
- assess marketing and advertising effectiveness to identify how participants first heard of the program as well as the most influential factor in their decision to participate.

The final survey was administered in September 2019 at the close of the pilot to the entire participant base. The key objectives of this capstone survey was to:

- assess the performance of the initiative's technology and information tools against expectations,
- determine perceived and/or actual financial benefit from participating against their expectations,
- assess participants overall satisfaction with the pilot and whether their participation in the pilot has altered the perception of their utility, and
- gauge participant views on whether the pilot prices should be more broadly rolled out within the province.

3. RESULTS

This chapter presents the results of both the price impact analysis as well as the process evaluation and is divided into the following sections:

- **TOU Price Impact Results** – presents the price impacts for each pricing scheme and treatment group by season and TOU Period.
- **Process Evaluation Results** – presents the results of both participant surveys and the interviews with LDC and CustomerFirst program managers.

3.1 TOU Price Impact Results

As discussed in section 2.1, this section will focus on the impacts of the quasi-experimental design involving the use of a matched control group.[45] The impacts are presented at the hourly level.

3.1.1 ESQ Price Energy Impacts

Table 19 summarizes the results for both treatment groups by season and TOU period. Figure 23 and Figure 24 present a graphical view of the impacts for the rate only and rate and enabling technology treatments respectively. We do not see statistically significant savings from either treatment group. The confidence bands are also wider for the rate and enabling technology treatment group which can be attributed partly to a smaller sample size compared to the rate only treatment group.

The results support the null hypothesis that participants did not make material behavioural changes.[46] The key to understanding these results lie in understanding three key underlying aspects related to electricity consumption that that drive these results:

1. Only a portion of electricity consumption can be reduced or shifted;

It is important to note that not all electricity consumption is elastic (optional or flexible or discretionary and hence sensitive to price), meaning that not all consumption can be shifted or reduced. A notable portion of consumption, for all intents and purposes from a practical standpoint, can be considered to be fixed (e.g. baseloads, refrigeration, etc.) and hence inelastic. This means that that changes to the price of electricity have no impact on this portion of electricity consumption.

2. The base RPP rates already follow a TOU structure; and

Ontario has already made the transition from a tiered rate structure to a TOU pricing structure for all residential households. During this transition, some customers, though admittedly not all, would have adjusted their behaviour to shift some consumption from the on-peak to off-peak periods and or reduce overall consumption where possible. This means that a portion of their elastic or discretionary consumption has already been shifted or reduced and there is less discretionary consumption that customers have at their disposal to further adjust behaviours as part of the pilot program.

3. The benefits of shifting behaviour, bill savings, vs. the cost, personal discomfort.

Rounding the average on-peak consumption to 1 kWh and assuming that a participant simply decides to reduce twenty percent of their on-peak period load, they would save 0.2 kWh per on-peak hour which would translate to (0.2 kWh times six on-peak hours times twenty weekdays) 24 kWh per month. The price differential between the regular RPP on-peak price vs. the ESQ on-peak price is

[45] The RED results may be located in the Interim Results Report, Navigant (2020) - https://www.oeb.ca/sites/default/files/CustomerFirst-Interim-Impacts-Report-20200203.pdf

[46] The only impact estimate that is close to statistical significance, but still statistically insignificant, is the winter on-peak period for the rate only treatment group. There could potentially be some space heating conservation, but it is important to note do not see this behaviour in the rate and enabling technology group and this is most likely statistical noise. When using a ninety percent confidence interval, there is a one in ten chance that an estimate can be close to rejecting or reject the null hypothesis of no savings by pure chance alone – a type one error. It is believed that such a Type I error has occurred in this case.

approximately four cents and this translates into monthly bill savings of approximately ($0.04 * 24 kWh) $0.96. The savings in terms of a dollar value are practically insignificant compared to the personal discomfort of having to adjust behaviour to the extent of a twenty percent reduction in on-peak consumption.

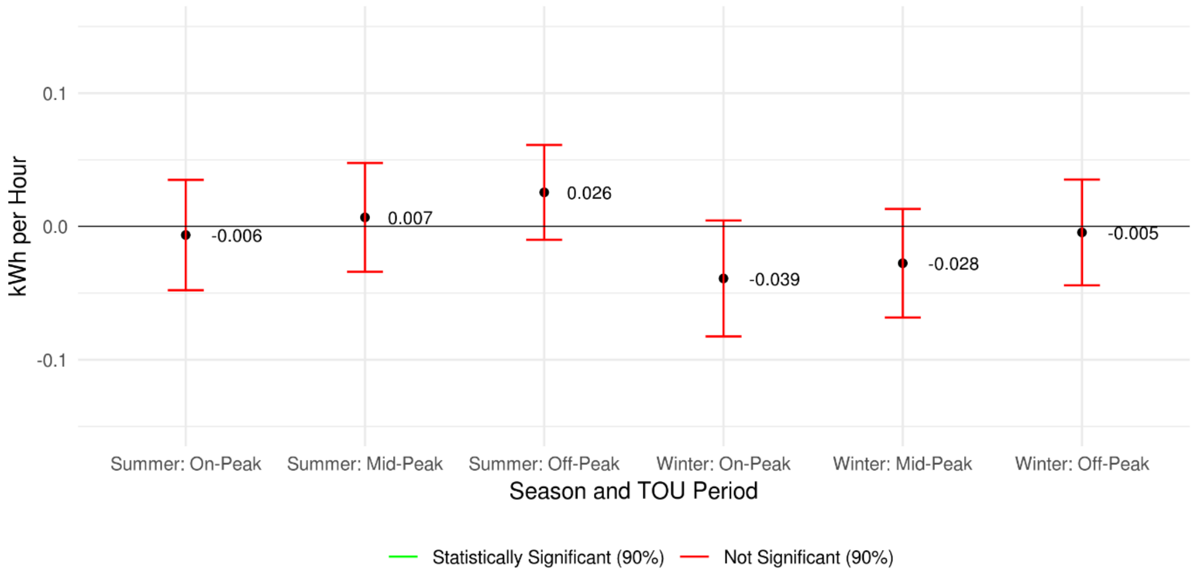
In summary, even though the ESQ price has an on-peak price that is thirty two percent higher and a mid-peak price that forty percent higher than the regular RPP TOU price, we do not see impacts that are statistically different from zero. The magnitude of the impacts is not very large relative to the uncertainty / variation in the data and the magnitude of the price differential may not be sufficient to incentivize participants to significantly modify their behaviour. This coupled with the small sample sizes and that the prices only affect a portion of total consumption and the dollar value of significant reductions in energy consumption is minimal (even less for load shifting), might explain why we do not see large impact estimates that are statistically significant.

Table 19. ESQ Price Energy Impacts

Treatment Group	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-Value	Relative Precision ± % (90% confidence)
Rate Only	Summer	On-Peak	-0.006	-0.83	0.797	638.12
		Mid-Peak	0.007	0.79	0.786	606.39
		Off-Peak	0.026	3.12	0.238	139.48
	Winter	On-Peak	-0.039	-3.61	0.140	111.44
		Mid-Peak	-0.028	-2.91	0.264	147.39
		Off-Peak	-0.005	-0.44	0.851	877.44
Rate and Enabling Technology	Summer	On-Peak	-0.024	-2.86	0.424	205.61
		Mid-Peak	-0.004	-0.48	0.881	1,095.98
		Off-Peak	0.018	2.07	0.550	275.14
	Winter	On-Peak	0.013	1.21	0.707	437.54
		Mid-Peak	-0.022	-2.34	0.504	246.33
		Off-Peak	0.047	4.43	0.198	127.86

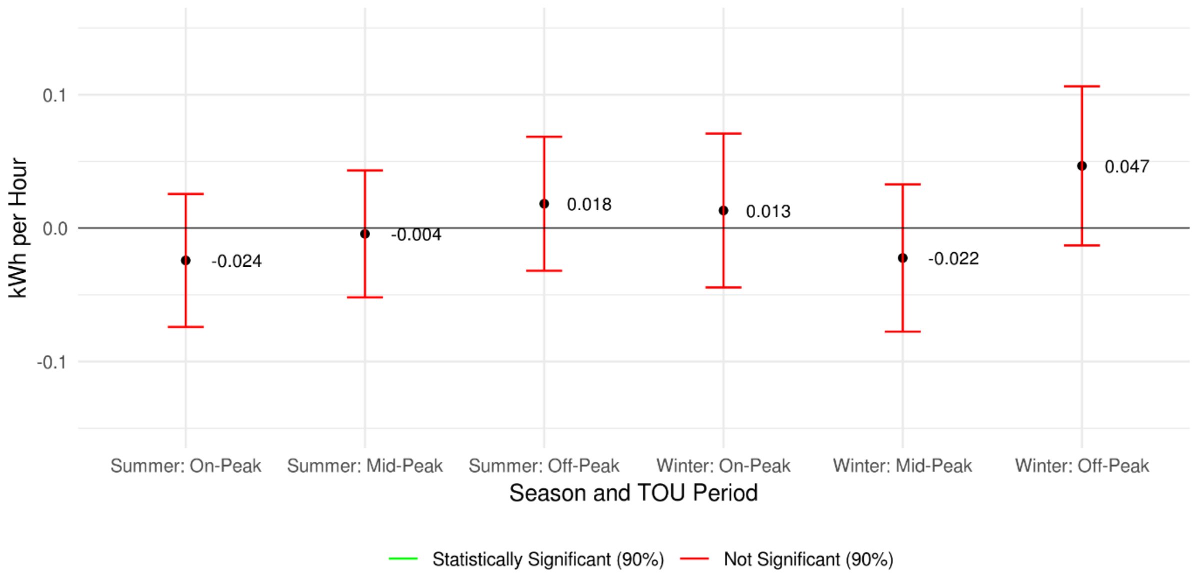
Source: Navigant Analysis. Negative Values indicate savings.

Figure 23. ESQ Price Energy Impacts – Rate Only



Source: Navigant Analysis

Figure 24. ESQ Price Energy Impacts – Rate and Enabling Technology



Source: Navigant Analysis

3.1.2 Seasonal Price Energy Impacts

Table 20 summarizes the results for both treatment groups by season. Figure 25 and Figure 26 present a graphical view of the impacts for the rate only and rate and enabling technology treatments respectively. Like the ESQ price, we do not see statistically significant savings from either treatment group and the confidence bands are wider for the rate and enabling technology treatment group which can partly be attributed to a smaller sample size compared to the rate only treatment group.

As with the ESQ price impacts, the results support the hypothesis that the participants did not make material behaviours changes[47] and the key to understanding these results lies in understanding the three key underlying aspects related to electricity consumption – not all consumption can be shifted or reduced, there is less elastic or discretionary consumption that is available for further behaviours changes given that Ontario has already made the move to TOU rates for residential customers, and that even major behavioural changes yield minimal bill savings.

Rounding the average on-peak consumption to 1 kWh again we assume a twenty percent reduction in on-peak demand. Assume further that the reduction across the twelve on-peak hours is split equally across the old on-peak and mid-peak periods. Effectively, they would save 0.2 kWh per Seasonal on-peak hour which would translate to (0.2 kWh times twelve Seasonal on-peak hours times twenty weekdays) 48 kWh per month.

The on-peak price is only two percent higher, but the old mid-peak period is now in the on-peak period which represents a forty percent increase in price. The price differential between the regular RPP on-peak price vs. the seasonal on-peak price is approximately 0.3 cents and this translates into monthly bill savings of approximately ($0.003 * 24 kWh) $0.07 for the savings attributable to the old on-peak hours. The savings attributable to the old mid-peak hours results in savings of approximately ($0.04 * 24 kWh) $0.96. Hence, the total bill savings are just over a dollar.

In summary, the savings in terms of a dollar value are practically insignificant compared to the discomfort that could be associated with having to significantly adjust behaviour and coupled with the relatively small sample sizes might explain why we do not see large impact estimates that are statistically significant.

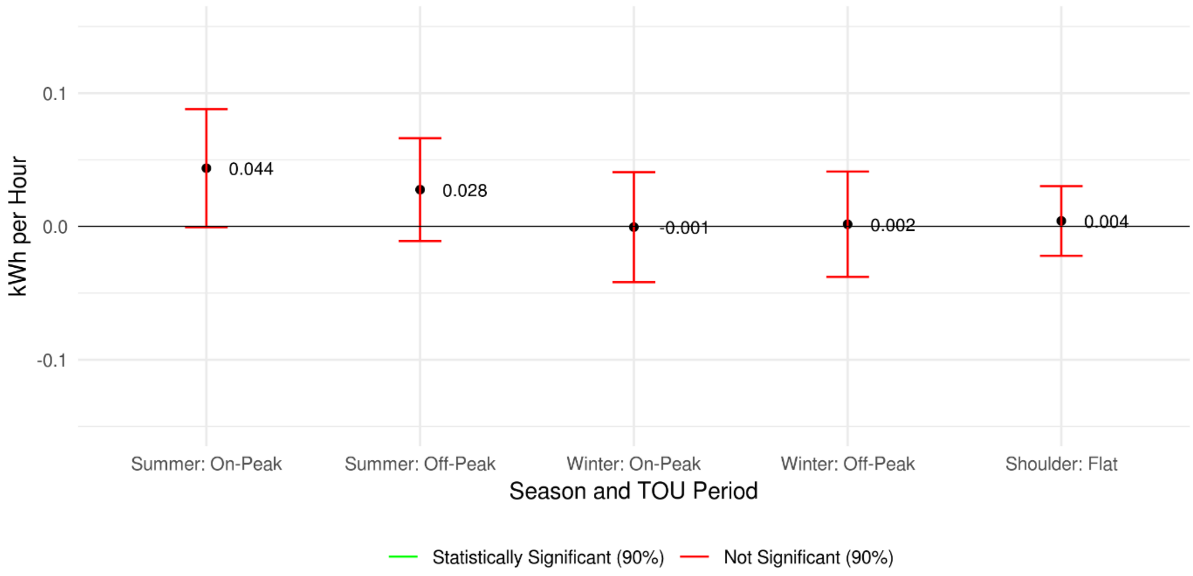
Table 20. Seasonal Price Energy Impacts

Treatment Group	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-Value	Relative Precision ± % (90% confidence)
Rate Only	Summer	On-Peak	0.044	5.15	0.105	101.44
		Off-Peak	0.028	3.27	0.240	140.00
	Winter	On-Peak	-0.001	-0.06	0.983	7,810.48
		Off-Peak	0.002	0.18	0.946	2,446.09
	Shoulder	Flat	0.004	0.55	0.796	637.29
Rate and Enabling Technology	Summer	On-Peak	-0.020	-1.94	0.598	324.09
		Off-Peak	-0.017	-1.76	0.612	311.56
	Winter	On-Peak	-0.008	-0.82	0.776	274.61
		Off-Peak	-0.016	-1.64	0.549	579.32
	Shoulder	Flat	-0.018	-2.22	0.359	179.46

Source: Navigant Analysis. Negative Values indicate savings.

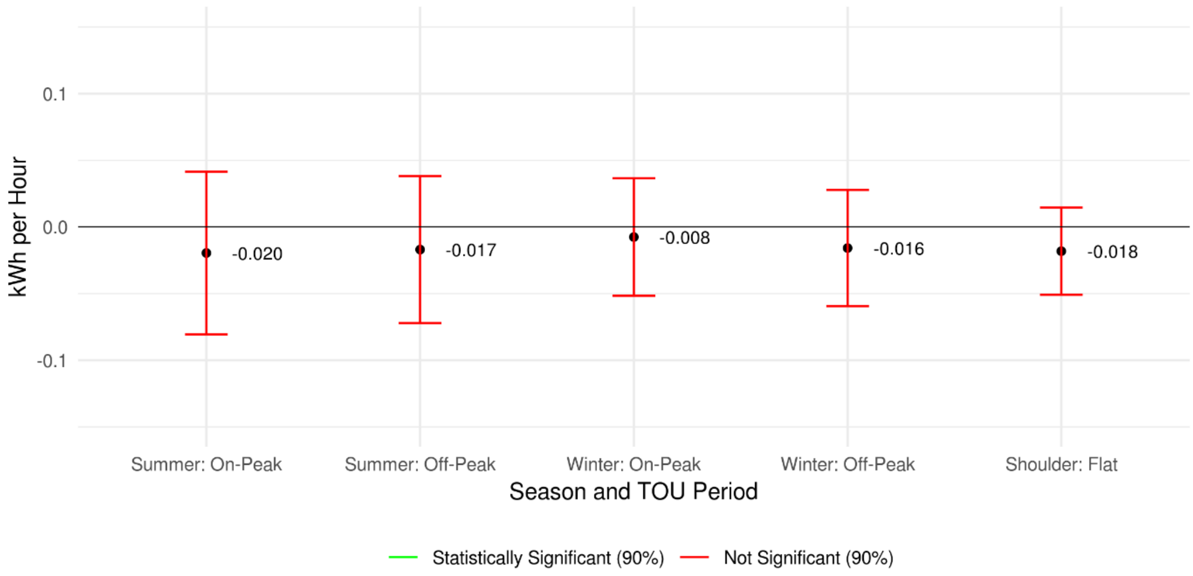
[47] The only impact estimate that is close to statistical significance, but still statistically insignificant, is the summer on-peak period for the rate only treatment group. There could potentially be a minor increase in consumption given that the pilot on-peak price is only slightly higher than the regular RPP price, see Table 5. However, this is counterintuitive to conventional theory / expectations which states that price and consumption are inversely related, and this is most likely statistical noise. When using a ninety percent confidence interval, there is a one in ten chance that an estimate can be close to rejecting or reject the null hypothesis of no savings by pure chance alone – a type one error. It is believed that such a Type I error has occurred in this case.

Figure 25. Seasonal Price Energy Impacts – Rate Only



Source: Navigant Analysis

Figure 26. Seasonal Price Energy Impacts – Rate and Enabling Technology



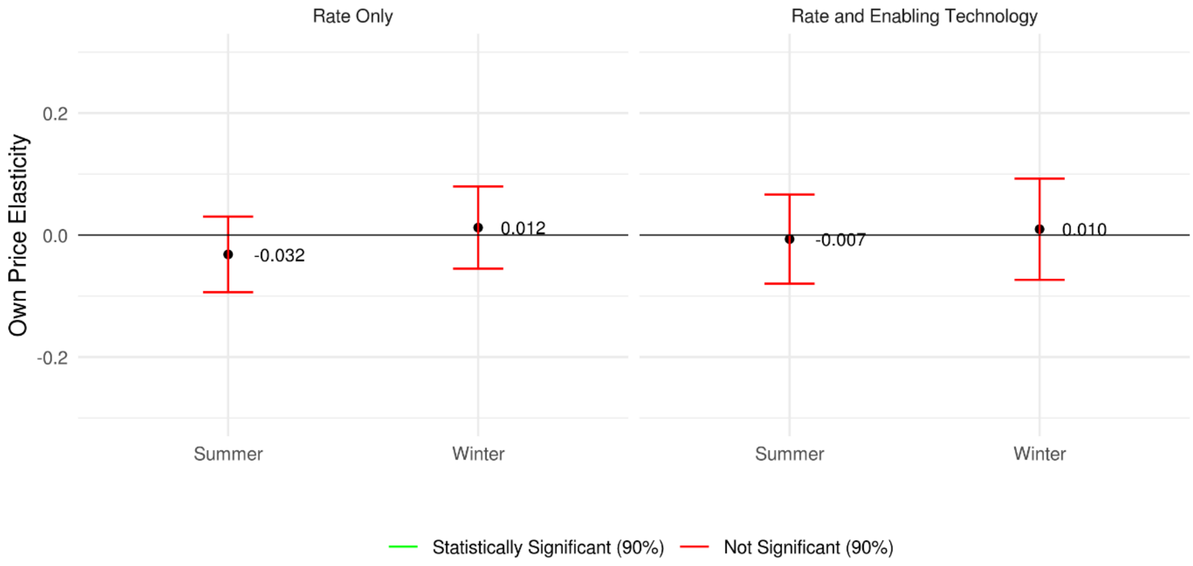
Source: Navigant Analysis

3.1.3 Price Elasticity of Demand

3.1.3.1 Own Price Elasticity

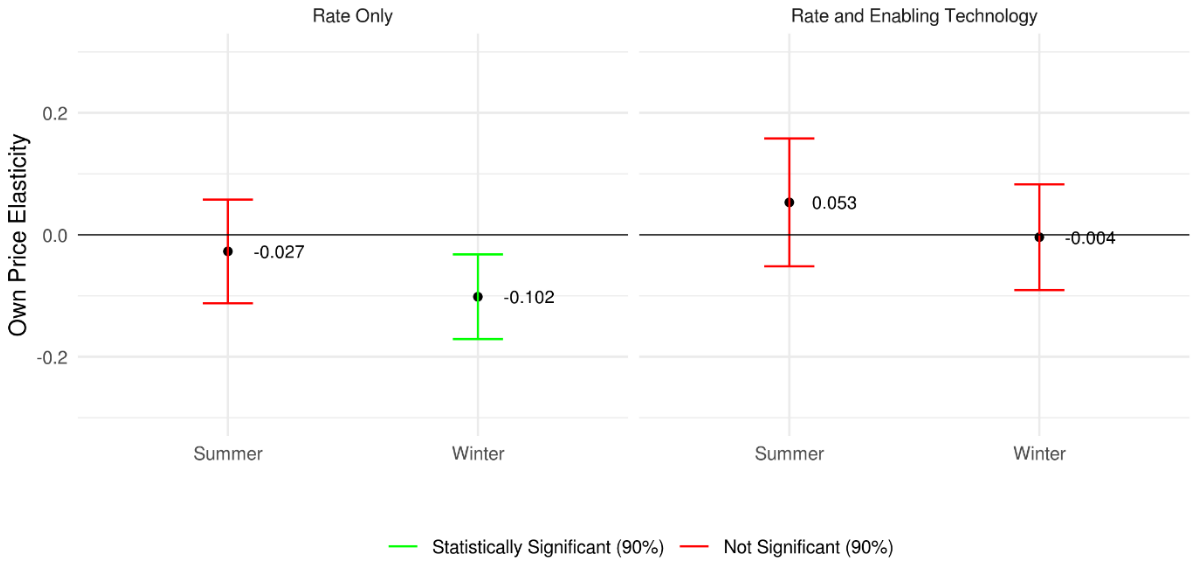
As mentioned in section 2.3.1, to estimate a robust set of own price elasticities more than one set of pricing schemes is usually required. The own price elasticity estimates are presented below for the sake of completeness, but the key takeaway is that the own price elasticity estimates are not robust. The elasticities are small in magnitude and are not statistically different from zero (slightly positive in some cases). This result is not surprising given that we are not seeing statistically significant impact estimates for the reasons discussed in section 3.1.1 and 3.1.2 for the ESQ and Seasonal pricing schemes respectively.

Figure 27. Own Price Elasticity – ESQ Price



Source: Navigant Analysis

Figure 28. Own Price Elasticity – Seasonal Price



Source: Navigant Analysis

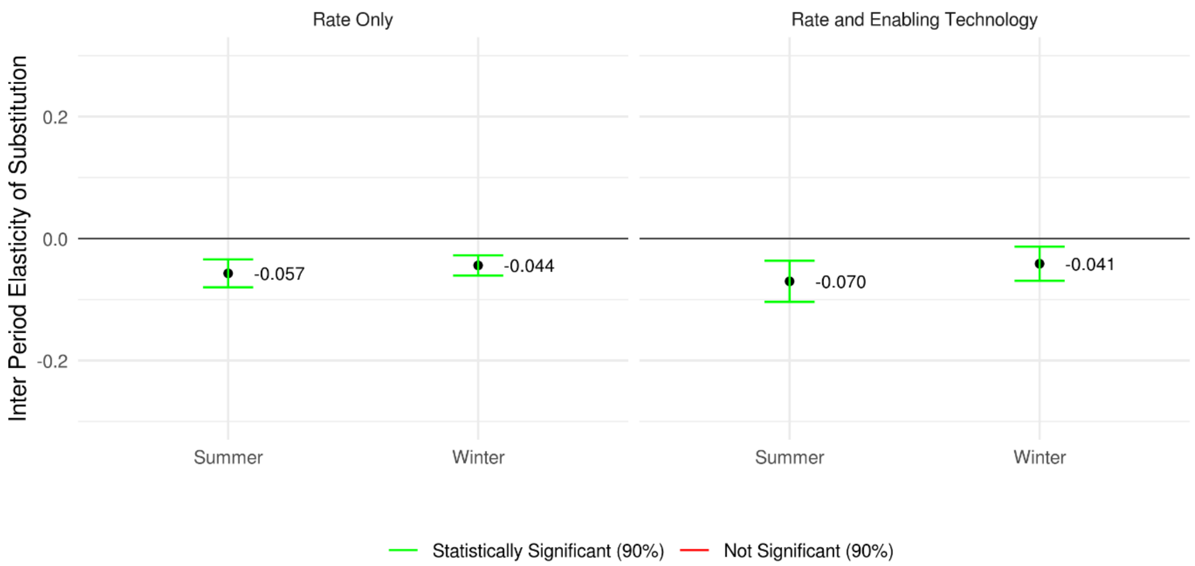
3.1.3.2 Inter Period Price Elasticity of Substitution

The on-peak to off-peak price elasticity of substitution is higher for the ESQ pricing scheme in comparison to the Seasonal pricing scheme and are also statistically significant. The Seasonal price elasticities are not statistically different from zero and have wider confidence bands. This result is not surprising given that the on-peak to off-peak price differentials are higher for the ESQ pricing scheme as compared to the Seasonal pricing scheme. The summer elasticities are slightly higher than the winter elasticities in general which could be due to electric space heating loads that are relatively inelastic.

In general, the magnitude of the on-peak to off-peak price elasticity of substitution is small. A one-hundred percent increase in the ratio of the on-peak to off-peak price would result in a shift in electricity consumption of at most seven percent. This result is consistent with the small and highly uncertain energy impact findings presented in section 3.1.1 and 3.1.2 for the ESQ and Seasonal pricing schemes respectively.. The statistically significant ESQ inter-period elasticities would suggest the presence of some load shifting but the magnitude is too small to obtain a robust impact estimate.

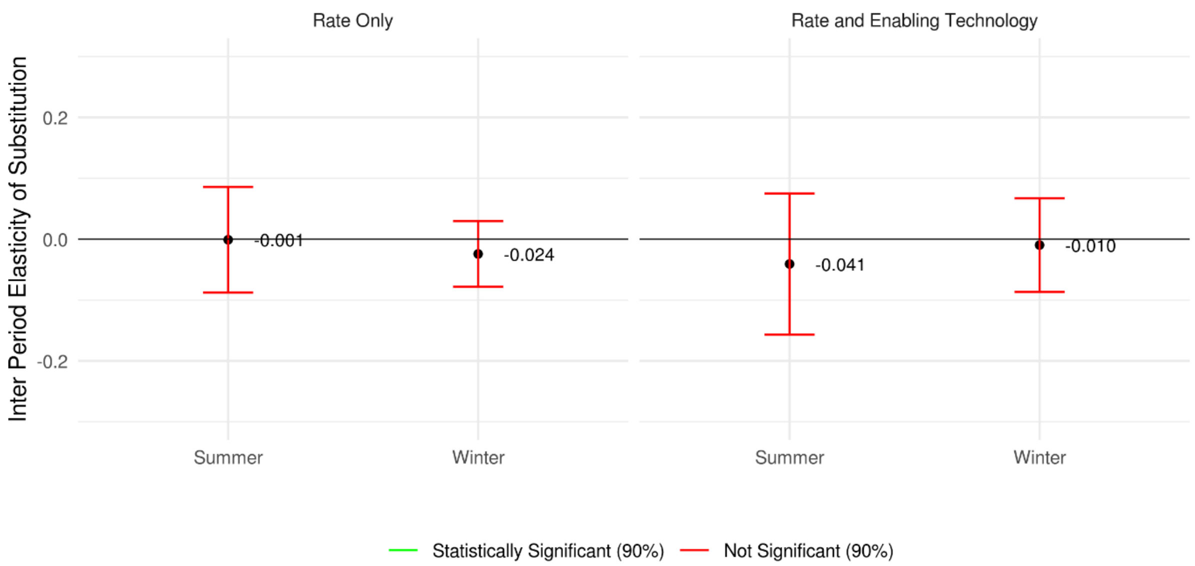
In summary, we can expect more shifting of consumption from the on-peak to the off-peak periods under the ESQ pricing scheme as compared to the Seasonal pricing scheme as the elasticities of substitution are higher and statistically significant.

Figure 29. Inter-Period Elasticity of Substitution – ESQ Price



Source: Navigant Analysis

Figure 30. Inter-Period Elasticity of Substitution – Seasonal Price



Source: Navigant Analysis

3.1.4 Revenue Adequacy

As part of the Regulated Price Plan, prices charged recover the costs of consumption over time meaning that the rates were designed to be revenue neutral. Revenue neutrality means that the rates charged under each price plan are revenue neutral assuming no behavioural response from participants.

To assess the revenue adequacy requirement of each pricing scheme, Navigant compared the aggregate consumption volumes in the pilot period and revenues associated with the each of the treatment groups for each LDC. For the purpose of this analysis, data was restricted to the participants and their matched controls. The revenue adequacy analysis is based only on the commodity cost, the TOU price, and does not incorporate any other charges such as regulator, transmission and distribution and taxes.

Table 21 and Table 22 show the revenue adequacy results for the ESQ and Seasonal pricing schemes respectively. The difference between the revenue that would have been collected under the standard TOU pricing scheme (status-quo) is about the same as what was collected under the pilot pricing schemes. The average revenue differential for the ESQ and seasonal pricing scheme is less than three-fourths of a percent and zero percent respectively.

Table 21. Revenue Adequacy – ESQ Price

Local Distribution Company	Treatment	$/kWh Status Quo	$/kWh ESQ	Change
Greater Sudbury Hydro	Rate Only	$0.081	$0.081	-0.71%
	Rate and Enabling Technology	$0.081	$0.080	-0.85%
	Control Group	$0.083	$0.084	1.51%
North Bay Hydro Distribution Ltd.	Rate Only	$0.082	$0.082	0.51%
	Rate and Enabling Technology	$0.082	$0.083	0.79%
	Control Group	$0.083	$0.084	1.48%
PUC Services Inc.	Rate Only	$0.082	$0.083	1.11%
	Rate and Enabling Technology	$0.082	$0.082	0.53%
	Control Group	$0.083	$0.084	1.62%

Source: Navigant Analysis

Table 22. Revenue Adequacy – Seasonal Price

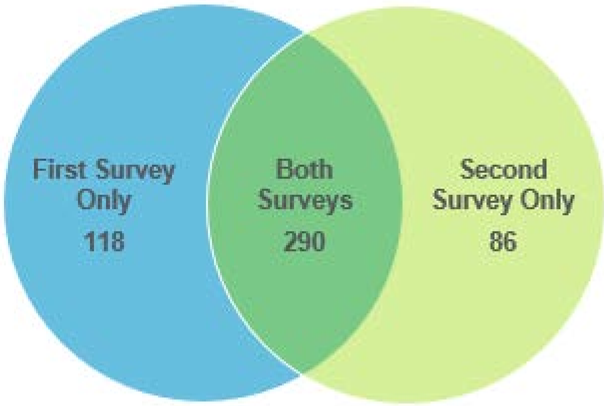
Local Distribution Company	Treatment	$/kWh Status Quo	$/kWh ESQ	Change
Northern Ontario Wires	Rate Only	$0.083	$0.083	-0.09%
	Rate and Enabling Technology	$0.082	$0.082	0.13%
	Control Group	$0.083	$0.083	-0.34%
Newmarket-Tay Power Distribution Ltd.	Rate Only	$0.082	$0.082	0.01%
	Rate and Enabling Technology	$0.082	$0.083	0.20%
	Control Group	$0.083	$0.083	0.11%

Source: Navigant Analysis

3.2 Process Evaluation Results

Navigant conducted two surveys throughout the pilot, one pre-pilot and one post-pilot. Navigant received 408 and 376 complete responses respectively, with 290 participating in both surveys, see Figure 31. Navigant also conducted interviews with each of the participating LDCs as well as with CustomerFirst staff, discussed below.

Figure 31. Survey Responses



Source: Navigant Analysis

Table 23 illustrates the total number of pilot participants and the response rates for both surveys for each utility. The response rates were higher than anticipated and are sufficient to draw reliable conclusions. Differing response rates across surveys are inevitable but as can be seen from Figure 31, there is a good overlap between the two surveys. Hence, this section is mainly focused on the results of the final survey and presents key pieces from the first survey as appropriate. The overlap between the two surveys is important since certain questions aim to track changes in behaviour before and after the pilot.

Table 23. Survey Response Rate

Local Distribution Company	Number of Participants	Completed First Survey	First Survey Response Rate	Completed Second Survey	Second Survey Response Rate
Greater Sudbury Hydro	255	91	36%	76	32%
North Bay Hydro Distribution Ltd.	158	78	49%	133	33%
PUC Services Inc.	209	86	41%	71	47%
Northern Ontario Wires	65	26	40%	24	39%
Newmarket-Tay Power Distribution Ltd.	404	127	31%	72	36%
All	**1091**	**408**	**37%**	**376**	**34%**

Source: Navigant Analysis

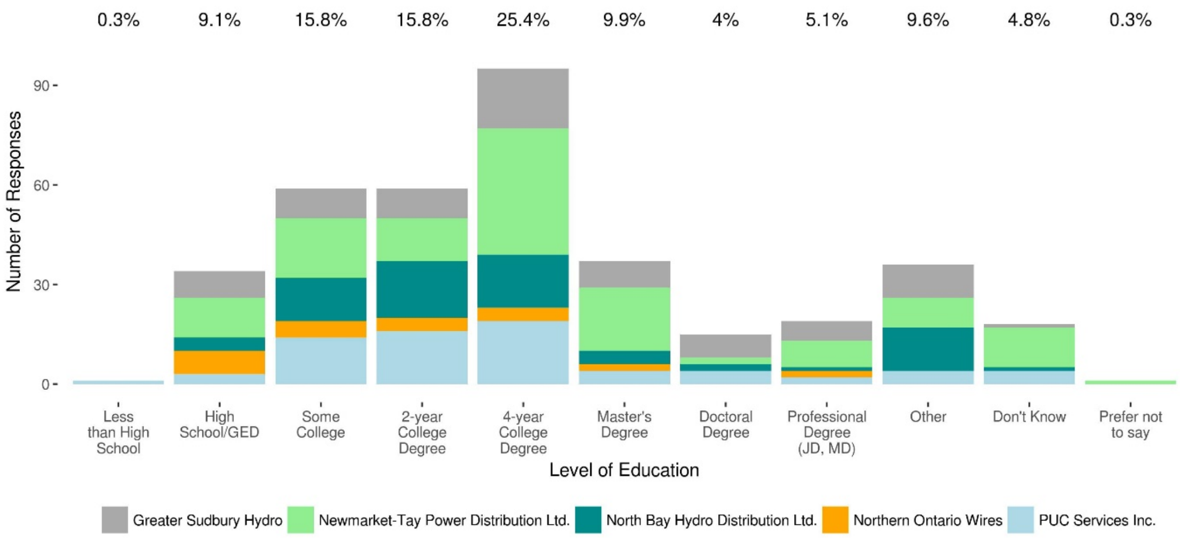
3.2.1 Participant Demographics and Characteristics

Various participant demographics were collected from participant surveys. The results shown below are drawn from the second survey but are consistent with what was seen in the first survey. This is expected given the large overlap between the two surveys. Navigant identified the following statistics:

- There are approximately 2.9[48] people per household across all utilities.
- Nineteen percent[49] of all homes were identified with an annual household income of less than $50,000.[50]
- The average age of survey respondents was in the range of forty-five to fifty-four years old.

The most common education level identified was a 4-year College Degree with twenty six percent of the survey population at this level. The distribution of education levels can be further explored in Figure 32 below. Of those with an annual income under $50,000, a higher proportion have a high school degree or attended some college rather than having obtained a four year or master's degree.

Figure 32. Education Level



Source: Navigant Analysis

Those working, both full and part time, as well as those going to school represent fifty two percent[51] of respondents. Comparatively, those who are at home all day, on account of being retired, working from home, or having dependents, represent forty-one percent[52] of respondents. Figure 33 shows a breakdown of the various occupation types per utility.

In general, those who are working from home could potentially have less opportunity to shift their consumption from the on or mid-peak periods to the off-peak period since they are likely in the home during on-peak and mid-peak periods; for example they may not be able to turn off the lights or adjust their thermostat settings as much as those who would leave the house.

[48] This compares to 2.5 people per household in the first survey.

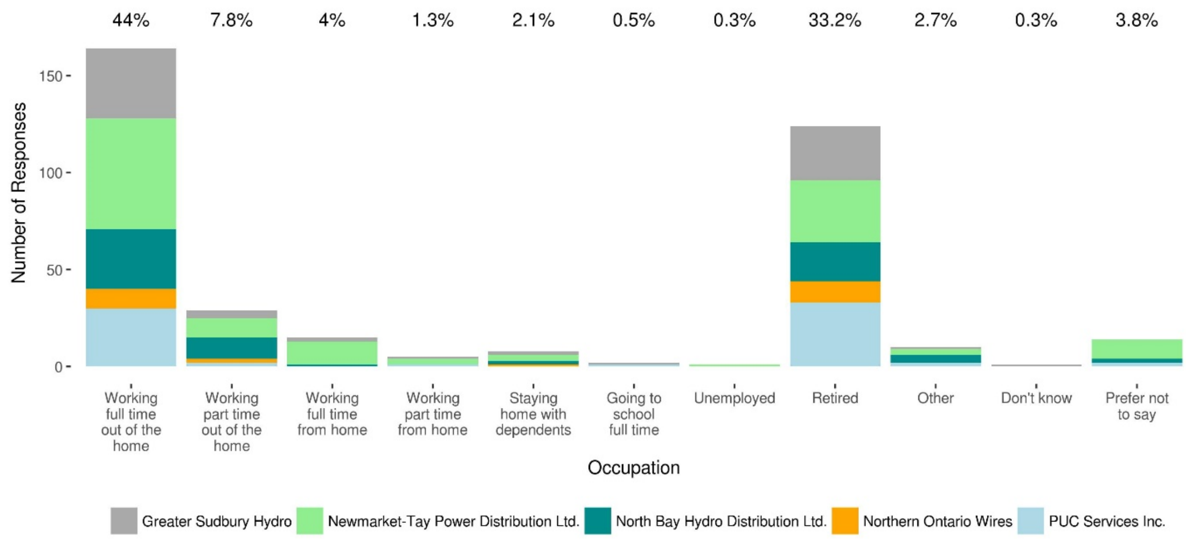
[49] Compared to twenty six percent in the first survey.

[50] Statistics Canada defines low income as households with a pre-tax income of approximately CAD 50,000 for a household of four persons - https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/tab/t4_2-eng.cfm.

[51] Compared to fifty seven percent in the first survey.

[52] Compared to thirty seven percent in the first survey.

Figure 33. Occupation Types

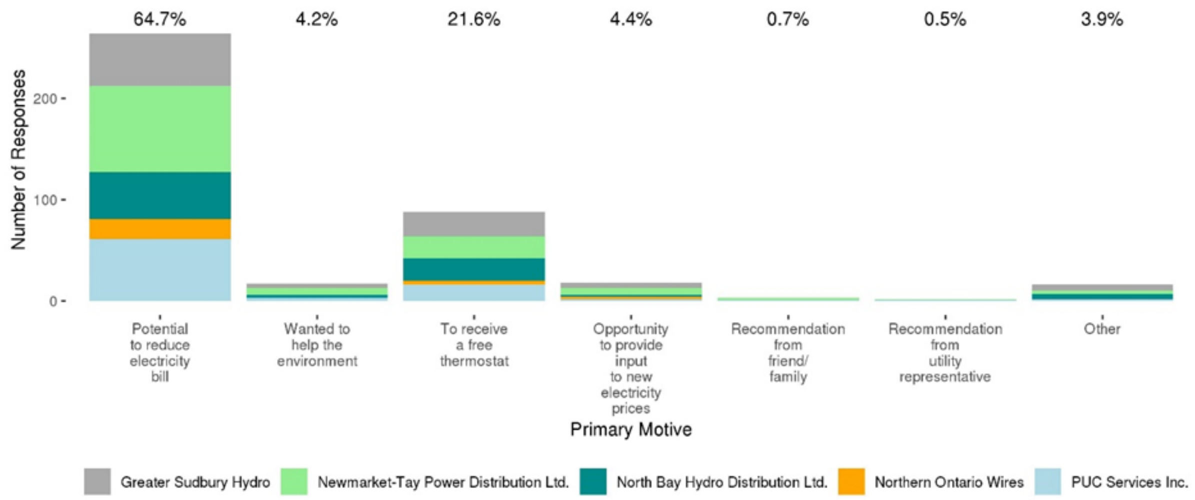


Source: Navigant Analysis

3.2.2 Participation Motives

Interviews with LDCs and CustomerFirst staff revealed that prior to enrolling in the pilot, some customers enquired whether the pilot prices would be beneficial to them given their historical bills and system types. The participation motives were only asked as part of the first survey and hence the results presented in this section are from the first survey. Overall, sixty-five percent of respondents indicated that their primary motivation to participate in the pilot was to reduce their electricity bill[53], while twenty-two percent wanted to receive a free thermostat. The distribution of primary participant motives can be seen in Figure 34. It should be noted that some respondents specified “All of the above” in the “Other: please describe” category.

Figure 34. Primary Motives for Participation

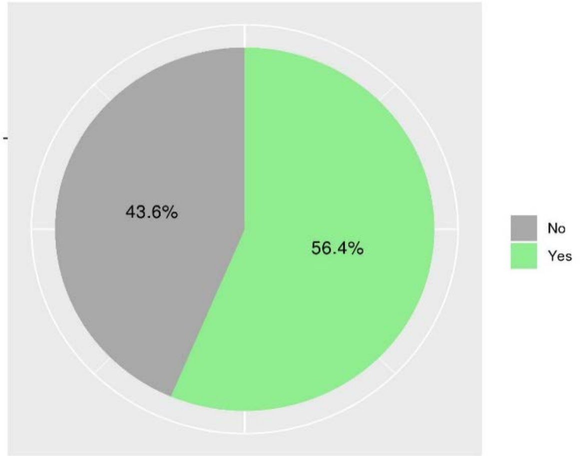


Source: Navigant Analysis

[53] CustomerFirst developed a bill calculator that was provided upon request and allowed potential participants to see what their potential bill impacts could be depending on the level of consumption they shift.

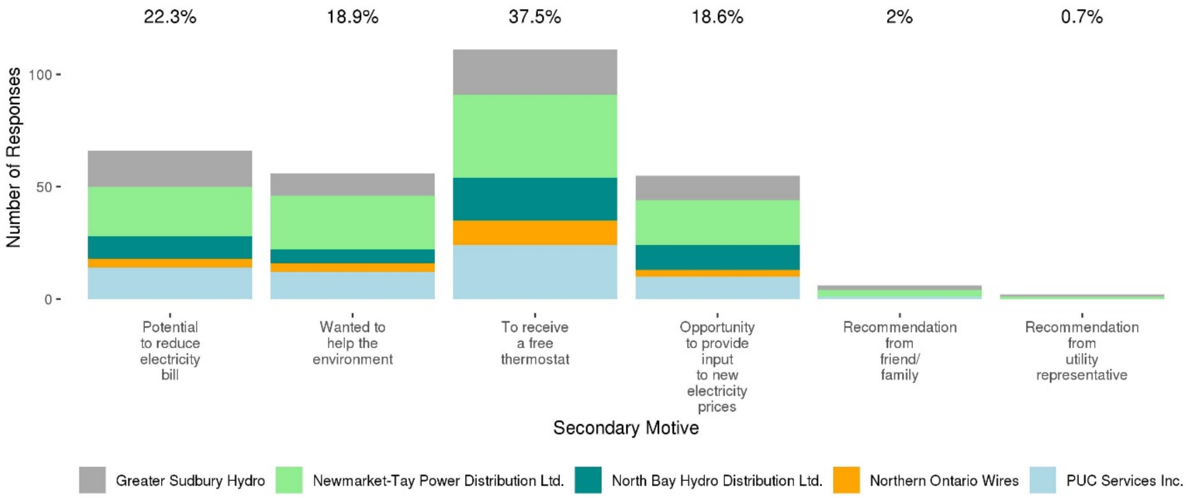
Over half of all respondents indicated that they had a secondary motive for participation as seen in Figure 35. The distribution of secondary motives for participation varied a little more than the primary motive, with thirty-seven percent enrolling to receive a free thermostat and the rest evenly distributed between reducing electricity bills, helping the environment, and providing input to new electricity prices. Secondary motives can be further explored in Figure 36.

Figure 35. Secondary Motive for Participation



Source: Navigant Analysis

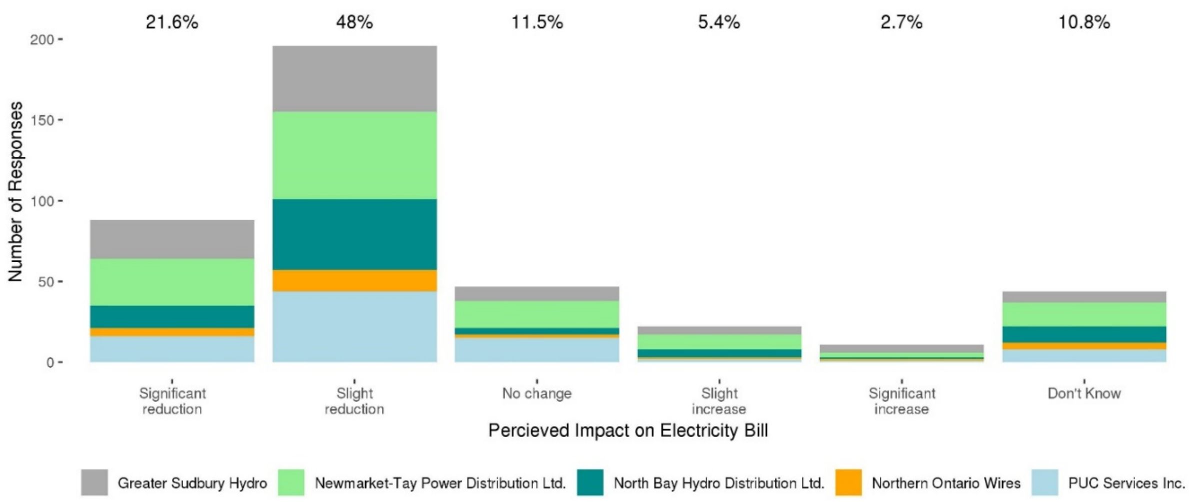
Figure 36. Secondary Motives for Participation



Source: Navigant Analysis

Consistent with respondent motives to reduce electricity bills, most respondents believed the pilot would help them achieve this goal. Over seventy percent of respondents believed they would see a decrease, eight percent believed they would see an increase, eleven percent believed it would not have any effect, while the rest are uncertain of the impacts on their bills, see Figure 37.

Figure 37. Perceived Impact on Electricity Bill



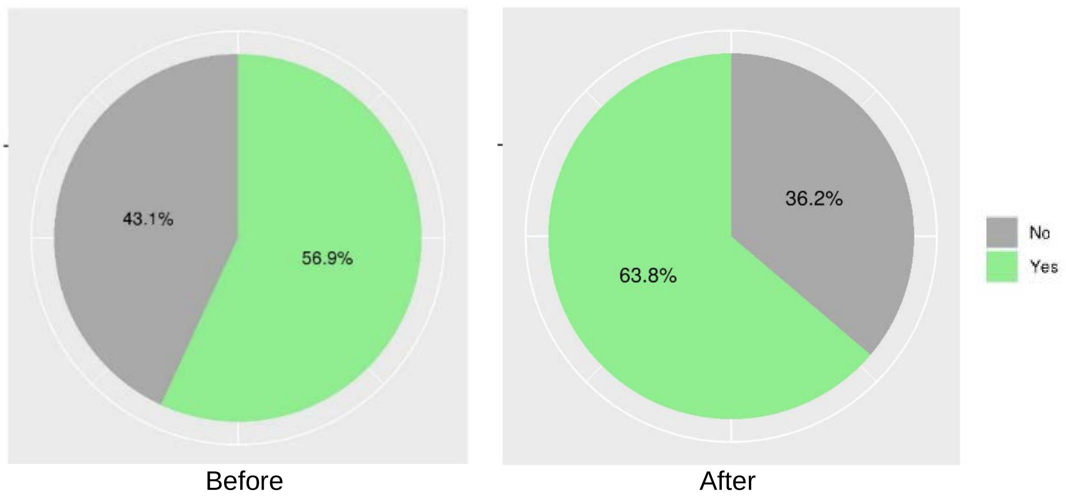
Source: Navigant Analysis

3.2.3 Behavioural Changes

Respondents were asked whether prior to signing up for the TOU pilot, they were aware of existing TOU prices in Ontario. Over half of the respondents were aware of the existing TOU prices in Ontario before the RPP pilot, as observed in Figure 38. After completing the pilot program over sixty percent of respondents became aware of TOU prices. However, LDC program managers indicated that some participants were unaware that their prices would be changing over the course of the day even after they enrolled in the pilot. After being educated on the price structures these participants decided to opt out of the pilot.

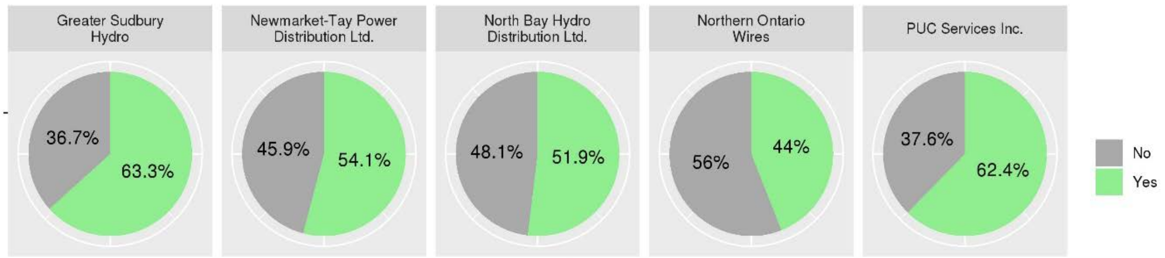
A breakdown of awareness of TOU rates before and after the pilot by utility can be seen in Figure 39 and Figure 40 respectively. It can be seen that for every utility except PUC Services there was an increase in awareness of TOU rates. There was a significant increase in awareness from forty-four percent to eighty-six percent in respondents from Northern Ontario Wires.

Figure 38. Awareness of TOU Rates Before and After RPP Pilot



Source: Navigant Analysis

Figure 39. Awareness of TOU Rates Before Pilot by Utility



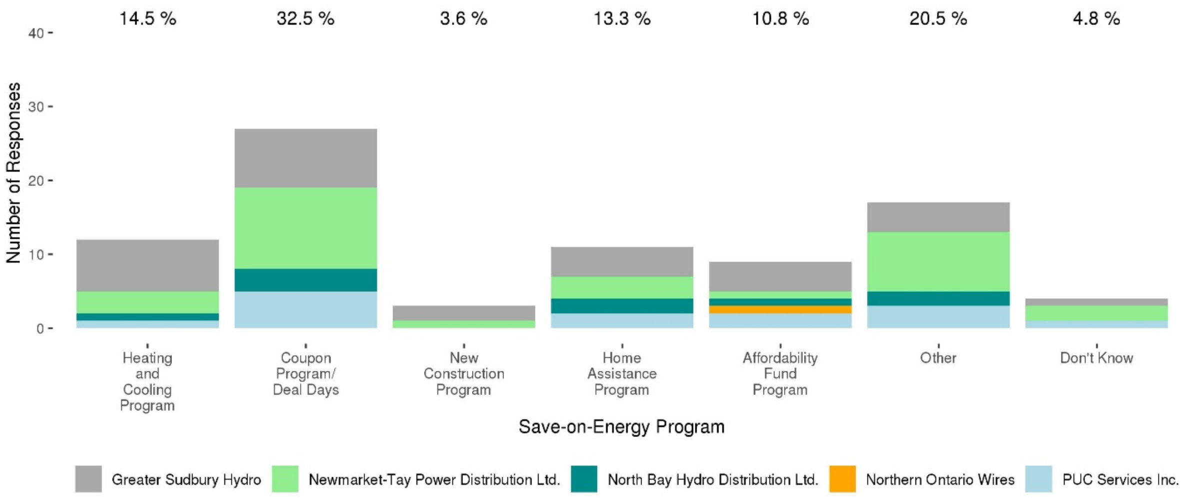
Source: Navigant Analysis

Figure 40. Awareness of TOU Rates After Pilot by Utility

Source: Navigant Analysis

Overall, seventeen percent of all survey respondents have participated in other Save-on-Energy programs before the RPP pilot. The most common program was the "Save-on-Energy Coupon Program" also known as "Deal Days", see Figure 41.

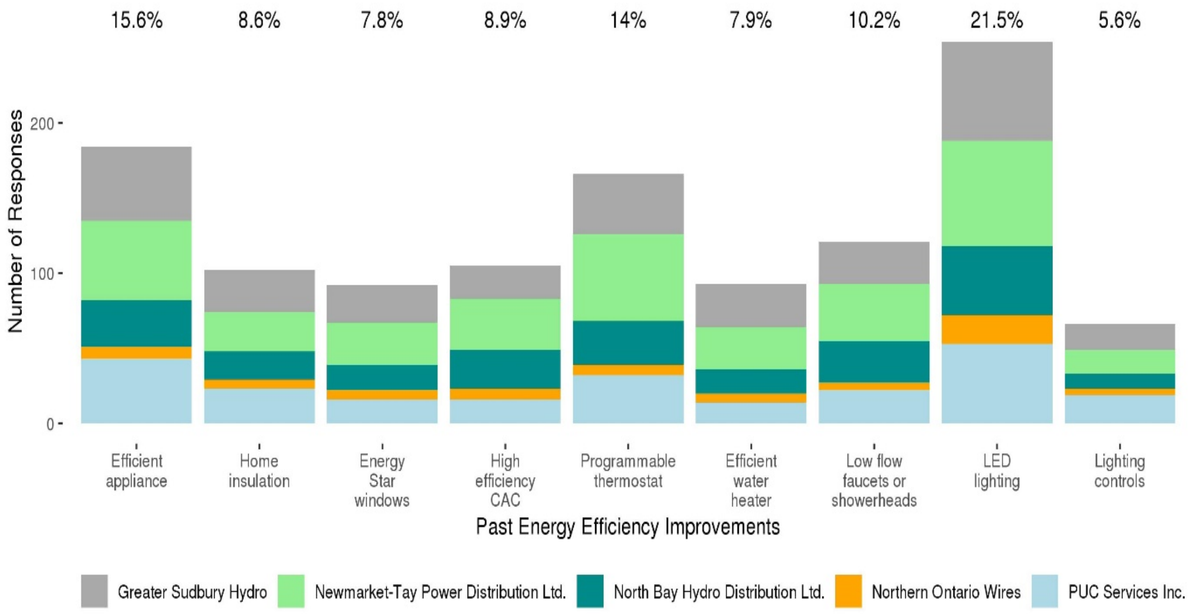
Figure 41. Participation in Save-on-Energy Programs Before RPP pilot



Source: Navigant Analysis

Before the RPP pilot, seventy-nine percent of survey respondents installed energy efficient equipment or made energy efficiency improvements. The most common changes include installing LED lighting, efficient appliances and programmable thermostats with many customers making multiple improvements, see Figure 42.

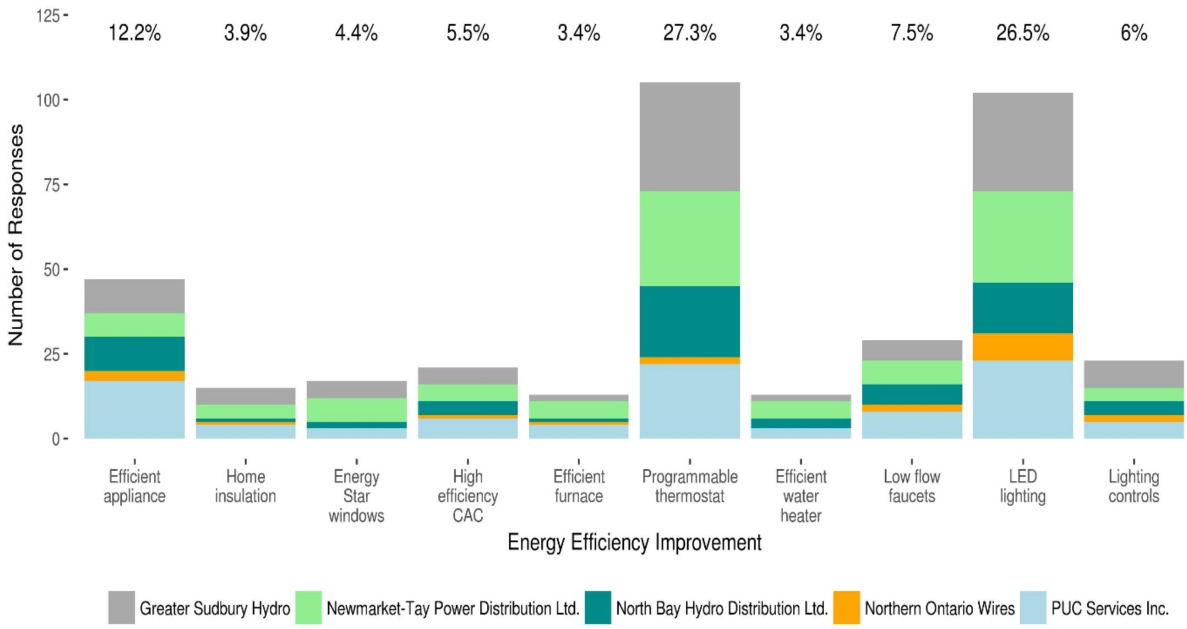
Figure 42. Energy Efficiency Improvements Made Before Pilot



Source: Navigant Analysis

At the end of the pilot in the final survey, participants were again asked about energy efficiency improvements they implemented over the course of the pilot period. During the course of the RPP pilot, forty-five percent of survey respondents reported making energy efficiency improvements. Similar to the pre-pilot improvements, the most common changes include installing LED lighting, efficient appliances and programmable thermostats with many customers making multiple improvements, see Figure 43.

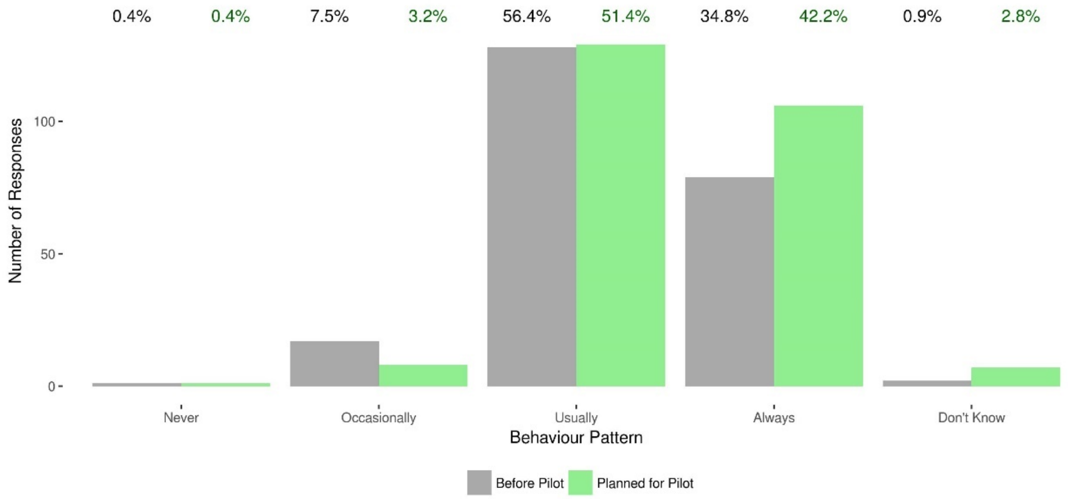
Figure 43. Pilot Period Energy Efficiency Improvements



Source: Navigant Analysis

In the first survey, at the start of the pilot, participants were asked how often they shifted or planned to shift their electricity consumption behaviour to mid or off-peak times before and during the RPP pilot respectively. Ninety-one percent of respondents said that prior to the pilot, they shifted their consumption patterns in varying degrees. Ninety-four percent of respondents said that they plan to shift their electricity consumption during the pilot, see Figure 44. A key observation from these responses is the seven percent increase in respondents who, now that they are enrolled in the pilot, said they plan to "always" shift their consumption when compared to their pre-pilot behaviour.

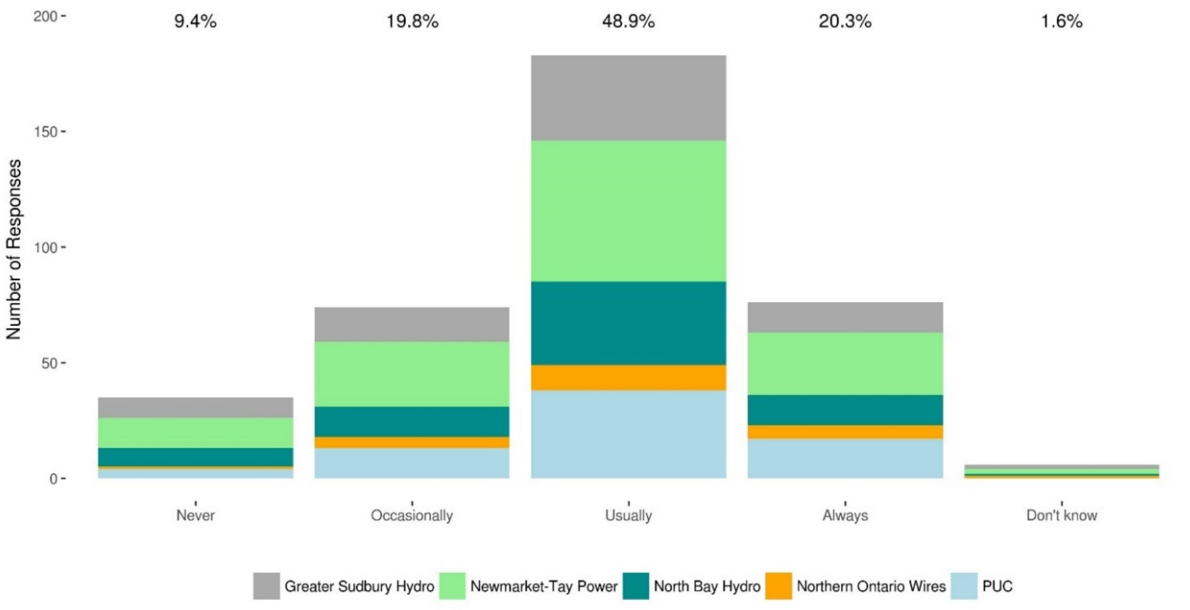
Figure 44. Frequency of Electricity Consumption Behavioural Changes Planned for Pilot Period



Source: Navigant Analysis

At the end of the pilot, in the final survey, forty-nine percent of respondents stated they usually changed their behaviour and twenty percent of respondents always changed their behaviour. This differs from participants' responses gathered in the first survey where a larger proportion, forty-two percent, indicated that they planned to 'always' shift their behaviour compared to twenty percent in the final survey that actually changed their behaviour "always". The frequency of pilot period behaviour changes can be seen in Figure 45.

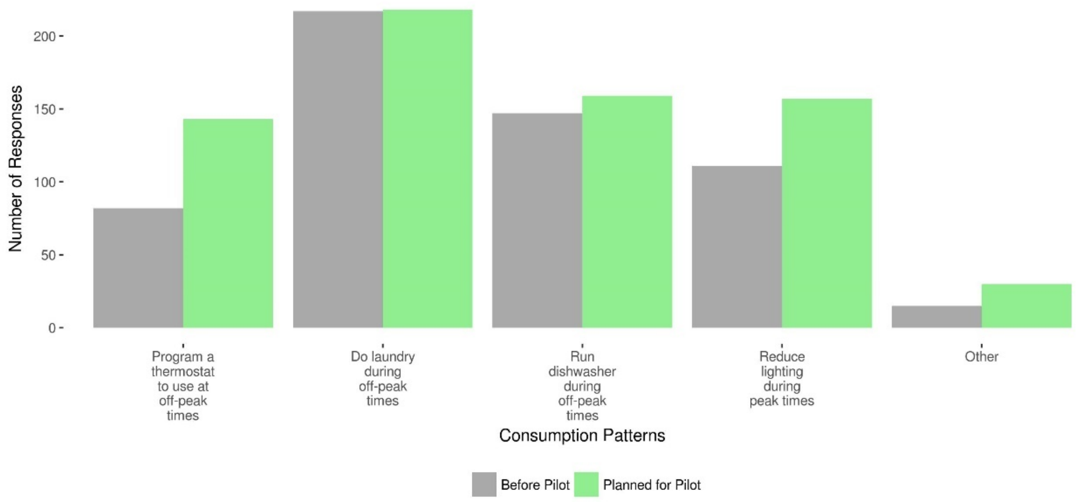
Figure 45. Frequency of Electricity Consumption Behaviour Changes During the Pilot



Source: Navigant Analysis

Common planned behavioural shifts included doing laundry and running the dishwasher during off-peak times, as well as reducing lighting during on-peak times. The changes in behaviour that respondents planned to implement throughout the pilot can be seen in Figure 46. These results are drawn from two questions included in the first survey, one asking about their prior behaviours, and the other asking about what they planned to do throughout the pilot. It should be noted that the largest increase is observed in programing a thermostat to automatically shift consumption to off-peak periods.

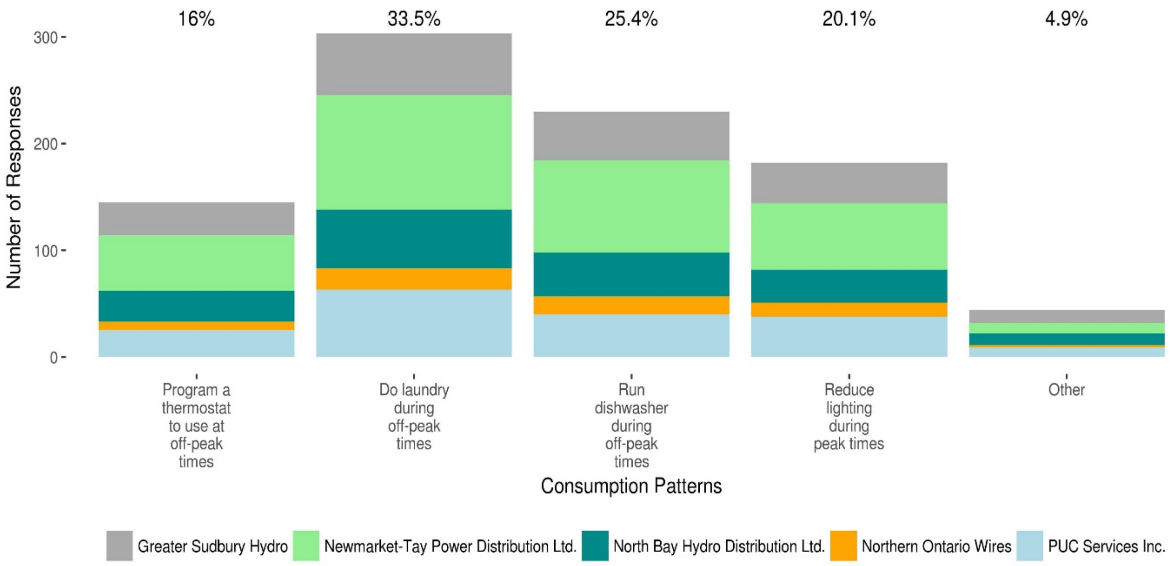
Figure 46. Change in Consumption Patterns Before and Planned for Pilot



Source: Navigant Analysis

During the pilot, respondents' planned changes in behaviour did occur. Similar to the values in Figure 46, sixteen percent programmed a thermostat, thirty-three percent did laundry at off-peak times, twenty-five percent ran the dishwasher at off-peak times, and twenty percent reduced their lighting during on-peak times. Their changes in behaviour during the pilot can be seen in Figure 47.

Figure 47. Change in Consumption Patterns During the Pilot



Source: Navigant Analysis

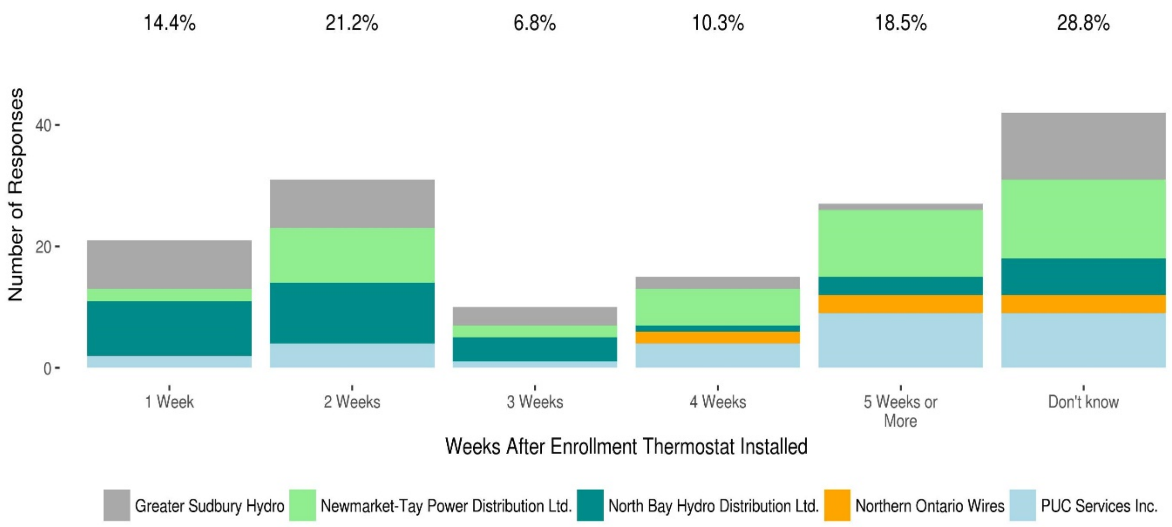
3.2.3.1 Enabling Technology

In the second survey, respondents in the rate and enabling technology group were asked additional questions as they had received a thermostat at the start of the pilot.

All participants of the pilot received the same smart thermostat.[54] Of the respondents that received a smart thermostat, approximately thirty-six percent of thermostats were installed within two weeks of enrollment, however approximately thirty percent of respondents waited a month or more before their thermostat was installed. A breakdown of when participants installed their thermostat is shown in Figure 48.

[54] The models were specific to whether the customers had electric or gas heating.

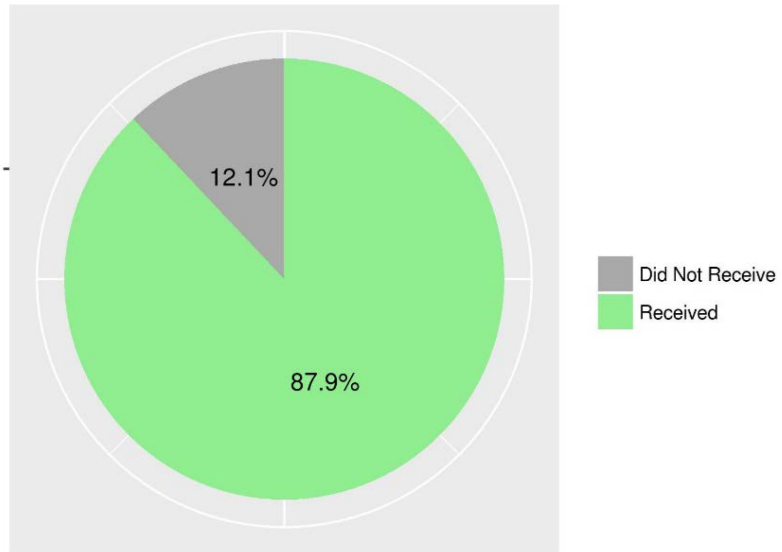
Figure 48. Duration to Complete Thermostat Installation



Source: Navigant Analysis

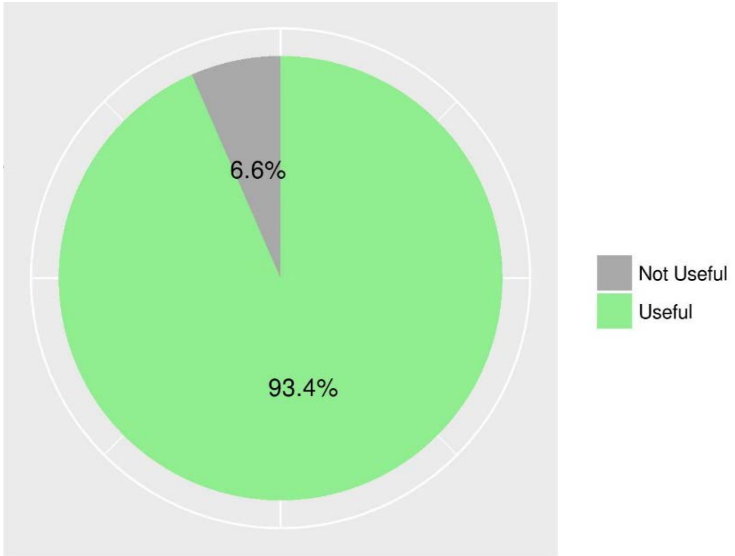
Approximately eighty-eight percent of respondents received instructions on how to program and/or use their new thermostat. The breakdown of those that received instructions can be seen in Figure 49. Of those that received instructions, ninety-three percent found them helpful, see Figure 50. Of the twelve percent that did not receive instructions, sixty percent would have valued receiving them, see Figure 51.

Figure 49. Received Instructions for Smart Thermostat



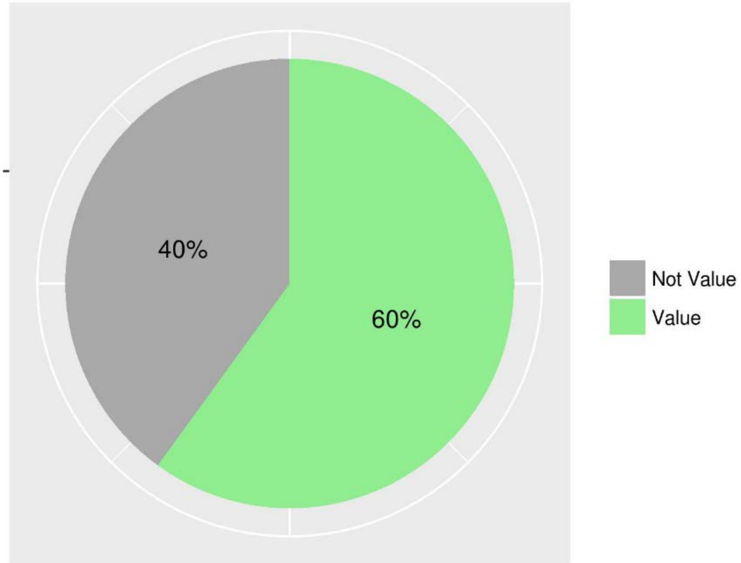
Source: Navigant Analysis

Figure 50. Found Instructions Useful



Source: Navigant Analysis

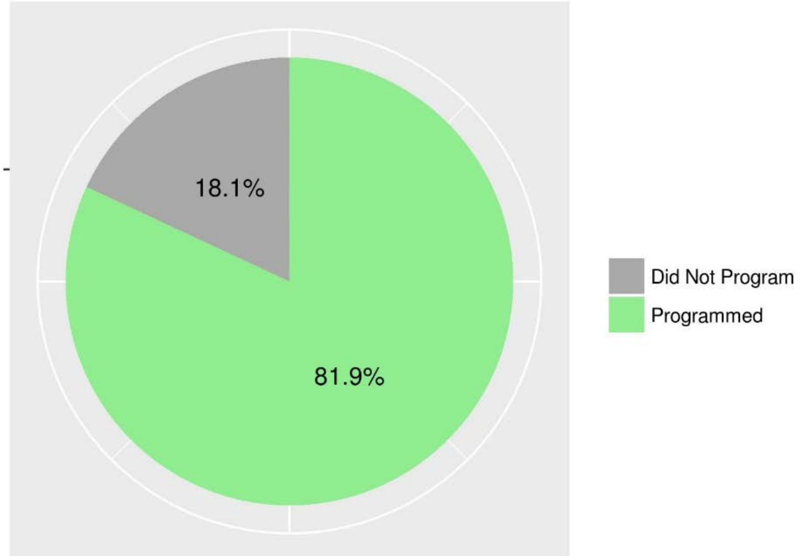
Figure 51. Would Have Valued Instructions



Source: Navigant Analysis

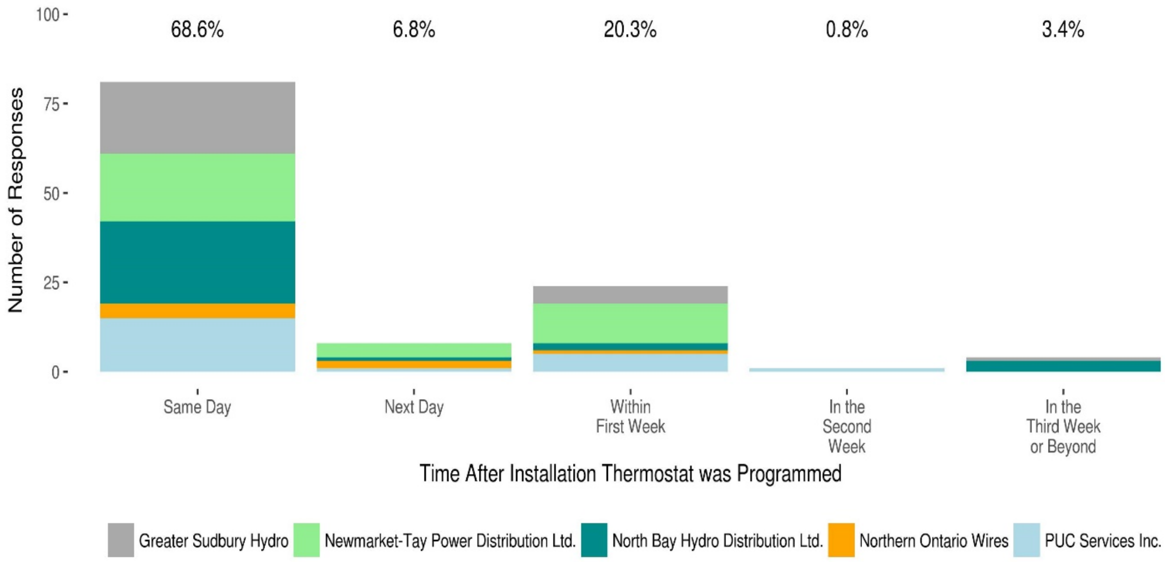
Approximately eighty-two percent of the survey respondents that received a thermostat programmed it, see Figure 52. Sixty nine percent of respondents programmed their thermostat on the same day it was installed, while seven percent did so the next day and twenty percent within the first week, see Figure 53.

Figure 52. Programmed Thermostat



Source: Navigant Analysis

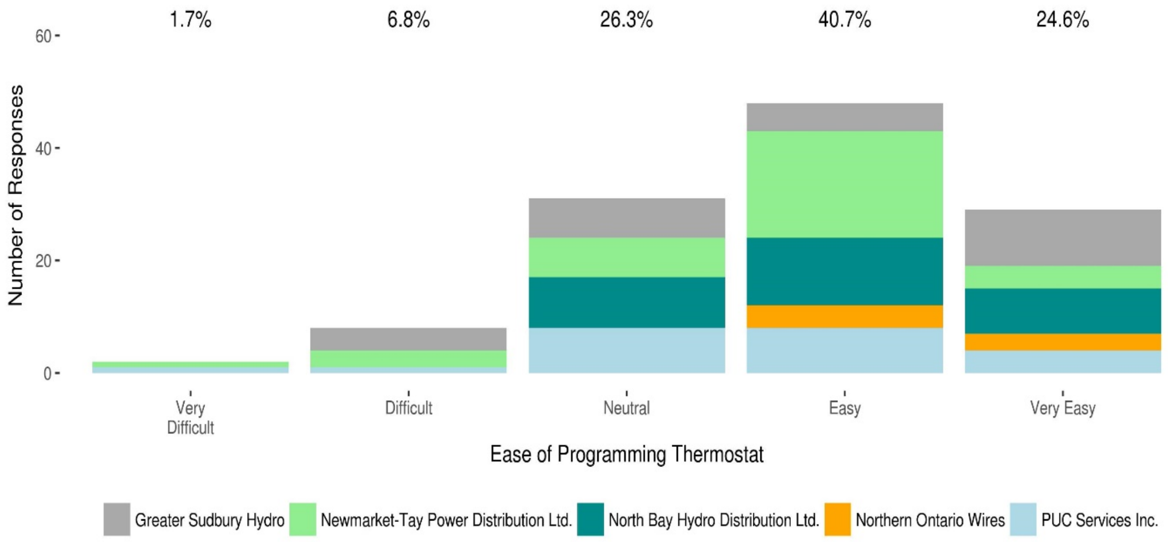
Figure 53. Time Taken to Program Thermostat



Source: Navigant Analysis

Approximately fifty-five percent of respondents stated that their thermostats were either easy or very easy to program. A breakdown of the difficulty level of programming the smart thermostat can be seen in Figure 54.

Figure 54. Ease of Programming Thermostat

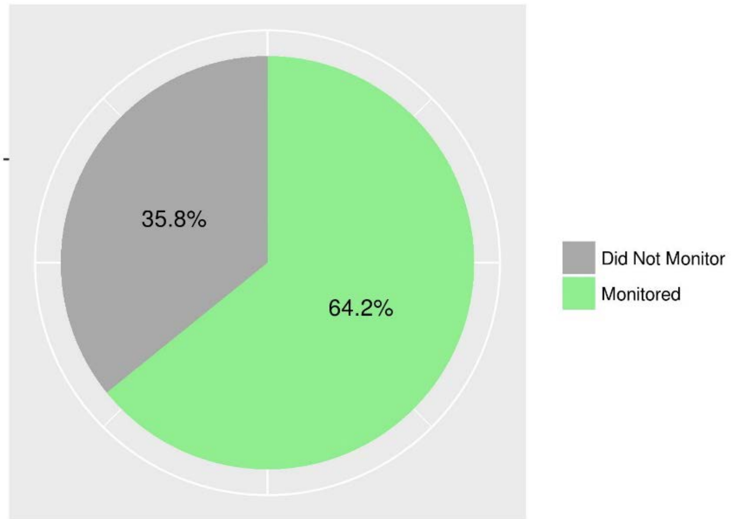


Source: Navigant Analysis

3.2.4 Bill Impacts

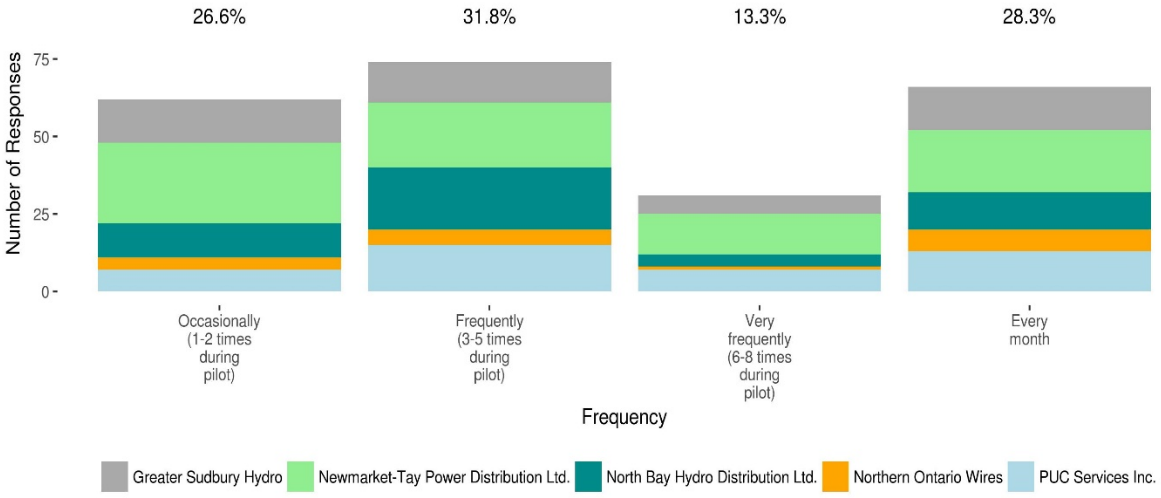
In the second survey, respondents were asked about their bill impacts. Approximately sixty-four percent of respondents monitored the impact of the new TOU prices on their electricity bill, see Figure 55. Most monitored them three to five times throughout the course of the pilot as seen in Figure 56.

Figure 55. Monitoring of Bill Impacts



Source: Navigant Analysis

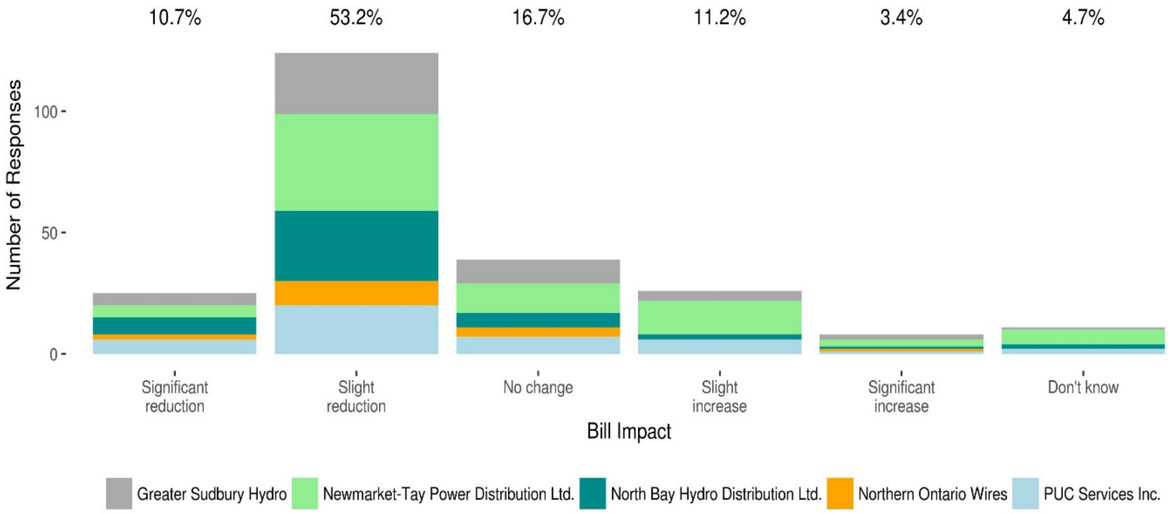
Figure 56. Frequency of Bill Monitoring



Source: Navigant Analysis

Of those that monitored their bills, just over half of the respondents noted a slight reduction in their electricity bill while ten percent noted a significant reduction. Approximately seventeen percent reported no change in their bills while fifteen percent reported a bill increase. A breakdown of respondents' bill impacts is shown in Figure 57.

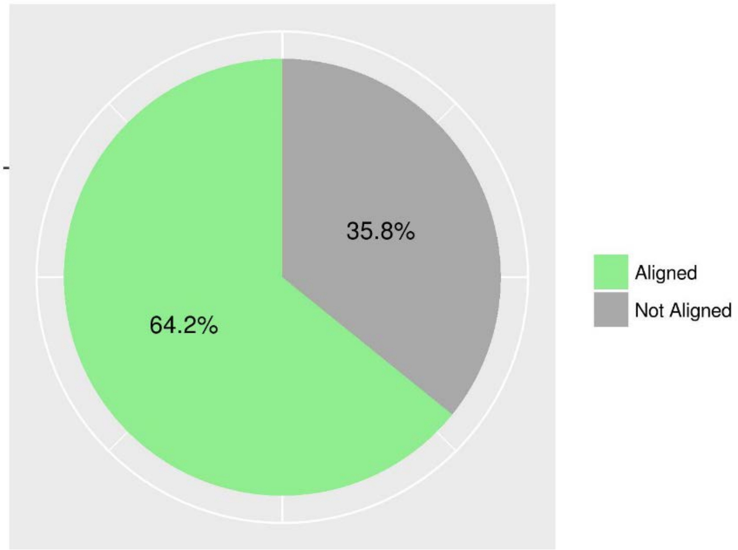
Figure 57. Bill Impacts



Source: Navigant Analysis

Most respondents stated that the bill impacts were aligned with their initial expectations when they enrolled in the pilot. A breakdown of whether the participant's initial expectations aligned with what they saw in their bill is shown in Figure 58.

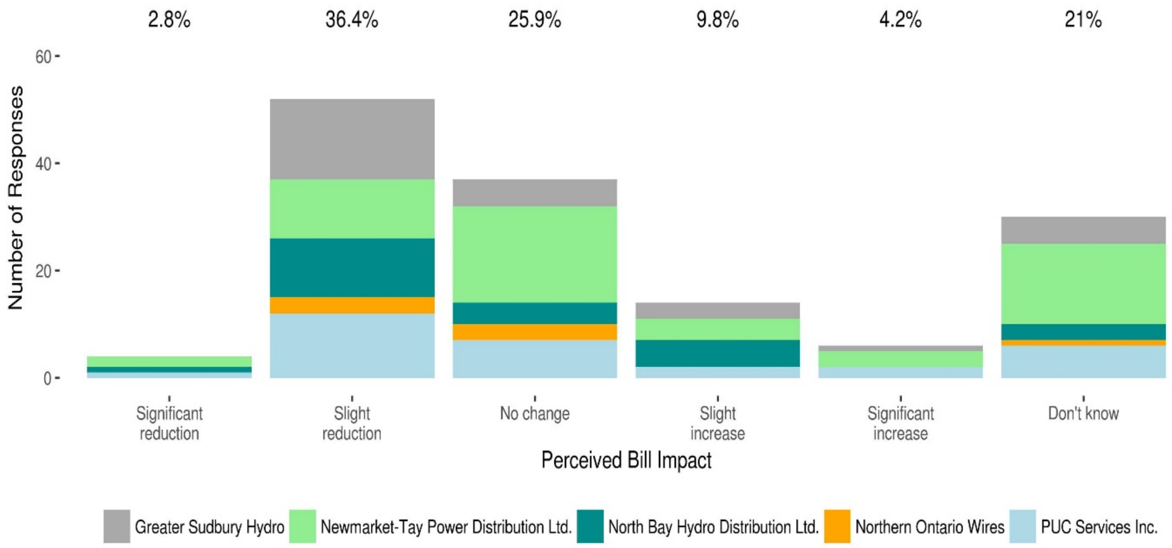
Figure 58. Bill Impact Expectations



Source: Navigant Analysis

Of the respondents that did not actively monitor their bills, approximately thirty-seven percent perceived that their bills saw a slight reduction, while twenty-six percent perceived no change and approximately fifteen percent perceived a bill increase. A breakdown of the perceived bill impacts is shown in Figure 59.

Figure 59. Perceived Bill Impacts

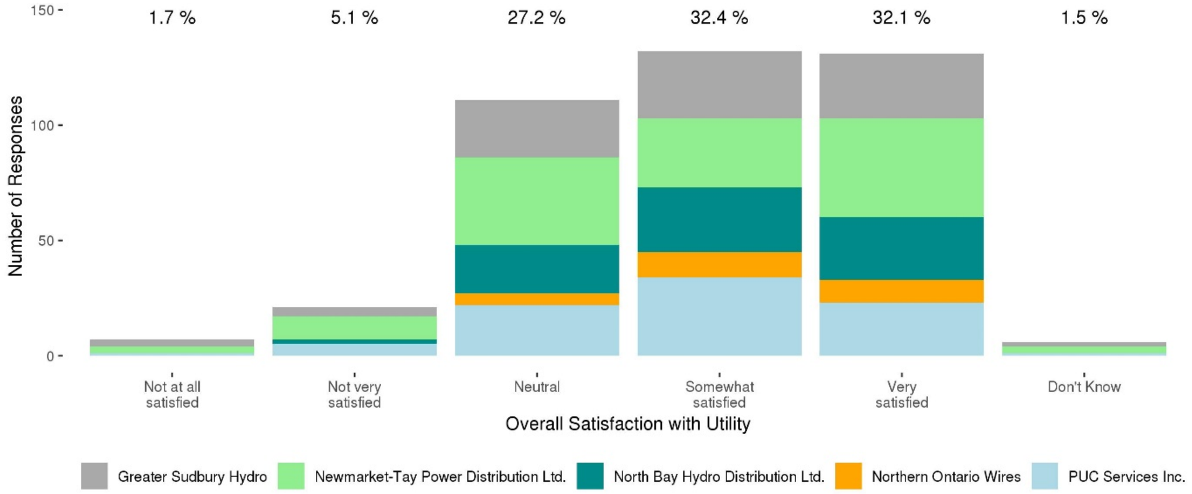


Source: Navigant Analysis

3.2.5 Customer Satisfaction

As part of the first survey, respondents were asked about their initial level of satisfaction with their utility. Figure 60 reveals that most respondents, over sixty percent, reported being satisfied with their utility overall while less than ten percent reported being unsatisfied.

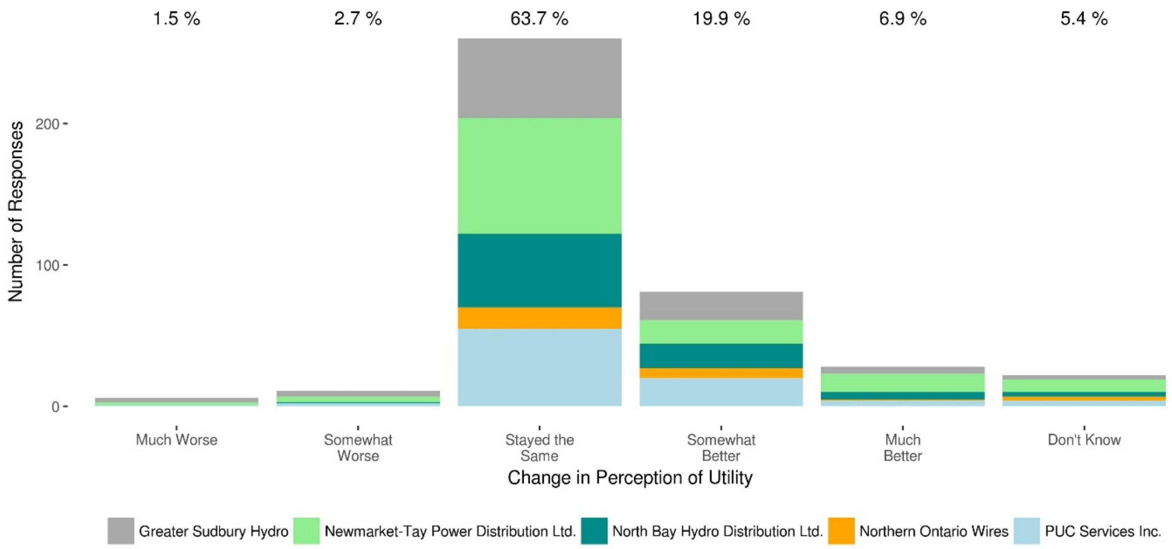
Figure 60 Initial Overall Respondent Satisfaction with Utility



Source: Navigant Analysis

Enrolling in the RPP pilot did not have significant impacts on customers' perception of their LDC. In the first survey, sixty-four percent of respondents reported no change in their perception of their utility, twenty percent of respondents reported their perception has become "somewhat better" and only four percent reported that their perception has been negatively affected as a result of the RPP pilot. Results by utility can be seen in Figure 61.

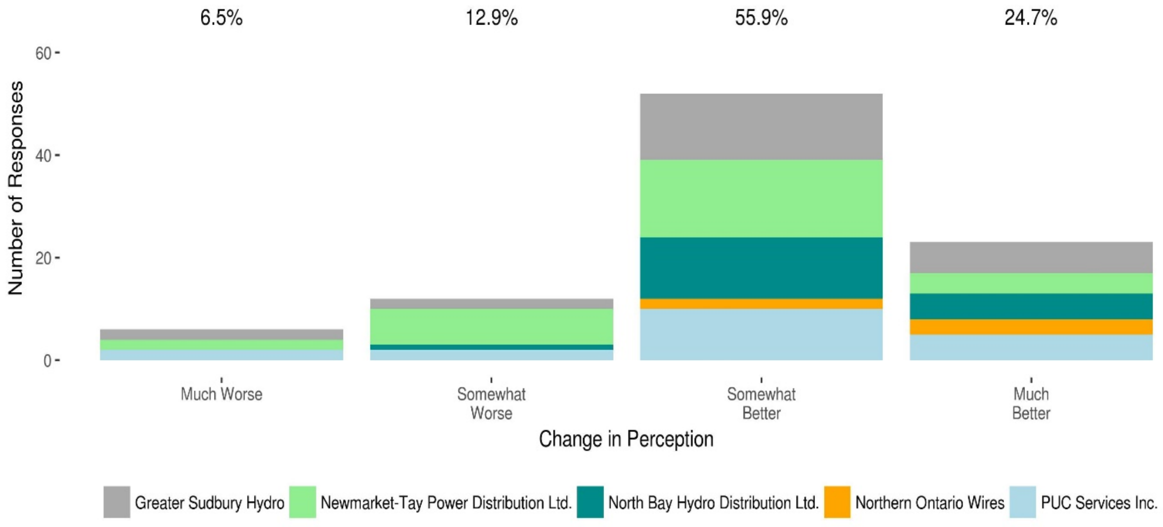
Figure 61. LDC Perception Post-Enrollment



Source: Navigant Analysis

In the second survey, approximately seventy percent of respondents reported no change in their perception of their utility. Of those that did report a change, fifty-six percent reported it was "somewhat better" and twenty-five percent reported it was "much better". A breakdown of their changes in perception can be seen in Figure 62.

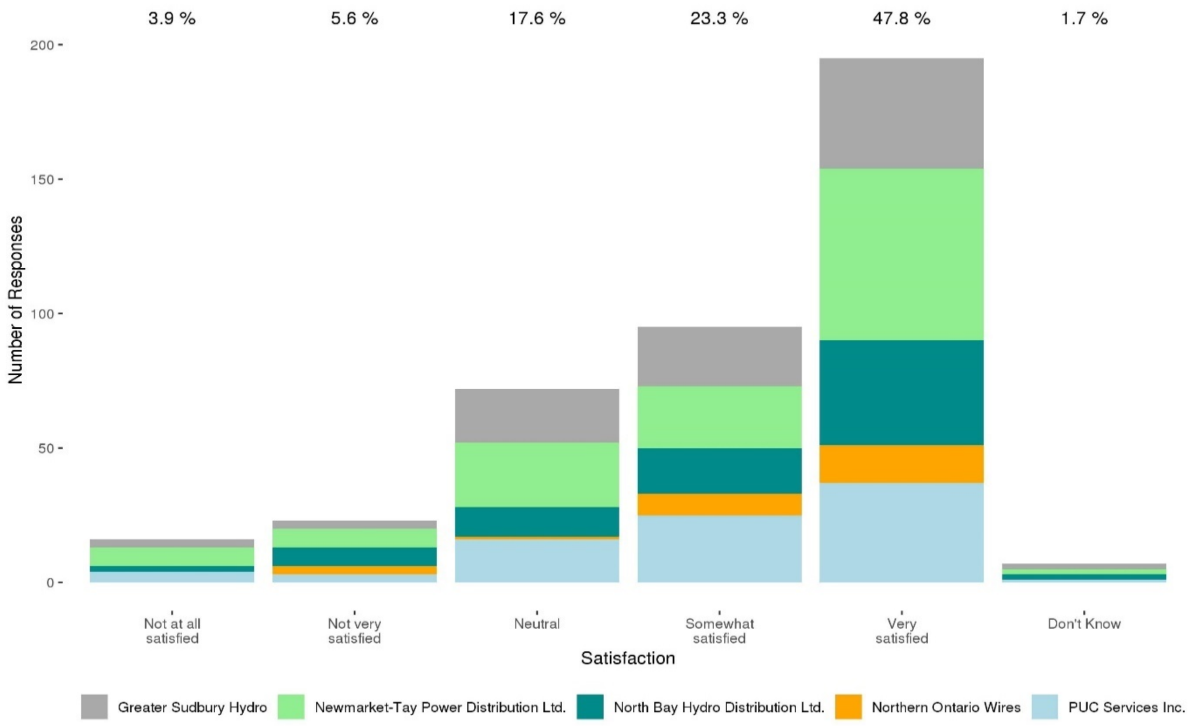
Figure 62. Change in Perception Post-Pilot



Source: Navigant Analysis

The registration or sign-up process required for the RPP pilot was well received by respondents. Seventy one percent of respondents were satisfied while only ten percent were not satisfied, and eighteen percent remained neutral as can be seen in Figure 63. The registration process was conducted by phone and LDC program managers reported that some customers experienced delays in call backs of up to four or five days. The LDC program managers also held the view that the registration window was quite narrow.

Figure 63. Registration Process Satisfaction

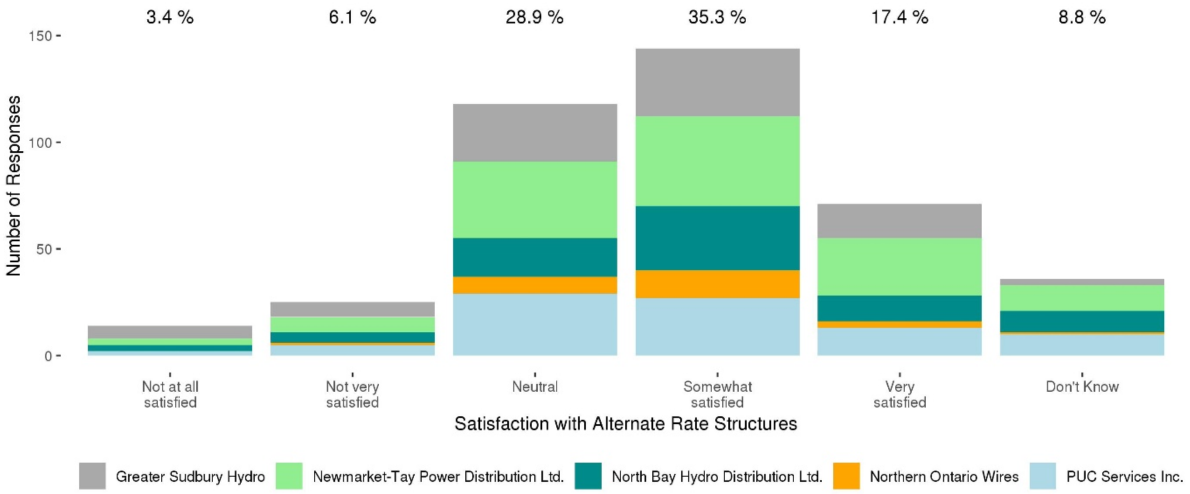


Source: Navigant Analysis

At the start of the pilot, respondents were asked what their initial perceptions of the pilot pricing schemes were and whether they were satisfied thus far with the offering. Initial impressions of the alternate price structures offered through the RPP pilot were received relatively well by respondents. Thirty-five percent reported being somewhat satisfied, seventeen percent being very satisfied and less than ten percent were unsatisfied as can be seen in Figure 64 .

However, LDC program managers believed that the incentives, namely the decrease in the off-peak price, did not offset the increase in on-peak and mid-peak prices. They believed the decreases were not significant enough to account for the risk of not shifting enough consumption to off-peak hours, thereby resulting in a higher bill. However, it is important to note that the response to the pricing scheme is what the pilot is designed to test.

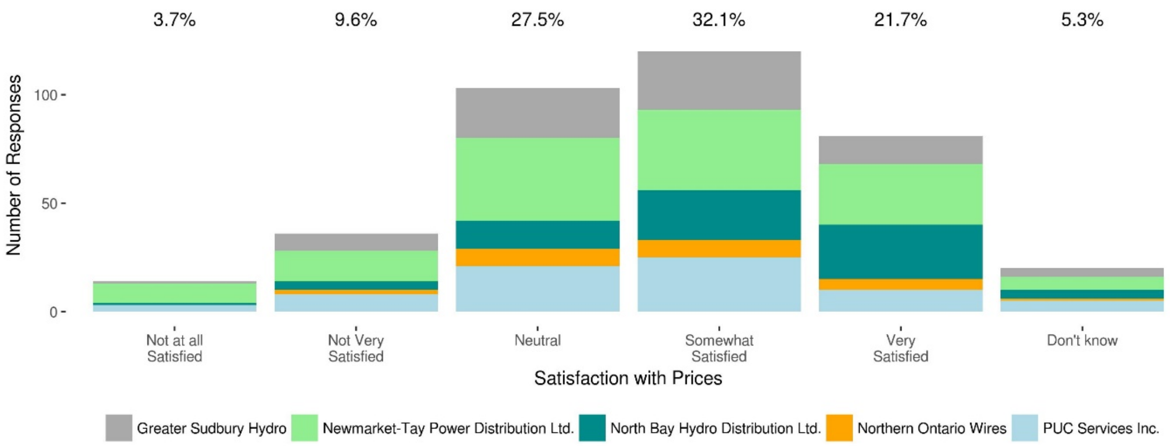
Figure 64. Initial Perception of Alternate Rate Structures



Source: Navigant Analysis

In the second survey respondents were asked about their satisfaction with the pilot prices. Their satisfaction levels can be seen in Figure 65. It can be seen that their perception once the pilot was complete, and their initial impressions are closely aligned, with a slightly higher percent being “very satisfied”.

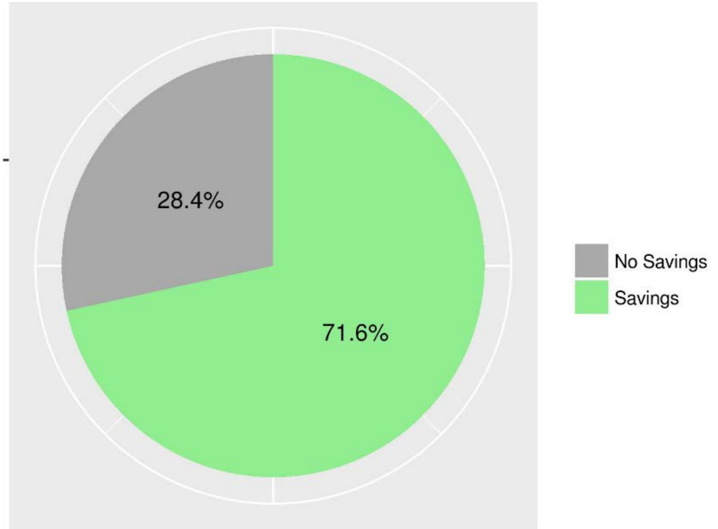
Figure 65. Post Pilot Satisfaction with TOU Prices



Source: Navigant Analysis

In the second survey, respondents who received a thermostat were asked if they believed it helped them achieve additional savings. Approximately seventy-two percent of respondents who programmed their thermostat believed it helped them achieve additional savings as seen in Figure 66.

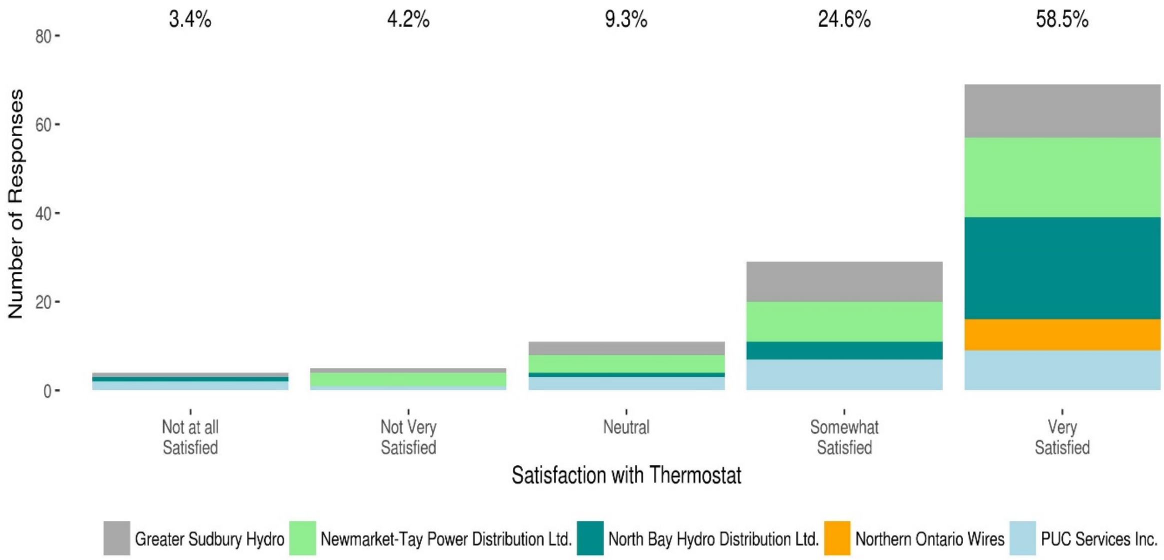
Figure 66. Achieved Additional Savings



Source: Navigant Analysis

A breakdown of how satisfied respondents were with their smart thermostats can be seen in Figure 67 below. It can be seen that over half of the respondents were very satisfied with their thermostats, with less than ten percent being either “not at all satisfied” or “not very satisfied”.

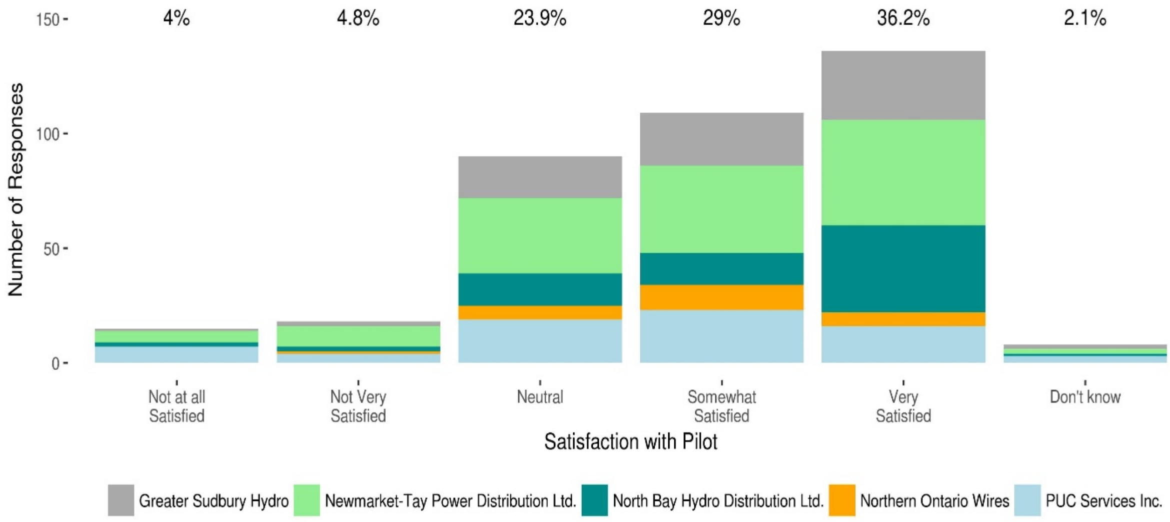
Figure 67. Satisfaction with Thermostat



Source: Navigant Analysis

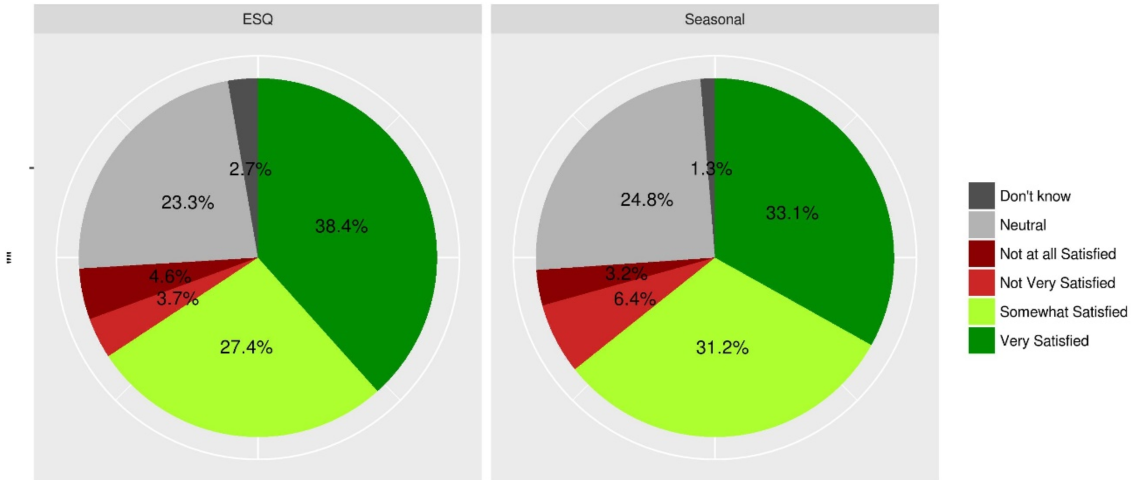
In the second survey, respondents were asked whether they were satisfied with the TOU pilot. The breakdown of their satisfaction levels post-pilot can be seen in Figure 68. Over sixty-five percent of respondents were satisfied with the pilot while twenty-four percent remained neutral and less than ten percent were not satisfied. A breakdown of satisfaction levels by pricing schemes can be seen in Figure 69. A slightly larger proportion of customers in the ESQ price were ‘very satisfied’ when compares to the Seasonal rate and vice versa for “somewhat satisfied”.

Figure 68. Satisfaction with TOU Pilot



Source: Navigant Analysis

Figure 69. Satisfaction with TOU Pilot by Pricing Scheme

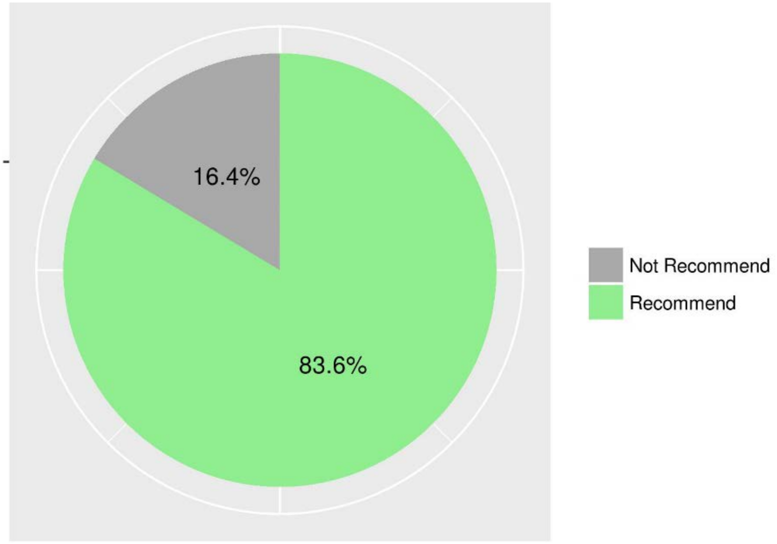


Source: Navigant Analysis

In the second survey, approximately eighty-four percent of respondents stated they would recommend the pilot program to a friend as seen in Figure 70. This is relatively consistent with the majority of respondents being satisfied with the pilot as seen in Figure 65. The recommendations split by rate can be seen in Figure 71, with a slightly higher proportion of ESQ respondents stating that they would recommend the pilot to a friend.

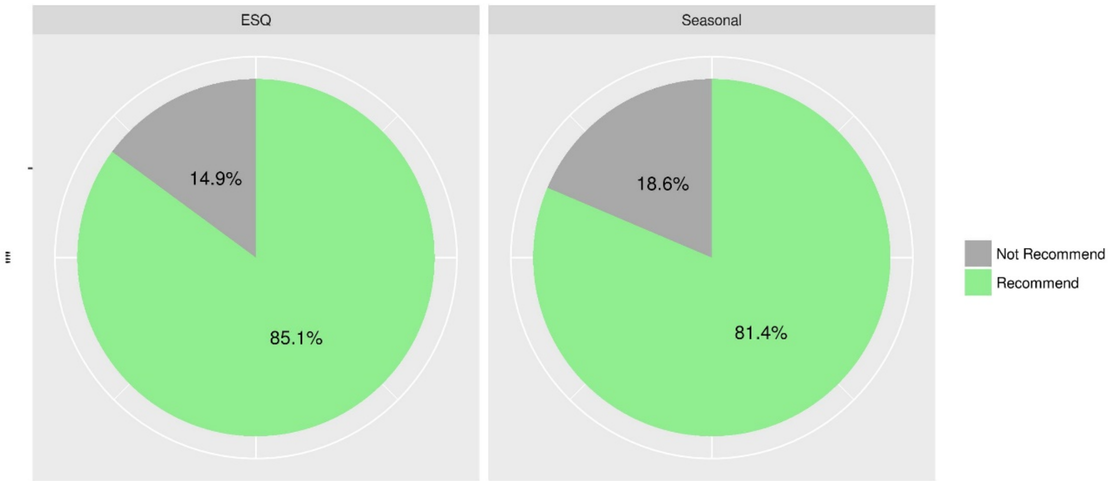
Approximately eighty-eight percent of respondents in the second survey would recommend the pilot to be rolled out province wide as seen in Figure 72. This is again consistent with respondent's overall satisfaction with the pilot. A breakdown of respondents' recommendation by pricing scheme can be seen in Figure 73, with a slightly higher proportion of those in the ESQ price recommending the pricing scheme for province-wide rollout.

Figure 70. Recommend Pilot to a Friend



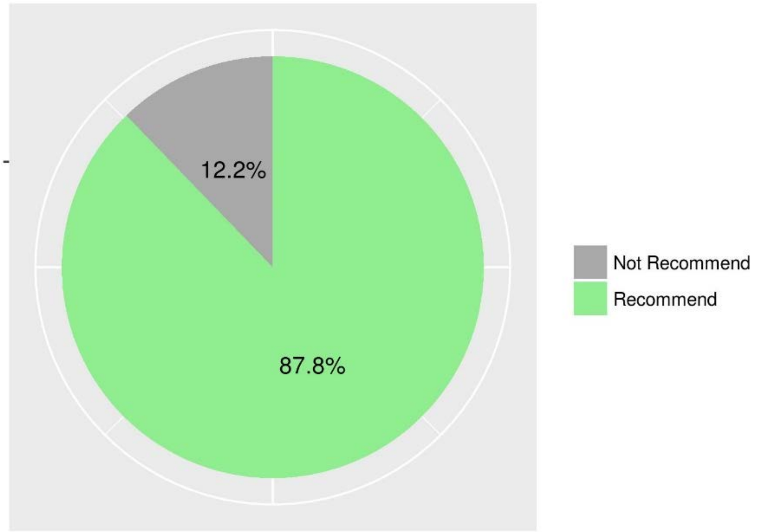
Source: Navigant Analysis

Figure 71. Recommend Pilot to a Friend by Pricing Scheme



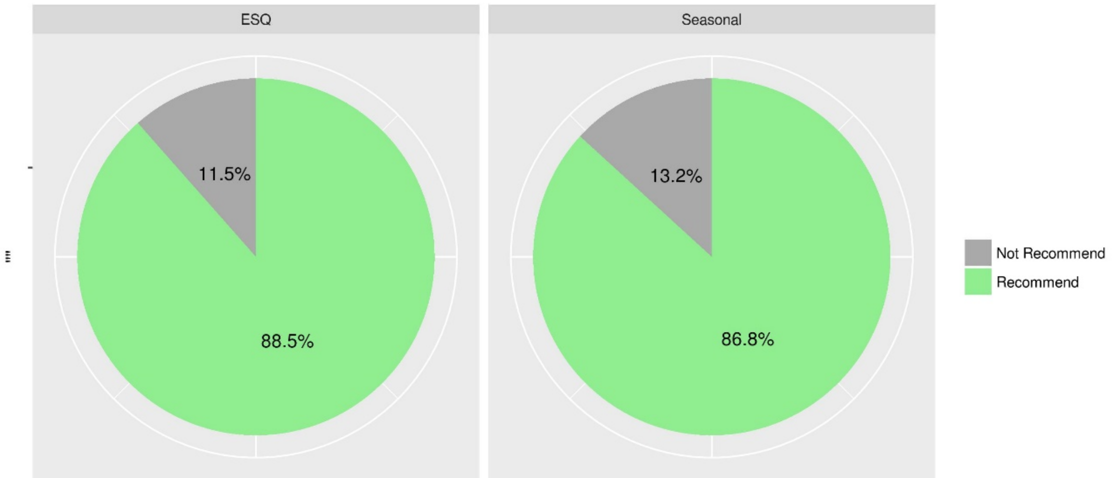
Source: Navigant Analysis

Figure 72. Recommend Pilot Prices for Province-Wide Rollout



Source: Navigant Analysis

Figure 73. Recommend Pilot Prices for Province-Wide Rollout by Pricing Scheme



Source: Navigant Analysis

3.2.6 Program Design and Implementation

Due to the requirement to maintain a Randomized Encouragement Design (RED) for the purpose of estimating energy impacts, marketing was done exclusively by direct mails. This is consistent with how participants first learned about the RPP pilot. Ninety two percent of respondents first learned of RPP pilot through the direct mail.

LDC program managers believed that there would have been higher enrollment had other marketing strategies been implemented. Furthermore, they believed that the marketing efforts should not have been restricted to only a fraction of the population (a third was randomly set aside as the control group and received no encouragement and associated marketing materials). However, this was a requirement of the RED experimental design. LDC program managers reported that some customers also expressed initial concerns about the legitimacy of the pilot as there was no publicly available information on the utility websites[55] but was also a requirement of the RED experimental design.

[55] A special website was created to allow participants to indicate their interest in signing up but there was no information on the public website due to the nature of the experimental design.

The first set of direct mails were sent out in July with the plan to close enrollments by the end of August.[56] LDC program managers believed that this time frame was too narrow especially when coupled with the limited marketing efforts. Due to lower than expected enrollment, a second round of enrollment was conducted in August through September to the same set of customers. Customers were sent a letter of confirmation to confirm their enrollment in the pilot, see Appendix D for sample communications.

Billing system changes varied by utility, but most utilities reported that they were manual and time-consuming. Key challenges included setting up new price structures, enrolling customers in the pilot, changing bill codes, adjusting prices, reverting to old prices if customers opted out and training staff on how to handle participant bills. For participants who moved during the pilot, original prices had to be reinstated for the new occupants. This came down to a resource management task and proved to be a challenge at times.

LDC program managers indicated that there were a few instances where thermostats were incompatible with the customers HVAC system and may have prevented them from participating in the study as no alternative thermostat was available. However, it is important to note that these customers were offered the option to participate in the rate only program which some customers accepted and were offered a thermostat at the end of the pilot. The LDC program managers also held the view that other incentives besides free thermostats should be explored as the market is fairly saturated with thermostats and that there were alternatives available to receive a free or discounted thermostat that did not require enrolling in the pilot.

Some customers who enrolled in the pilot in August of 2018 opted out of the study when they received high bills which they attributed to the pilot. The LDC program managers indicated that the high bills were actually related to high temperatures which are typical for this time of the year and that the pilot prices had not yet been applied to the bills when these individuals opted out. They recommended that the prices be tailored to the regions or utility, for example northern utilities serve customers that are dependent on electric space heating which leaves them little opportunity to shift a large portion of their load during the winter season.

LDC program managers held the viewpoint that it may be best to plan to start future pilots in the shoulder months (i.e. not in the summer or winter)[57] or phase participants in over the peak and shoulder months respectively to prevent opt outs after seeing an initial high bill. Some participants with electrically heated homes opted out because their bills started to increase significantly as they were unable to shift the heating load to off-peak times.

All calls for the RPP pilot were forwarded to a dedicated CustomerFirst call center which prevented additional load on the utility call centers that they were not equipped for which could have impacted customer perceptions in a negative way. However, some confusion was created when customers called the utility call centers and were re-directed to the dedicated CustomerFirst line.

[56] The direct mails were intended to be sent out in June 2018 but due to challenges with the printers and Canada Post, mailers were sent out in July.

[57] The original plan intended for the pilot to start in August 2018 but due to the challenges with getting the first set of direct mails out in June and the need to conduct a second round of enrollment, the pilot start date was deferred to October 2018.

4. CONCLUSIONS AND RECOMMENDATIONS

Two TOU pilot pricing schemes, Enhanced and Seasonal, were piloted across five local distribution companies with each distributor being assigned a particular pricing scheme. The experimental design employed for this pilot was a Randomized Encouragement Design wherein customers were randomly assigned to either a treatment or control group and the customers in the treatment groups were encouraged to participate in the pilot via direct mail. They were incentivized with a thermostat at the end of the pilot (rate only treatment) or at the beginning of the pilot (rate and enabling technology treatment).

Due to the challenges associated with low enrollment, a quasi-experimental design that involves the use of a matched control group was used to obtain more robust impact estimates. The matched controls were selected from the group of customers who were randomized into the control group as part of the RED and hence were never exposed to any form of encouragement. Neither the ESQ nor the Seasonal pricing schemes have yielded statistically significant savings, at a reasonable level of confidence and precision, in either season.

This result is driven by three key factors. Not all electricity consumption can be shifted or conserved and hence the price affects only the portion of total consumption, that which can be considered discretionary. Since the starting point is a TOU pricing scheme, those not on the regular RPP rates were excluded from the study population, participants have less flexibility to further shift or conserve electricity. Finally, even substantial conservation during the on-peak periods result in practically insignificant bill savings, a few dollars per month at most.

The negative impact estimates, with some being more significant than others, and the negative regions of the confidence bands could potentially indicate that there may be some small albeit highly uncertain savings (impacts) for some customers. However, this cannot be broadly generalized given that the confidence bands straddle zero and the three key factors described in the paragraph above.

The most notable difference between the ESQ and Seasonal impact analysis is that the ESQ pricing scheme has higher on-peak to off-peak inter-period elasticities of substitution as compared to the Seasonal pricing scheme and are statistically significant. This indicates more substitution for the ESQ pricing scheme as compared to the Seasonal pricing scheme which is understandable given the higher on-peak to off-peak pricing ratios.

The overall impact results are also consistent with participant expectations and behaviours over the course of the pilot. Prior to enrolling in the pilot, most participants expected to see a slight reduction in their bills and some actually expected an increase. During the pilot, ten percent of survey respondents stated that they never changed their behaviour over the course of the pilot and twenty percent reported that they occasionally changed their behaviour. Effectively, thirty percent of the respondents did not modify their behaviours in any significant way which would also have a notable effect on the impact estimates.

However, approximately seventy percent of survey respondents self-reported making behavioural changes over the course of the pilot. Furthermore, most were satisfied with the pilot prices, across both pricing schemes, and recommended a broader provide wide rollout. While at first glance, this may appear to be a contradiction to the statistically insignificant impact findings, the explanation lies in a cautious interpretation of the results.

Even though survey respondents may have modified their behaviour in some ways during the pilot, it may not be significant enough to manifest in the form of statistically significant impact estimates. Prior to enrolling in the pilot, ninety-one percent of respondents reported that they had shifted their consumption patterns in varying degrees, and the incremental behavioural changes undertaken during the pilot may not be as significant as the respondents may perceive.

Furthermore, approximately eighty percent of respondents had made various energy efficiency improvements prior to enrolling in the pilot demonstrating that they were already engaged in energy conservation and twenty percent of respondents did not program their thermostat. This does not mean that the survey does not have value, just that the interpretation requires caution when comparing to the impact results.[58]

The following key takeaways could be of value to the design and implementation of future pilots:

1. **The Piloted On-Peak to Off-Peak Price Differentials, for both Pricing Schemes, May Not Be Sufficient on their Own to Encourage Load Shifting or Conservation when Starting from TOU Prices**

As demonstrated in the results section, even significant further conservation in consumption during the on-peak period (twenty percent in the example provided) would result in minimal bill savings (a few dollars at most) under the piloted pricing schemes compared to the relative discomfort that one may have to endure to conserve so much energy during the on-peak period. This is further substantiated by the very small magnitude of the inter-period elasticities of substitution.

If a jurisdiction has already made the transition from a flat or tiered rate structure to a TOU pricing structure for almost all residential households, it is reasonable to expect that some customers, though admittedly not all, would have made some behavioural changes that would have resulted in shifting some consumption from the on-peak to off-peak periods and or some reductions in overall consumption. This is also consistent with survey findings where ninety-one percent of respondents reported that they shifted their consumption patterns in varying degrees prior to enrolling in the pilot. This would limit their ability to further adjust behaviours as part of the pilot program.

2. **Future TOU Pilots that Start from TOU Prices and Pilot Similar TOU Structures with Different Prices may require Larger Sample Sizes than those Starting from Flat or Tiered Structures.**

Future TOU pilot programs could consider planning for larger sample sizes when starting from TOU prices than then normally would if there were starting from a flat or tiered pricing as the impacts that one would expect to see would be smaller in comparison. The purpose of any such pilot is to be able to state for a statistical fact, with a high degree of confidence and precision that the impacts of the proposed pricing scheme are significant as this lends credibility to future decisions that may be based on such pilots (for example a province wide rollout of the prices).

While some of the impacts estimated as part of the pilot may be negative, indicating savings, the confidence bands are fairly wide, straddling zero, and the relative precision is low. Larger sample sizes could aid in achieving more precise estimates thereby supporting more definitive statements and future decision making.

3. **Survey Respondents Reported Positive Impressions with Pilot Enrollment but There Is Potential to Improve Response Time and Mitigate Confusion**

The registration process to enroll in the pilot was well received by respondents with over seventy-one percent being satisfied. The registration process was conducted by phone and all calls for the pilot were directed to a dedicated CustomerFirst call center which prevented additional load on the LDC call centers that they were not equipped for.

However, some confusion was created when customers called the utility call centers and were simply re-directed to the dedicated CustomerFirst line. A simple explanation from the LDC call center representatives of why customers were being transferred would greatly aid in easing customer concerns. Additional clarifications could also be provided in the marketing materials.

Interviews with LDC program managers also revealed that some customers experienced delays in call backs of up to four or five days. Ensuring adequate resources for call centers could reduce the response time and positively impact enrollment numbers. This could potentially be a key contributor to the low enrollment seen in this pilot.

[58] Survey respondents may be more engaged in general and hence may be more likely to take action as compared to non-respondents.

4. Increasing the Enrollment Window Could Increase Enrollment Numbers

The first set of direct mails were sent out in July with the plan to close enrollments by the end of August. Due to lower than expected enrollment, a second round of enrollment was conducted in August through September to the same set of customers. For future pilots, the enrollment window could be increased which would aid in achieving higher enrollment numbers. This would not interfere with any experimental design; for example, in the case of an RED customers can simply be provided a longer timeframe to respond to the encouragement provided.

5. Provide Instructions for Enabling Technology

Twelve percent of respondents reported that they did not receive instructions, of which sixty percent stated that they would have valued receiving them. Instructions for any enabling technology, such as smart thermostats, should be provided to all participants by default. Some additional tips for usage and savings could also be provided within the context of the pilot to make them easier to digest. This could potentially reduce the number of participants that do not program the technology at all and or reduce the time taken by participants to program the technology.

6. Account for Distributor Billing System Limitations

LDC program managers noted that the billing system updates were a labour intensive manual process and required training for staff on how to prepare participant bills. While this is beyond the scope of control of CustomerFirst or the OEB, consideration could be given to the costs associated with program management as the costs associated with manual intervention can increase exponentially as enrollment and billing complexity increase. While billing system upgrades are often complex and expensive, future programs should consider whether the billing systems provide the needed flexibility, and ease of use, to be able to test more complex rate structures.

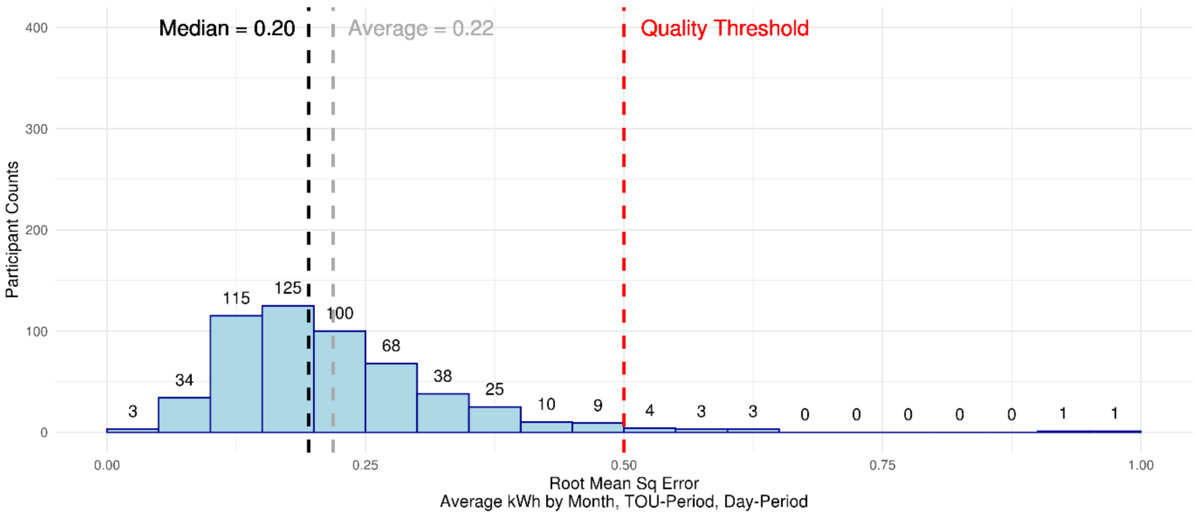
APPENDIX A. QUASI EXPERIMENTAL METHODOLOGY: ADDITIONAL DETAIL

A.1 Matched Controls RMSE Distribution

This appendix presents the distribution of the root mean squared error (RMSE) for each pricing scheme by season. All figures have been zoomed into an RMSE area between zero and one. Participants whose best match had an RMSE of greater than 0.5 were excluded from the analysis.

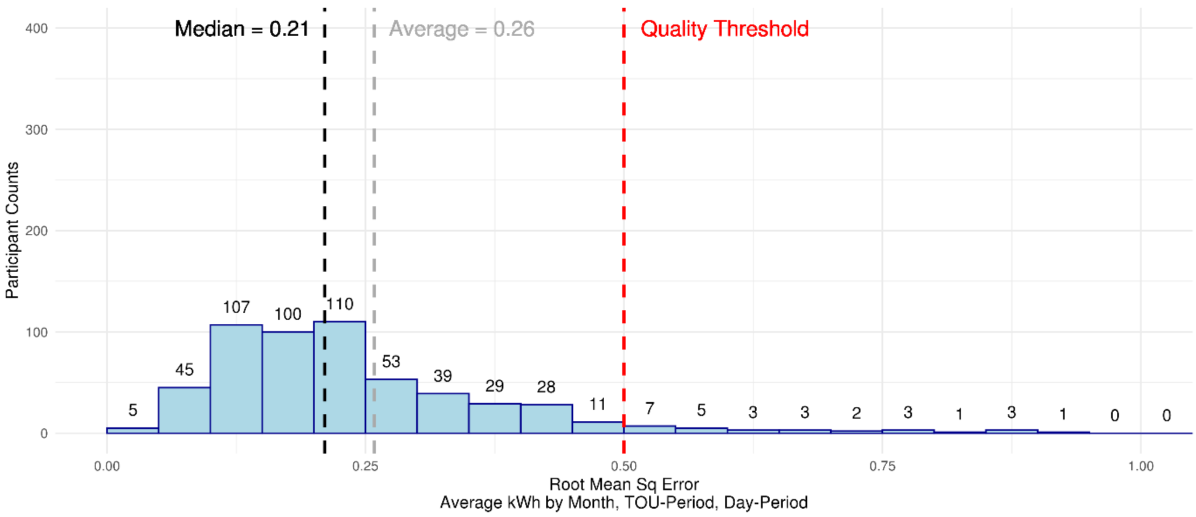
A.1.1 ESQ Price

Figure 74. Hourly Matching RMSE Distribution – ESQ Price – Summer



Source: Navigant Analysis

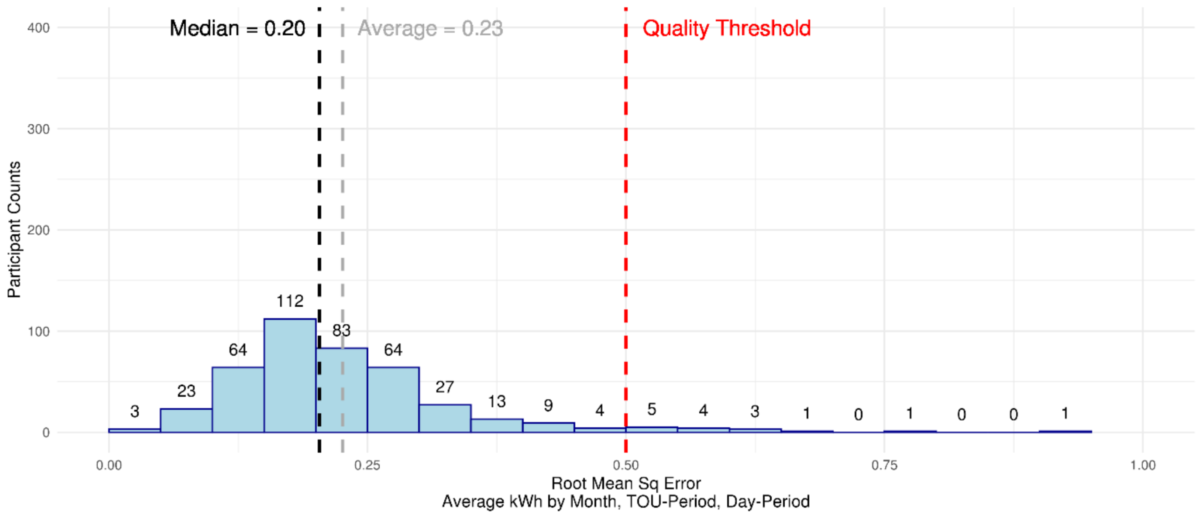
Figure 75. Hourly Matching RMSE Distribution – ESQ Price – Winter



Source: Navigant Analysis

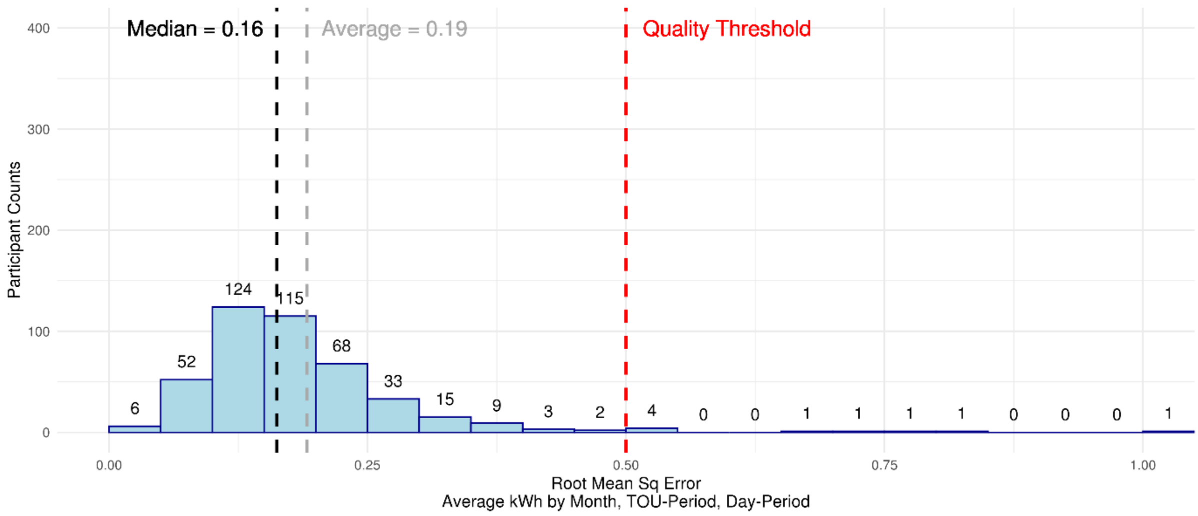
A.1.2 Seasonal Price

Figure 76. Hourly Matching RMSE Distribution – Seasonal Price – Summer



Source: Navigant Analysis

Figure 77. Hourly Matching RMSE Distribution – Seasonal Price – Winter



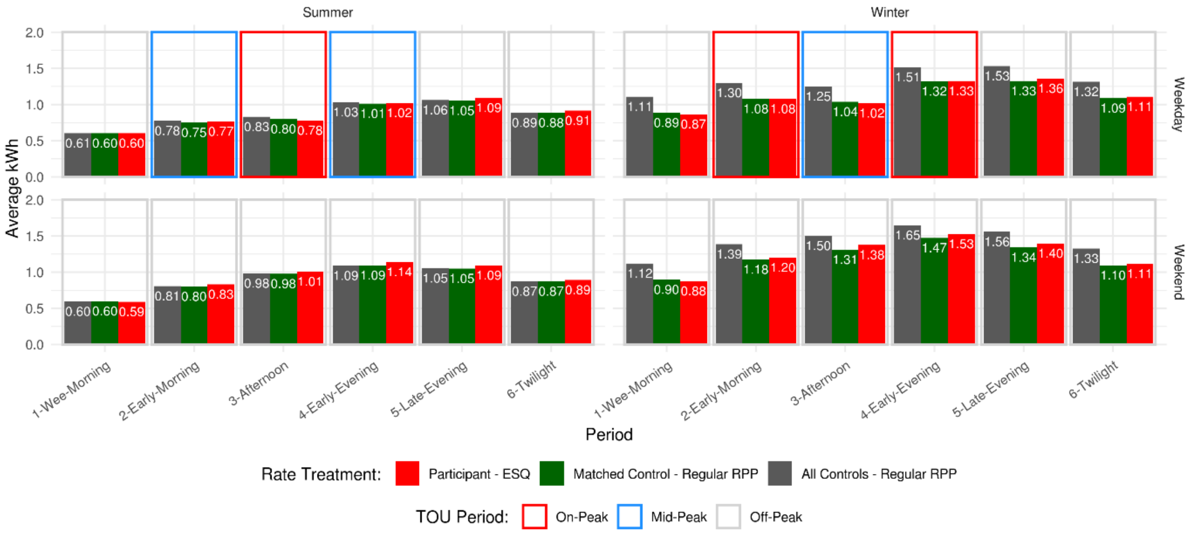
Source: Navigant Analysis

A.2 Matched Control Plots by Rate and Treatment Group

This appendix shows the breakdown of the hourly matching by pricing scheme and treatment group.

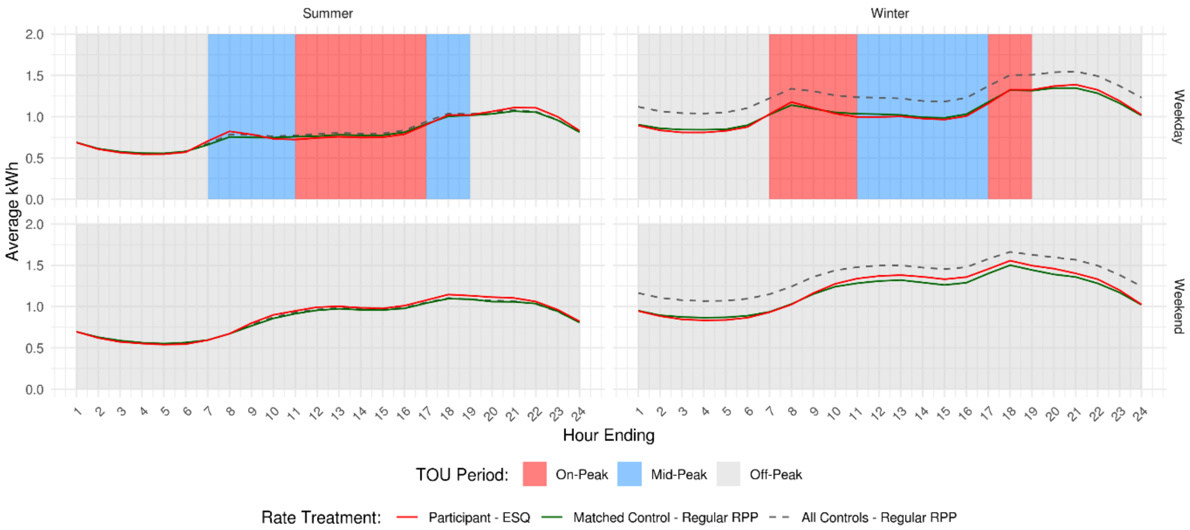
A.2.1 ESQ Price – Rate Only

Figure 78. Matched Control by TOU Period and Day Period – ESQ Price – Rate Only



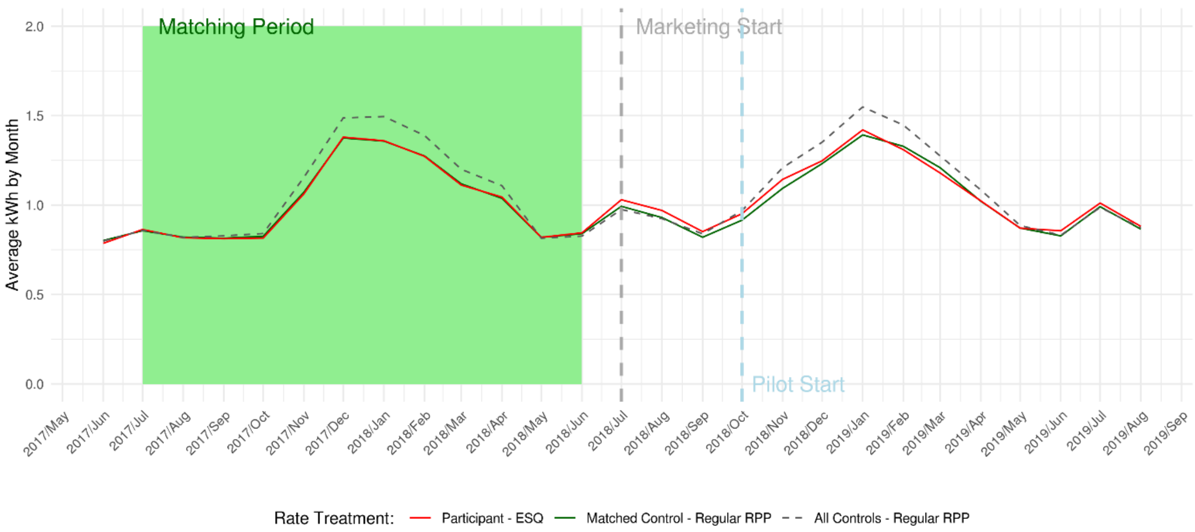
Source: Navigant Analysis

Figure 79. Matched Control Load Profiles – ESQ Price – Rate Only



Source: Navigant Analysis

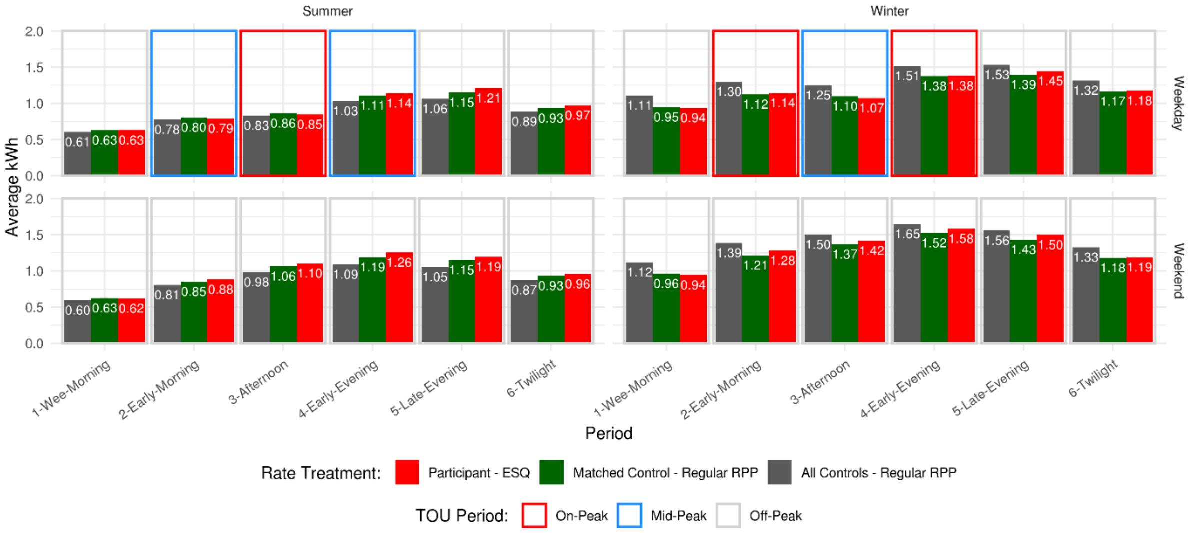
Figure 80. Matched Control Monthly Profiles – ESQ Price – Rate Only[59]



Source: Navigant Analysis

A.2.2 ESQ Price – Rate and Enabling Technology

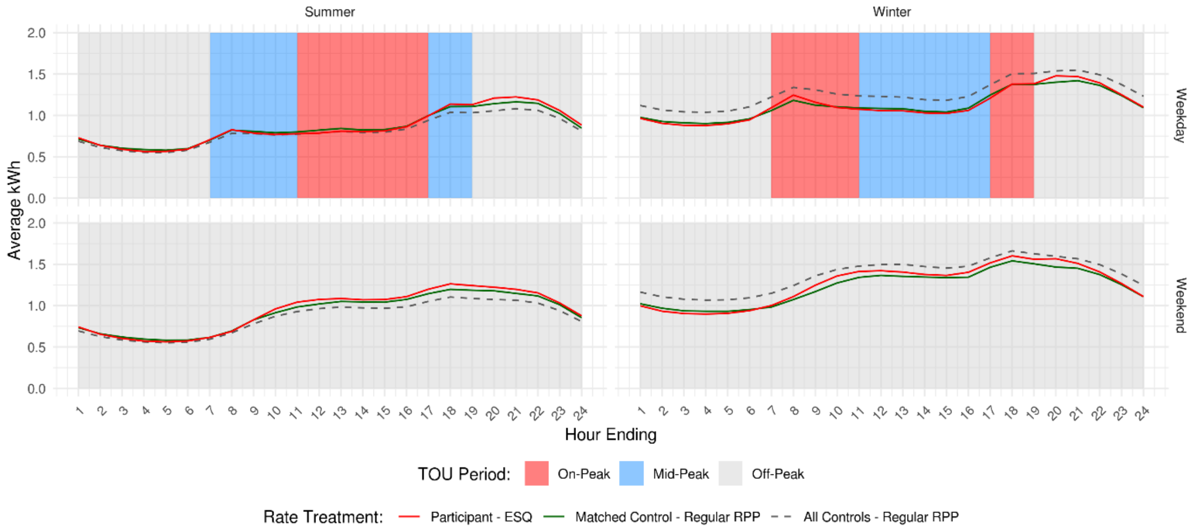
Figure 81. Matched Control by TOU Period and Day Period – ESQ Price – Rate and Enabling Technology



Source: Navigant Analysis

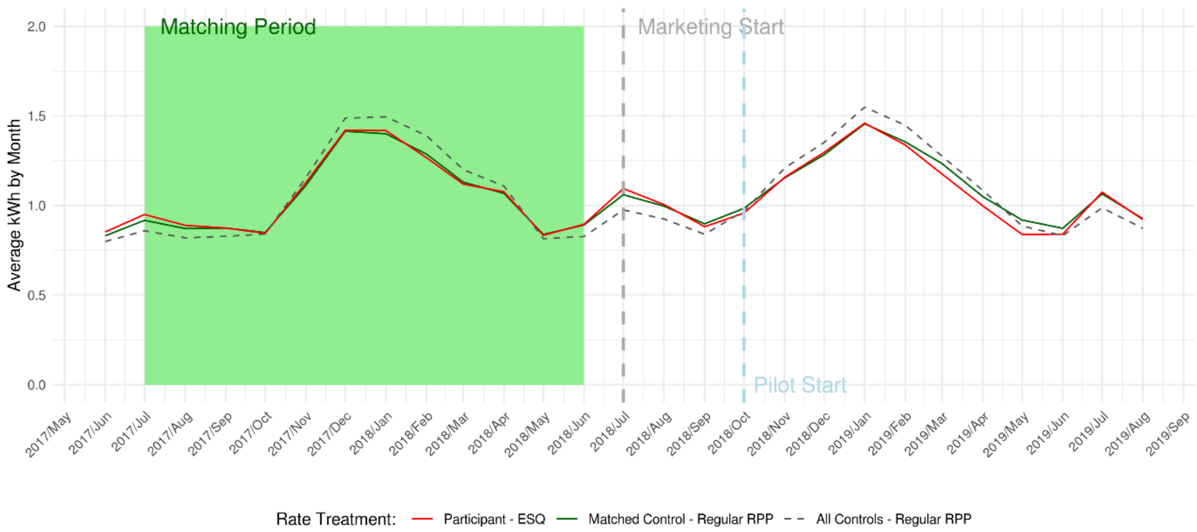
[59] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

Figure 82. Matched Control Load Profiles – ESQ Price – Rate and Enabling Technology



Source: Navigant Analysis

Figure 83. Matched Control Monthly Profiles – ESQ Price – Rate and Enabling Technology[60]

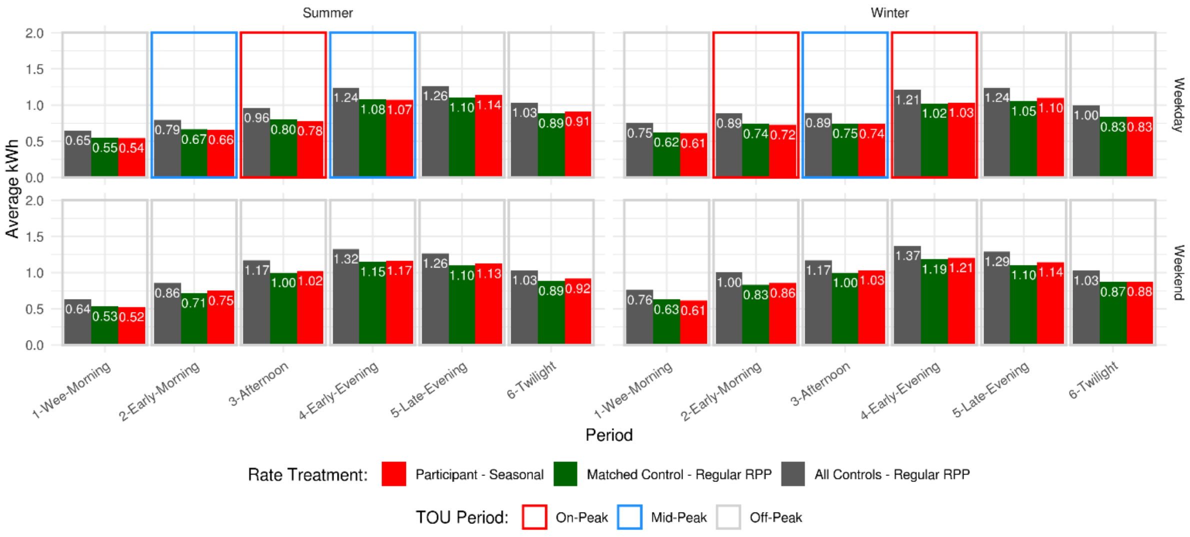


Source: Navigant Analysis

[60] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

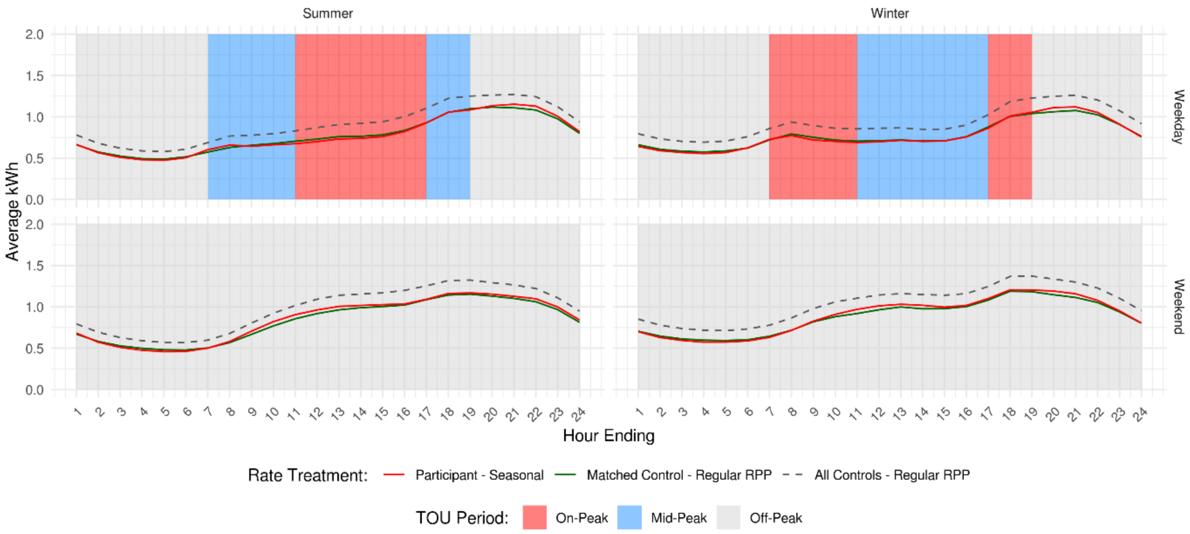
A.2.3 Seasonal Price – Rate Only

Figure 84. Matched Control by TOU Period and Day Period – Seasonal Price – Rate Only



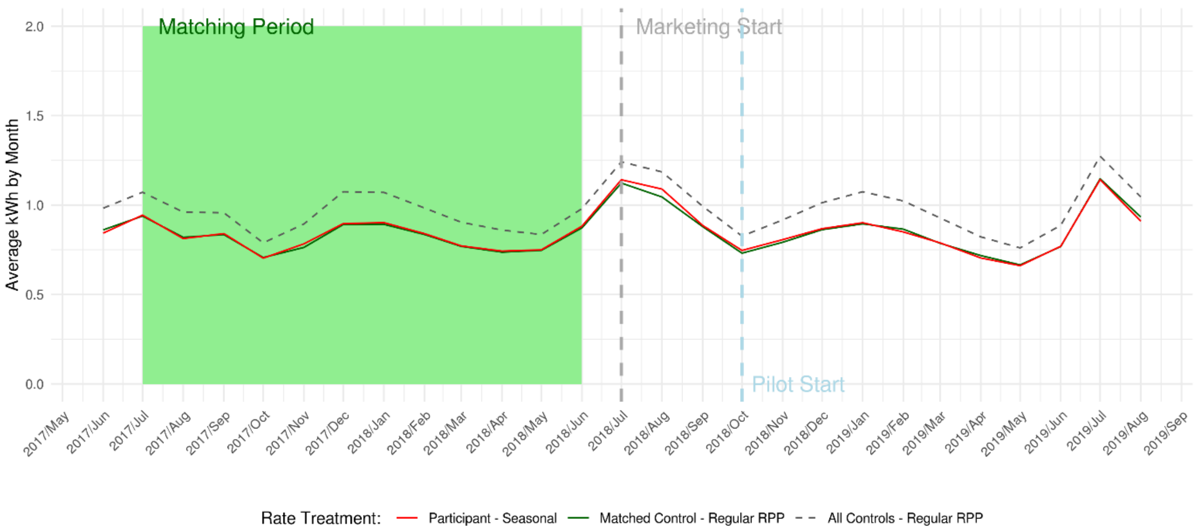
Source: Navigant Analysis

Figure 85. Matched Control Load Profiles – Seasonal Price – Rate Only



Source: Navigant Analysis

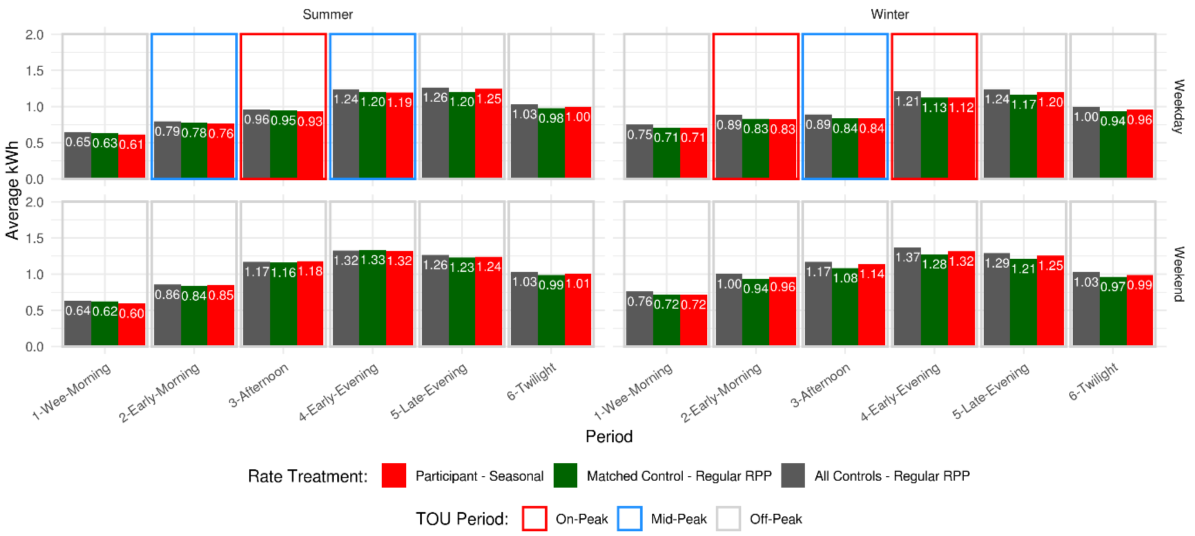
Figure 86. Matched Control Monthly Profiles – Seasonal Price – Rate Only[61]



Source: Navigant Analysis

A.2.4 Seasonal Price – Rate Only

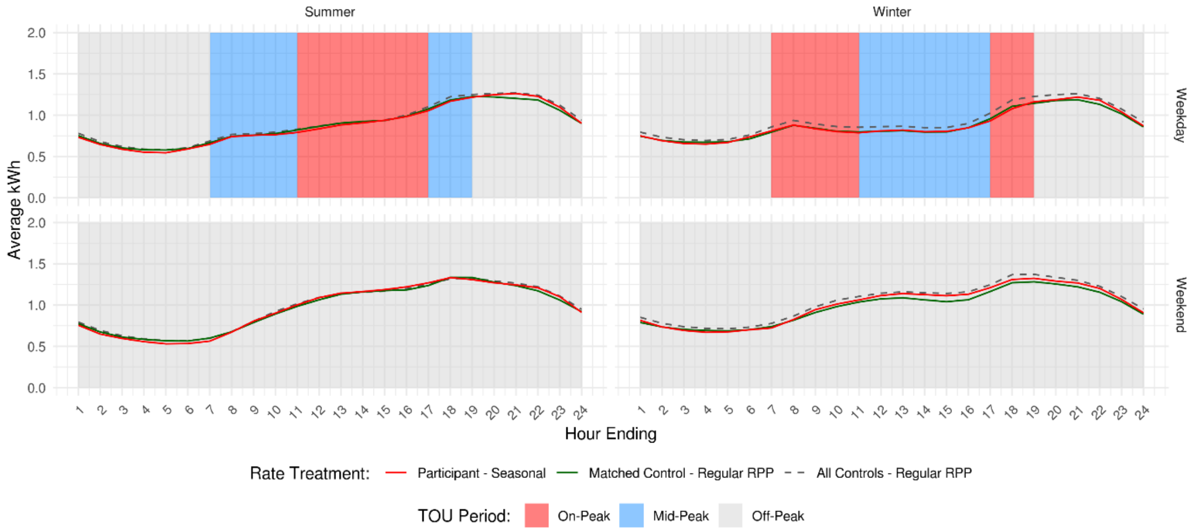
Figure 87. Matched Control by TOU Period and Day Period – Seasonal Price – Rate and Enabling Technology



Source: Navigant Analysis

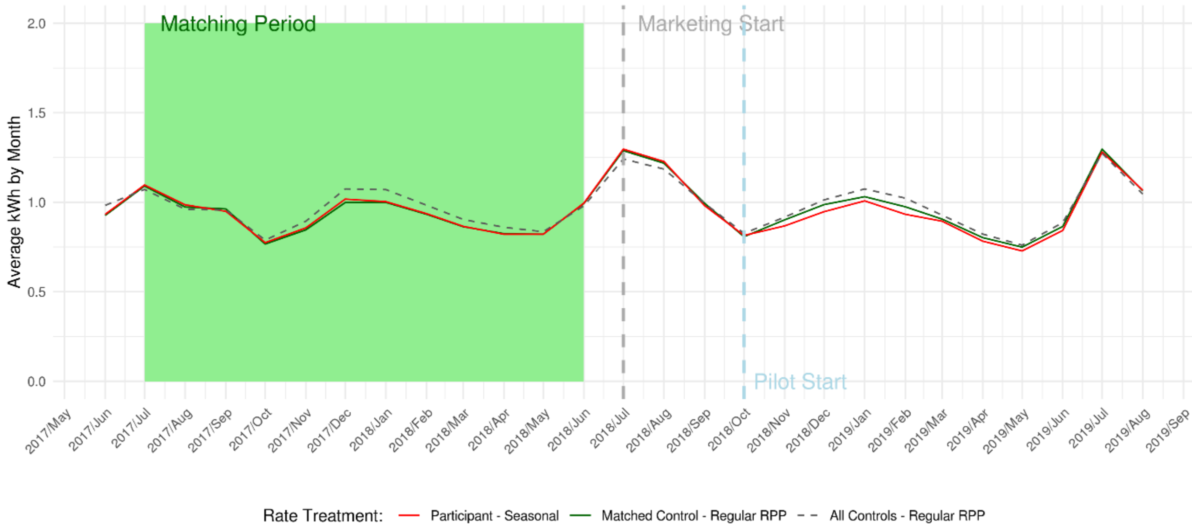
[61] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

Figure 88. Matched Control Load Profiles – Seasonal Price – Rate and Enabling Technology



Source: Navigant Analysis

Figure 89. Matched Control Monthly Profiles – Seasonal Price – Rate and Enabling Technology[62]



Source: Navigant Analysis

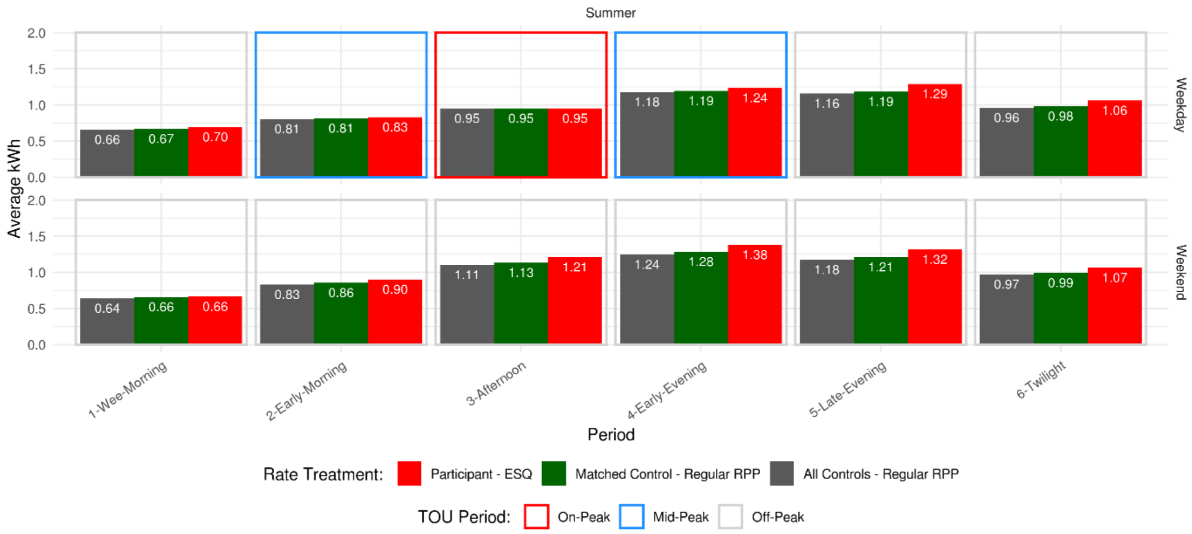
A.3 Matched Control Plots for the Marketing Period

This appendix compares the matched controls to the participants during the marketing period. Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot prices, but some customers were on the pilot prices prior to October 2019. These plots are purely for illustrative purposes to see how participants and their matched controls compare over the marketing period.

[62] Navigant notes a caveat that customers did enroll over the marketing timeframe and were put on the pilot rates on their next billing cycle. By October 2019, all participants were on the pilot pricing schemes but some were on the pilot prices prior to October 2019.

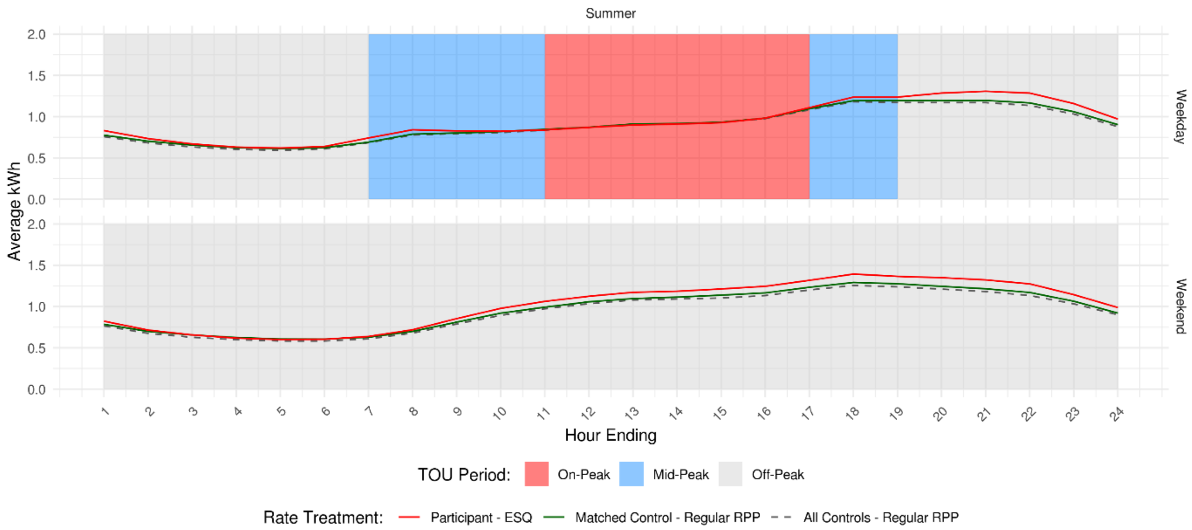
A.3.1 ESQ Price

Figure 90. Marketing Period Matched Control by TOU Period and Day Period – ESQ Price



Source: Navigant Analysis

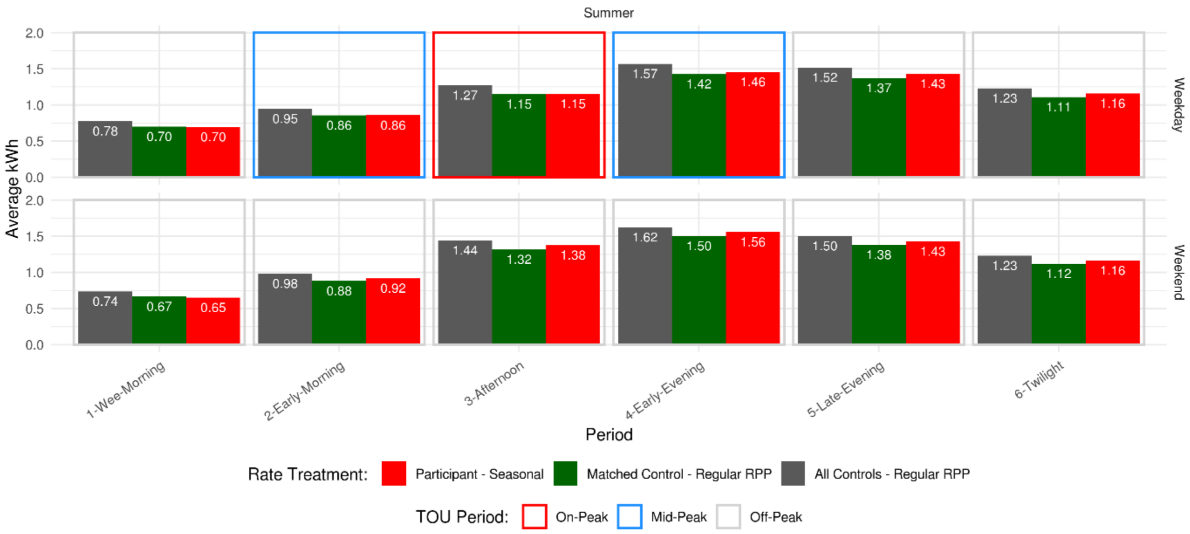
Figure 91. Marketing Period Matched Control Load Profiles – ESQ Price



Source: Navigant Analysis

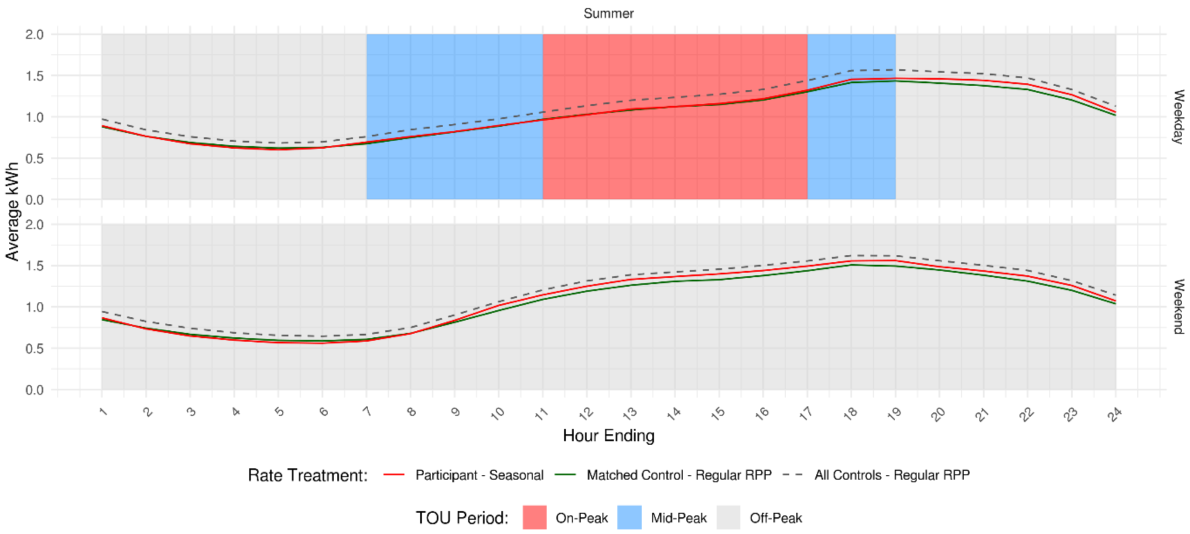
A.3.2 Seasonal Price

Figure 92. Marketing Period Matched Control by TOU Period and Day Period – Seasonal Price



Source: Navigant Analysis

Figure 93. Marketing Period Matched Control Load Profiles – Seasonal Price

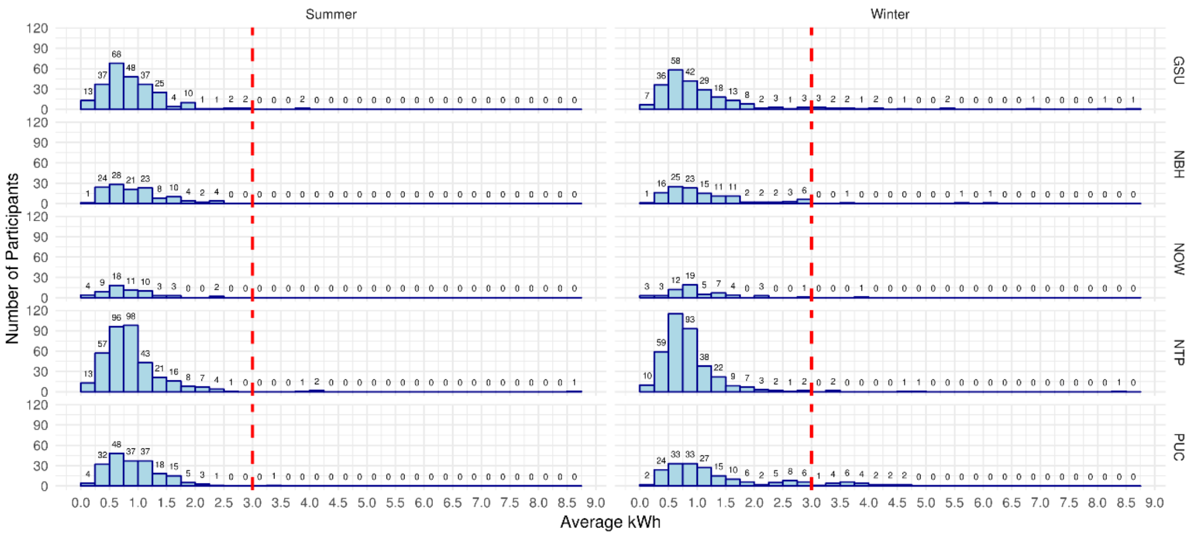


Source: Navigant Analysis

A.4 Outlier Analysis: Additional Detail

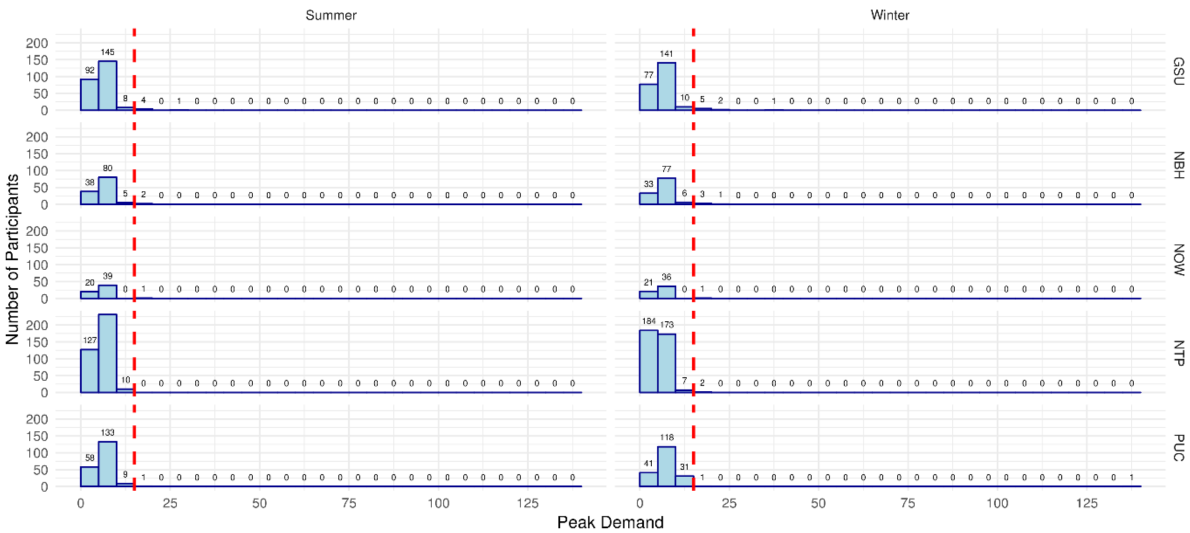
This appendix presents the distribution of the average energy consumption and peak demand for each pricing scheme by season. Participants with an average energy consumption greater than 3 kWh or less than 0.1, or peak demand greater than 15 kW were excluded from the analysis.

Figure 94. Outlier Analysis – Average kWh Distribution



Source: Navigant Analysis

Figure 95. Outlier Analysis – Peak Demand Distribution



Source: Navigant Analysis

APPENDIX B. PRE-PERIOD LOAD PROFILES BY LDC AND SEASON

This appendix compares the pre-period usage for each LDC by season and treatment group.

B.1 ESQ Price Distributor Load Profiles

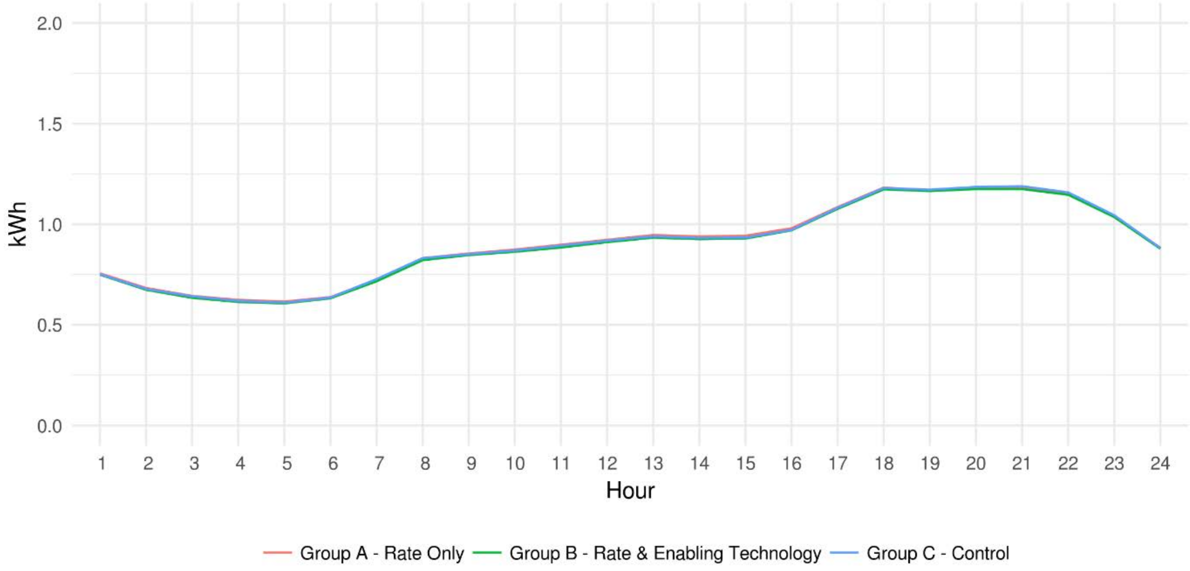
Figure 96. Greater Sudbury Hydro Pre-Period Comparison by Treatment Group - Summer

Source: Navigant Analysis

Figure 97. Greater Sudbury Hydro Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

Figure 98. North Bay Hydro Distribution Ltd. Pre-Period Comparison by Treatment Group - Summer

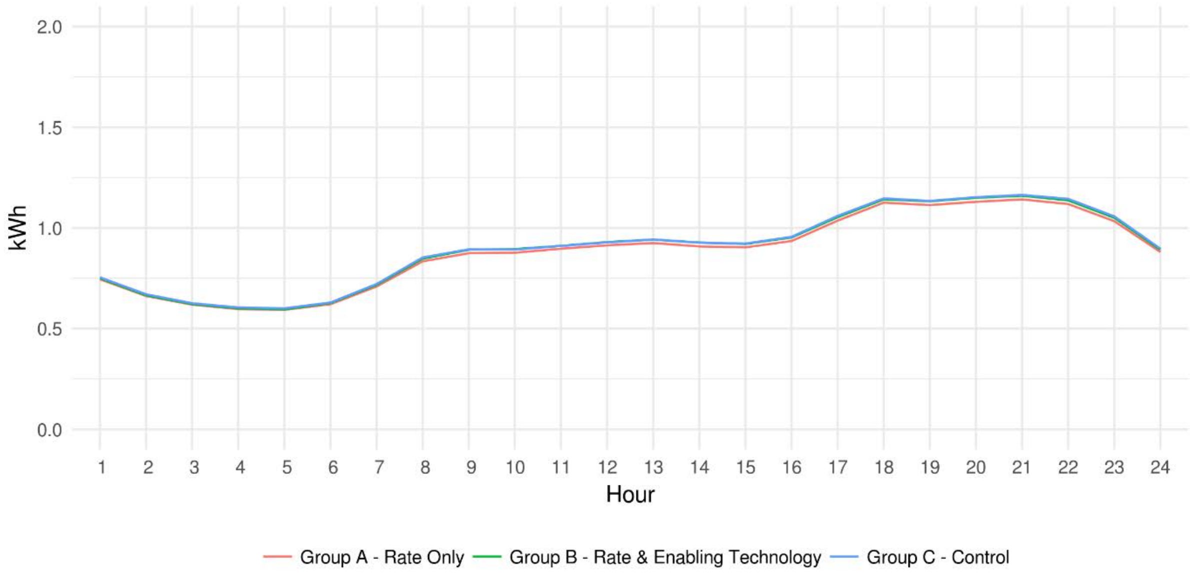


Source: Navigant Analysis

Figure 99. North Bay Hydro Distribution Ltd. Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

Figure 100. PUC Services Inc. Pre-Period Comparison by Treatment Group - Summer



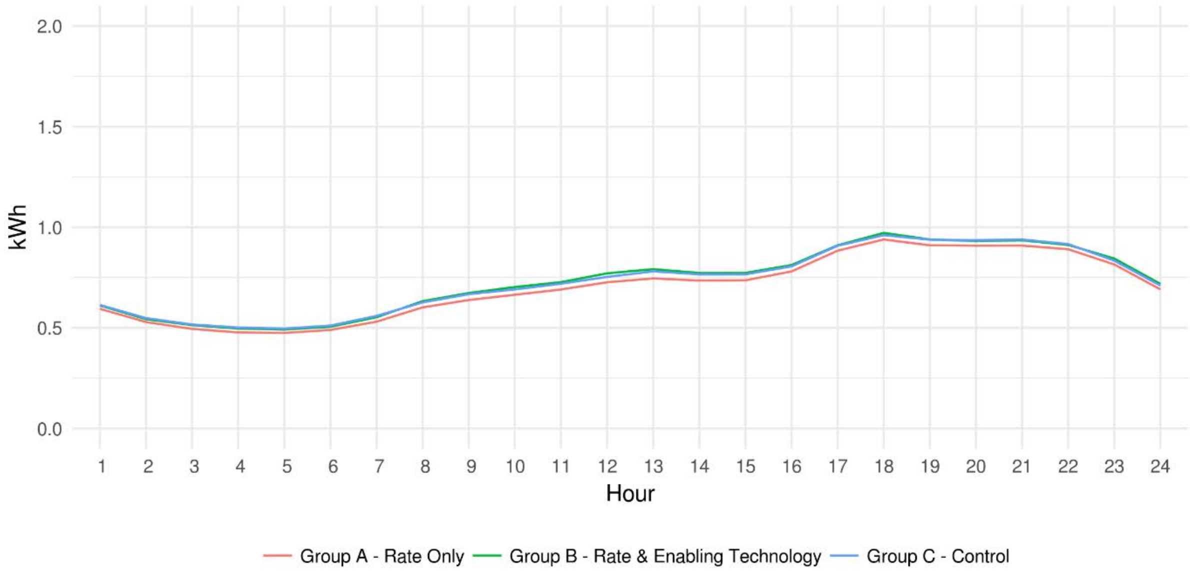
Source: Navigant Analysis

Figure 101. PUC Services Inc. Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

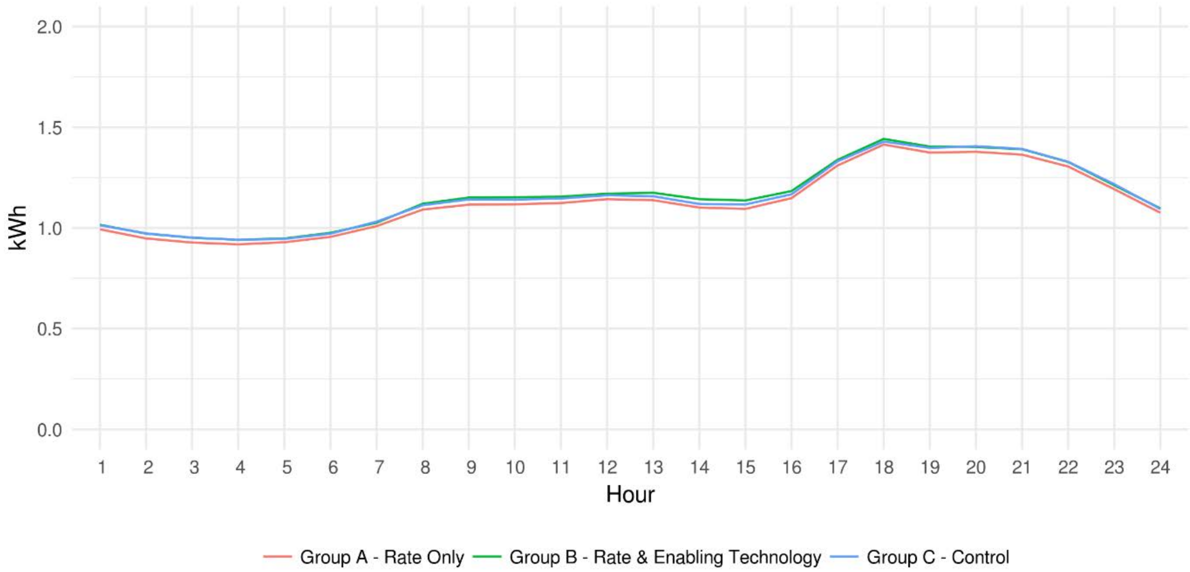
B.2 Seasonal Price Distributor Load Profiles

Figure 102. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Summer



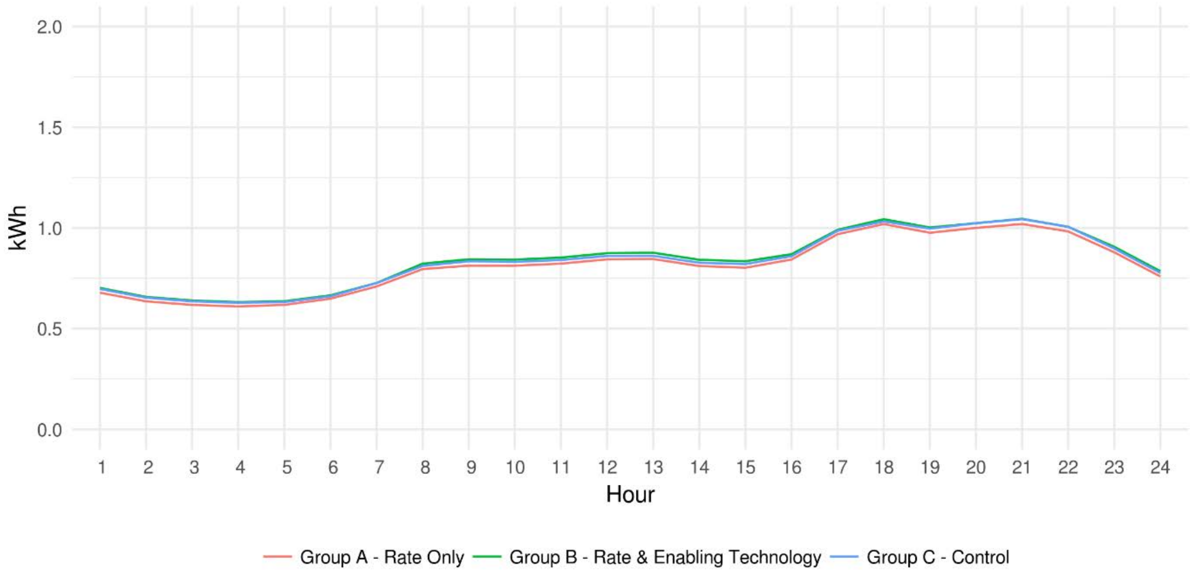
Source: Navigant Analysis

Figure 103. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Winter



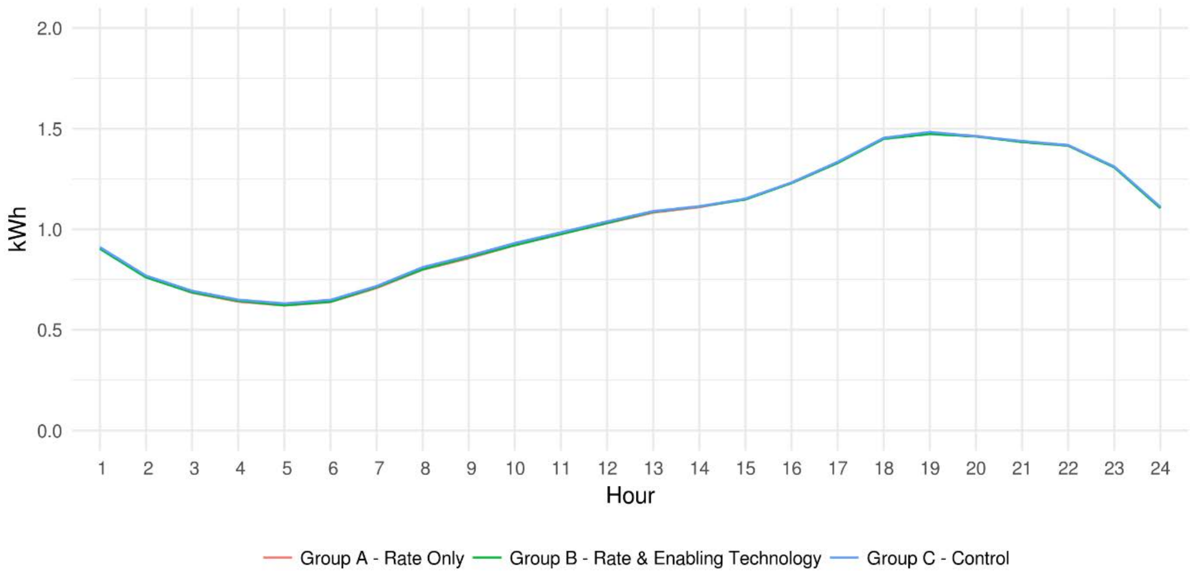
Source: Navigant Analysis

Figure 104. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Shoulder



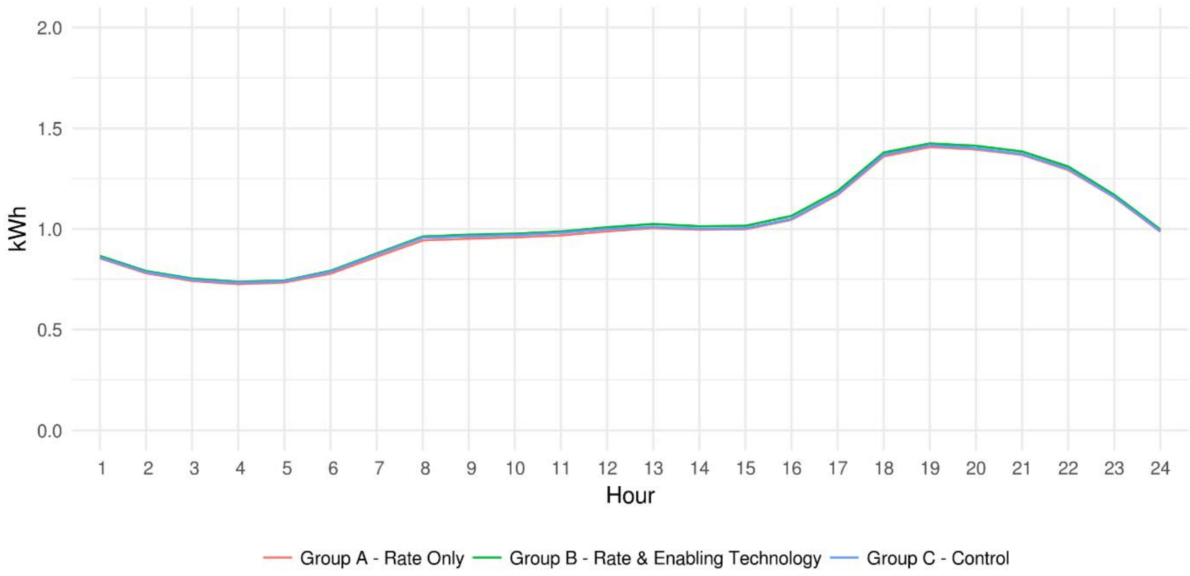
Source: Navigant Analysis

Figure 105. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Summer



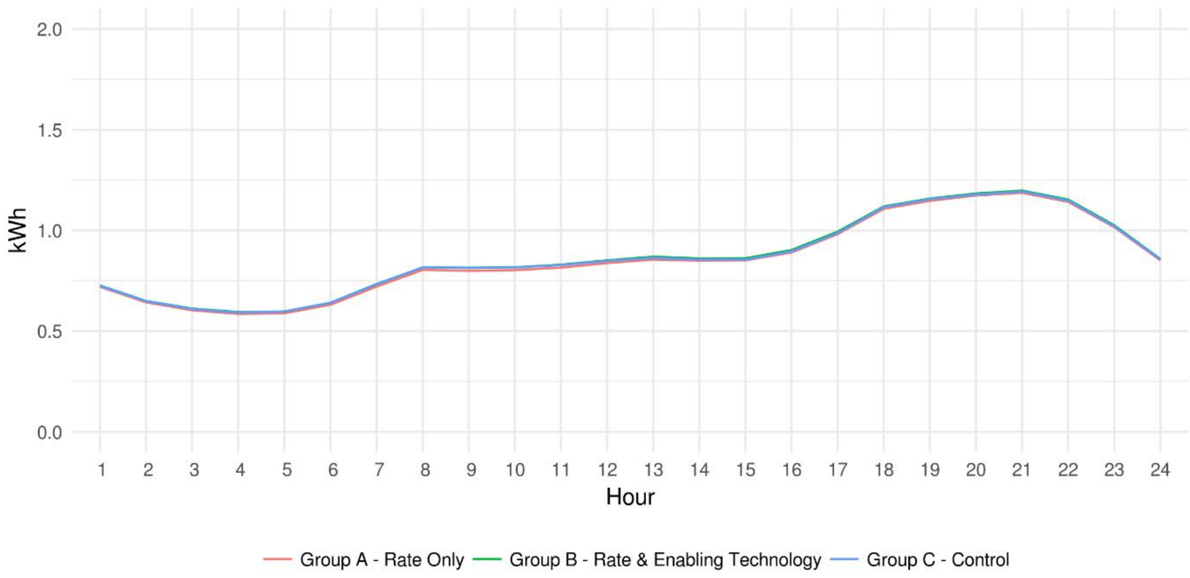
Source: Navigant Analysis

Figure 106. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Winter



Source: Navigant Analysis

Figure 107. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Shoulder



Source: Navigant Analysis

APPENDIX C. OPT-IN ANALYSIS

Given the low enrollment and the associated challenges with obtaining conclusive price impacts from the RED analysis during the interim report, Navigant had investigated whether the customers who opted-in from the two treatment groups had pre-period load shapes that were notably different from the remainder of the treatment group to provide some additional insight into whether they have notably different consumption patterns and potentially shed some light on why they may have chosen to opt-in. The load shapes for each LDC by season are presented below.

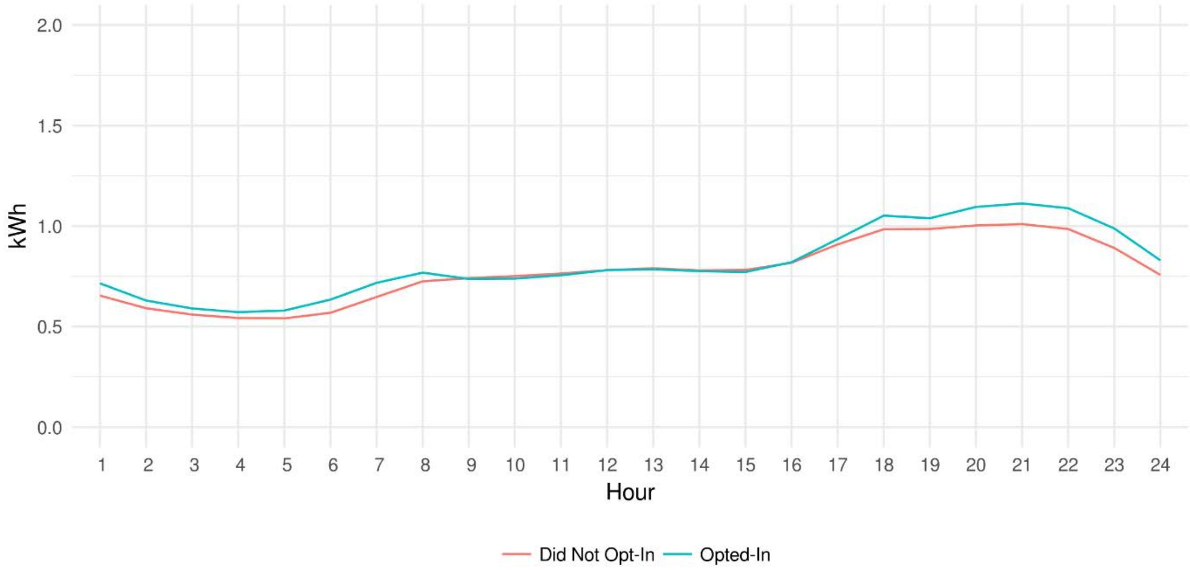
- **ESQ Price**: While the load shapes of those who opted-in were not notably different from those who did not, Navigant noted that those customers who opted-in had slightly higher consumption levels in the off-peak and slightly lower in the on-peak and at times mid-peak periods. This trend was more pronounced in the summer as compared to the winter. In some cases, as in North Bay Hydro, the winter load shapes for those who opted in were consistently below those who did not in all hours but maintained a similar hourly shape. This may add some insight into why they chose to opt in as they may be able to take advantage of the lower off-peak rates and potentially be able to shift more consumption to the off-peak periods.

- **Seasonal Price**: The summer, winter and shoulder load profiles are very similar with slight variations in magnitude for those who opted-in vs. those who did not and hence no clear insights can be drawn. The customers who were encouraged with a thermostat at the end of the pilot (rate only treatment, group A) and opted-in had a slightly lower consumption in all hours compared to those who did not opt-in, while this trend was reversed for those who were encouraged with a thermostat at the start of the pilot (rate and enabling technology treatment, group B).

This appendix compares the load profiles of those who opted-in vs. those who did not for each LDC and treatment group.

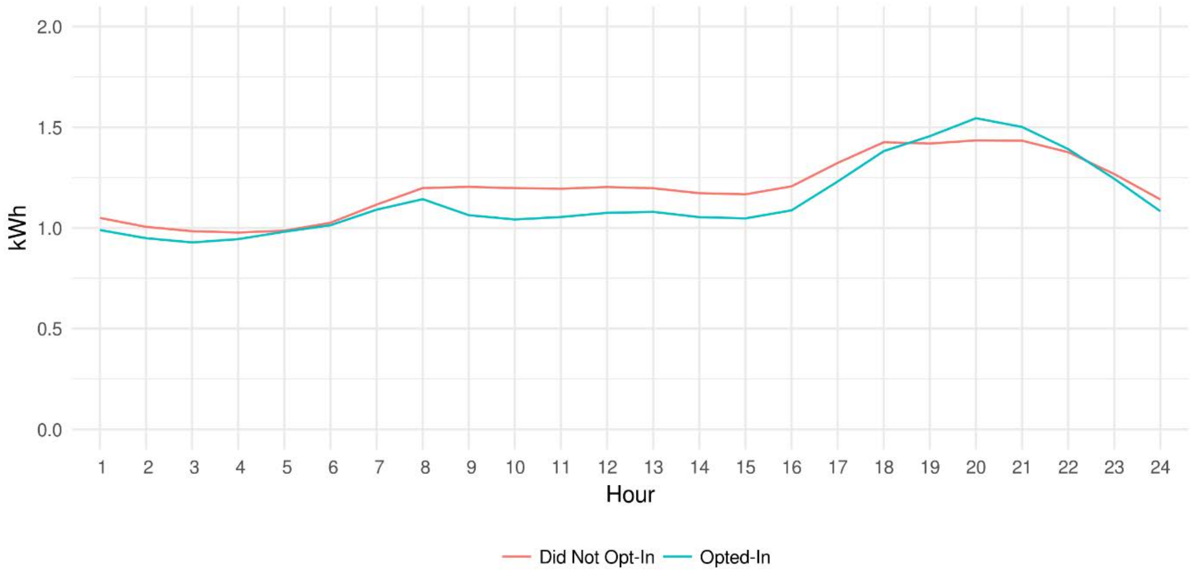
C.1 ESQ Price Distributor Load Profiles

Figure 108. Greater Sudbury Hydro Rate Only Opt-In Comparison - Summer



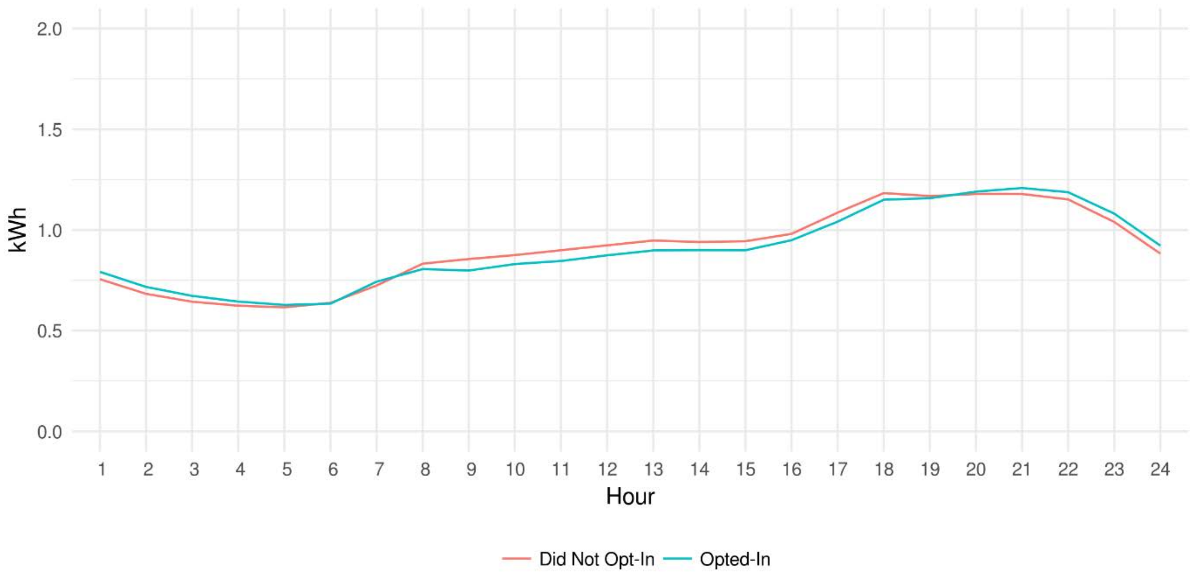
Source: Navigant Analysis

Figure 109. Greater Sudbury Hydro Rate Only Opt-In Comparison - Winter



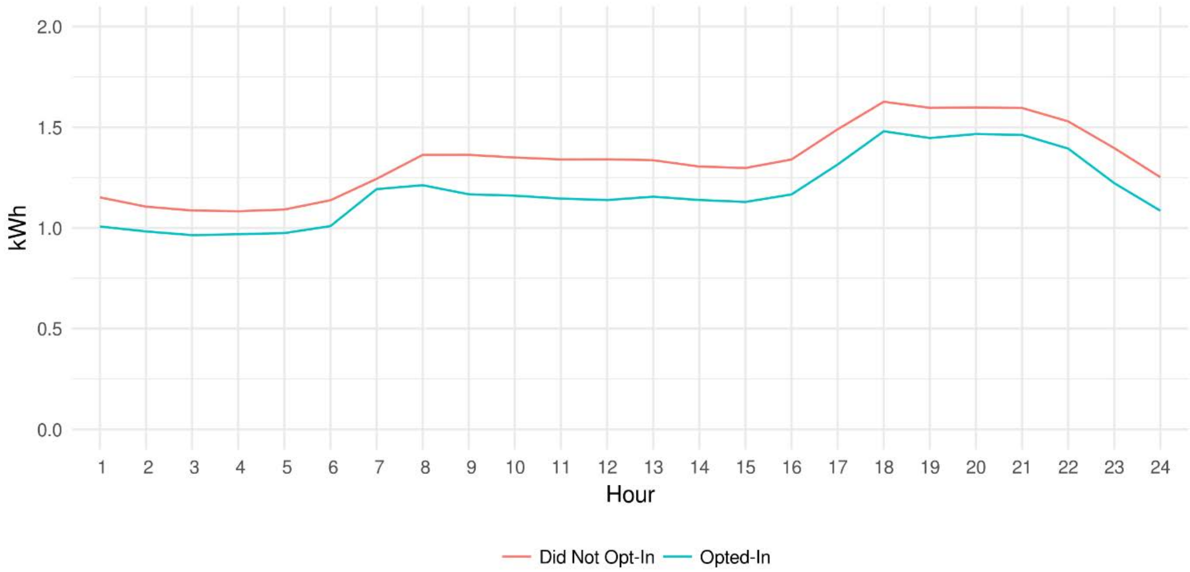
Source: Navigant Analysis

Figure 110. North Bay Hydro Distribution Ltd. Rate Only Opt-In Comparison - Summer



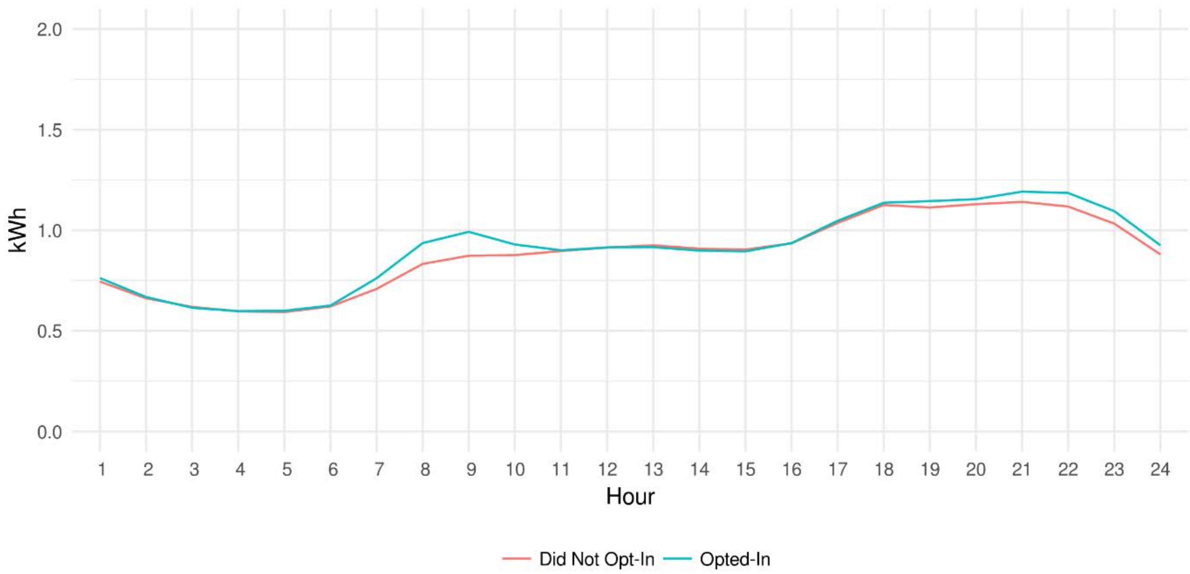
Source: Navigant Analysis

Figure 111. North Bay Hydro Distribution Ltd. Rate Only Opt-In Comparison - Winter



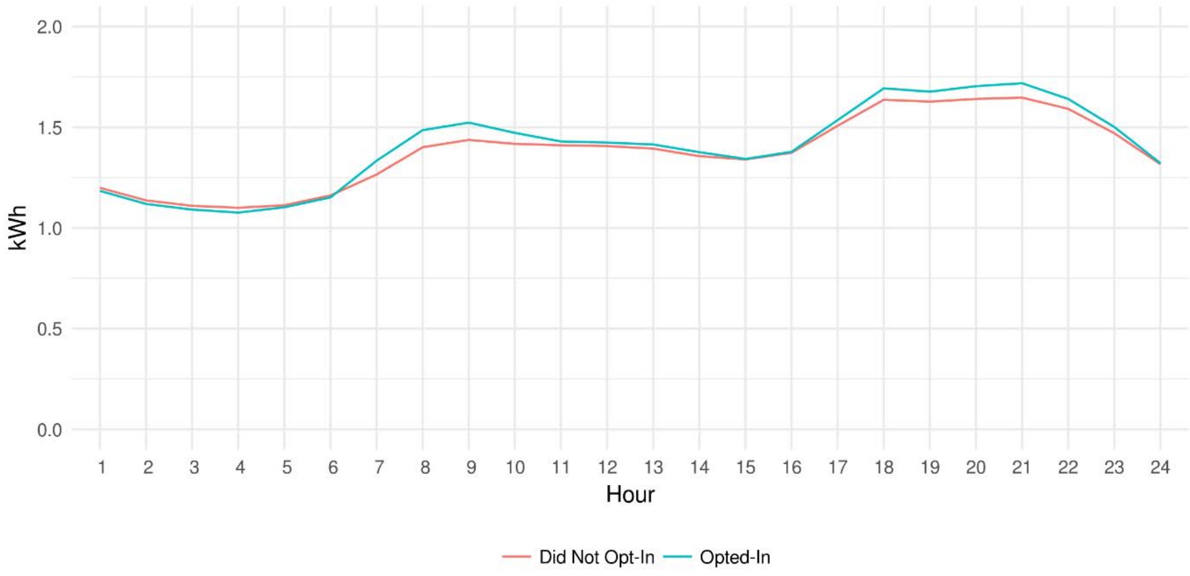
Source: Navigant Analysis

Figure 112. PUC Services Inc. Rate Only Opt-In Comparison - Summer



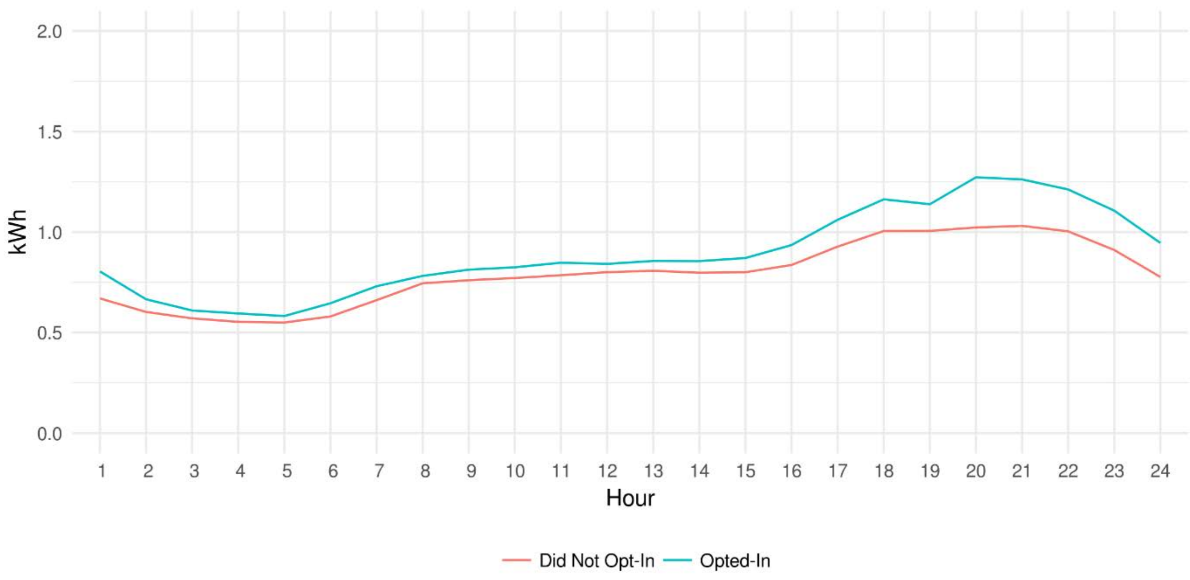
Source: Navigant Analysis

Figure 113. PUC Services Inc. Rate Only Opt-In Comparison - Winter



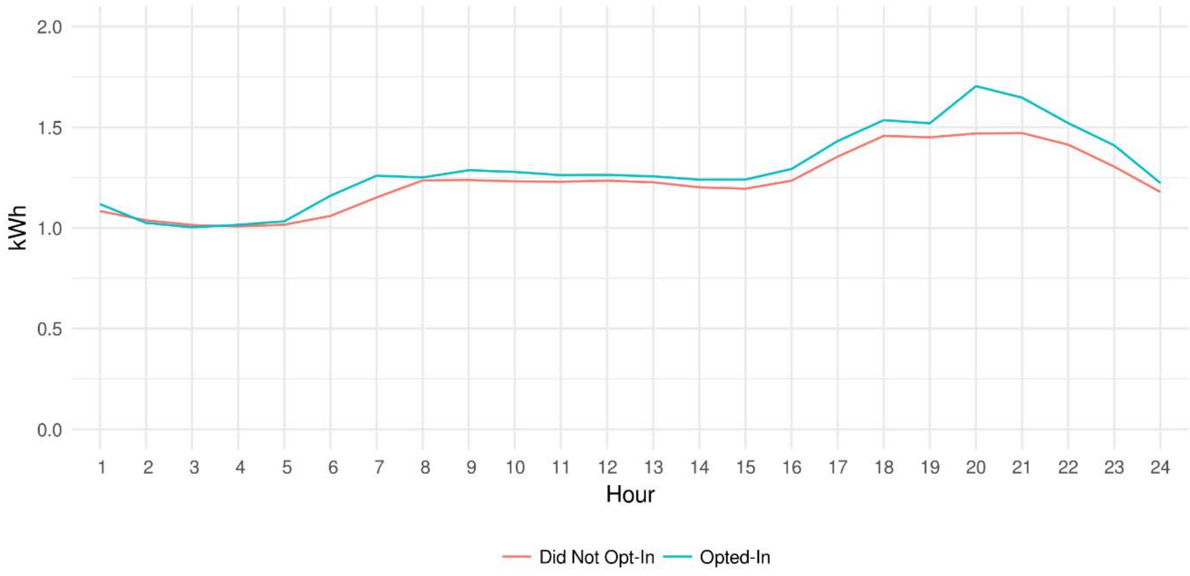
Source: Navigant Analysis

Figure 114. Greater Sudbury Hydro Rate and Enabling Technology Opt-In Comparison - Summer



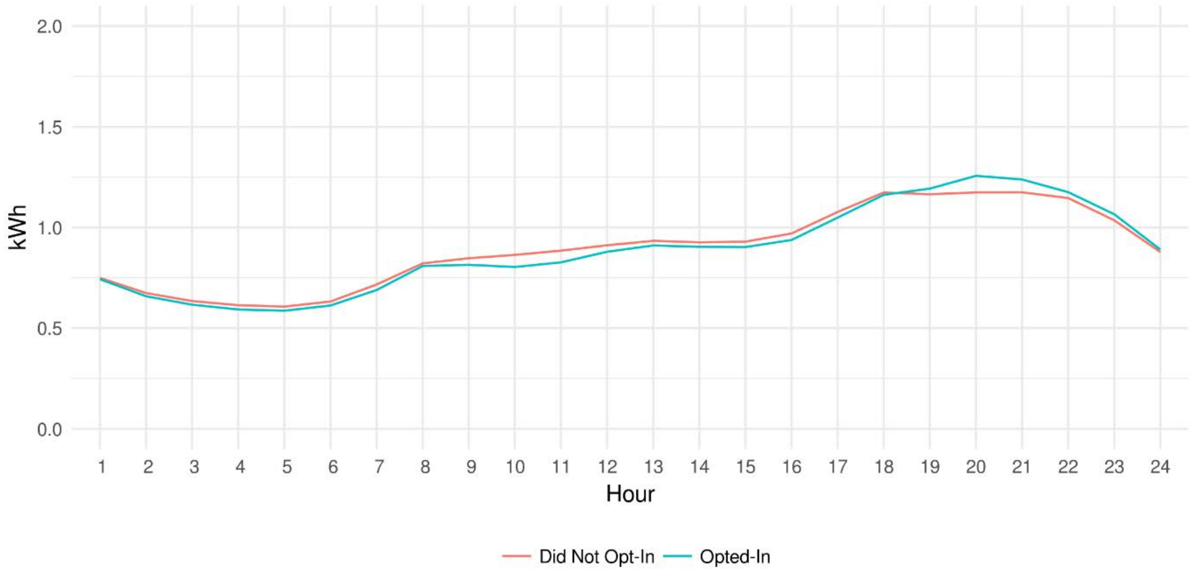
Source: Navigant Analysis

Figure 115. Greater Sudbury Hydro Rate and Enabling Technology Opt-In Comparison - Winter



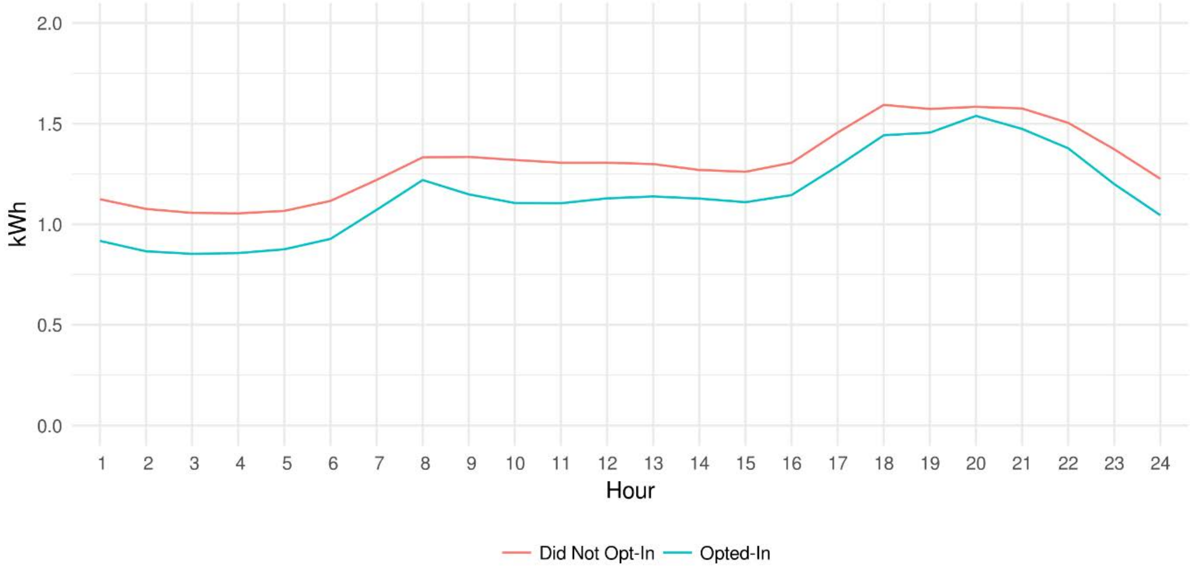
Source: Navigant Analysis

Figure 116. North Bay Hydro Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Summer



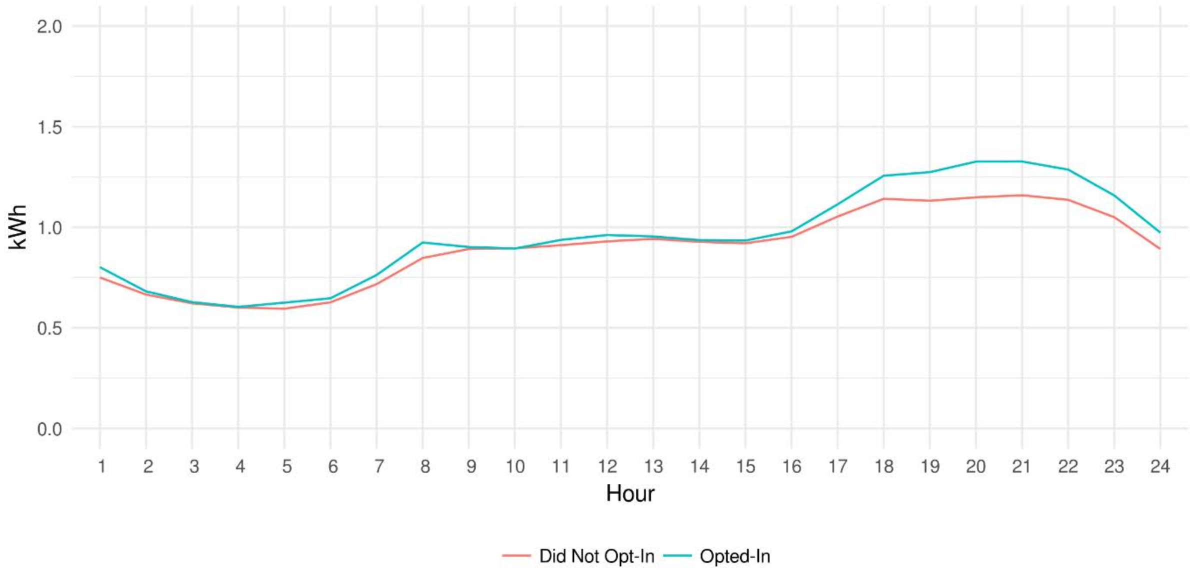
Source: Navigant Analysis

Figure 117. North Bay Hydro Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Winter



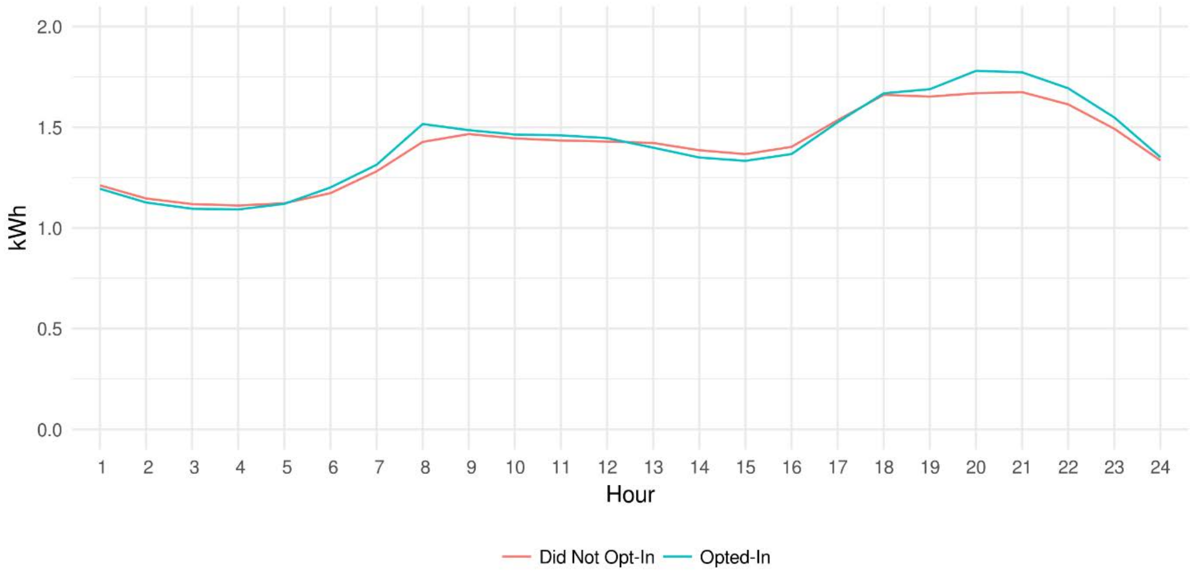
Source: Navigant Analysis

Figure 118. PUC Services Inc. Rate and Enabling Technology Opt-In Comparison - Summer



Source: Navigant Analysis

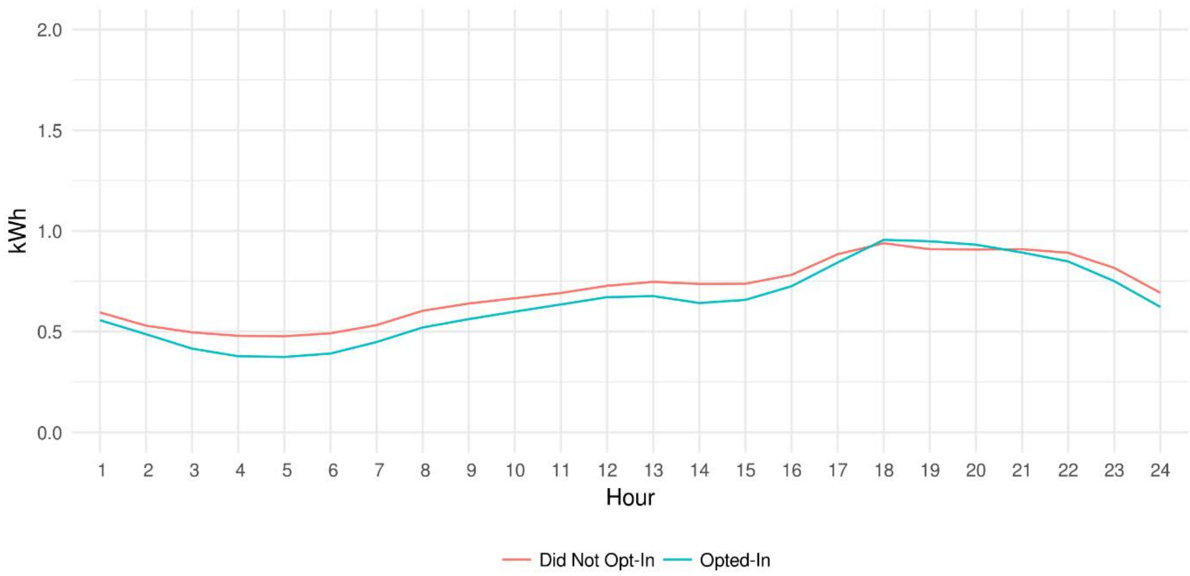
Figure 119. PUC Services Inc. Rate and Enabling Technology Opt-In Comparison - Winter



Source: Navigant Analysis

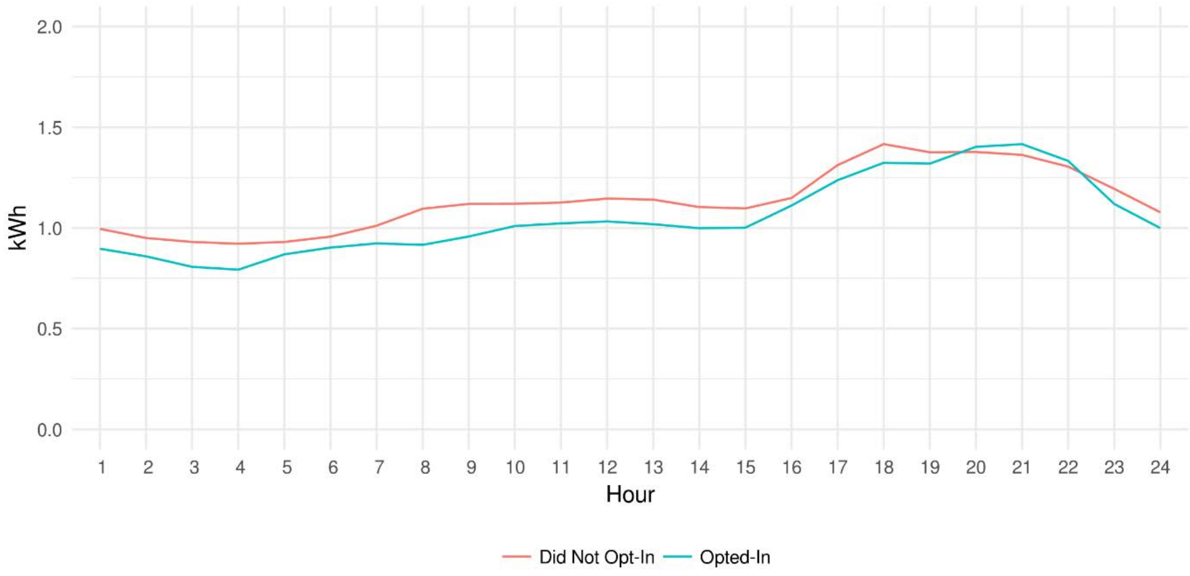
C.2 Seasonal Price Distributor Load Profiles

Figure 120. Northern Ontario Wires Rate Only Opt-In Comparison - Summer



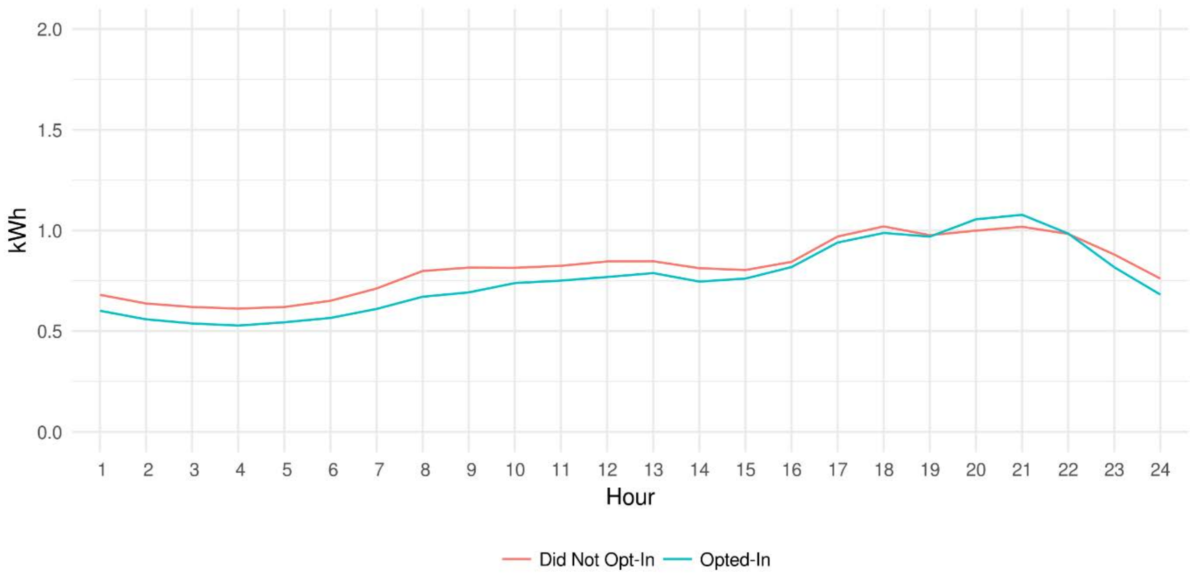
Source: Navigant Analysis

Figure 121. Northern Ontario Wires Rate Only Opt-In Comparison - Winter



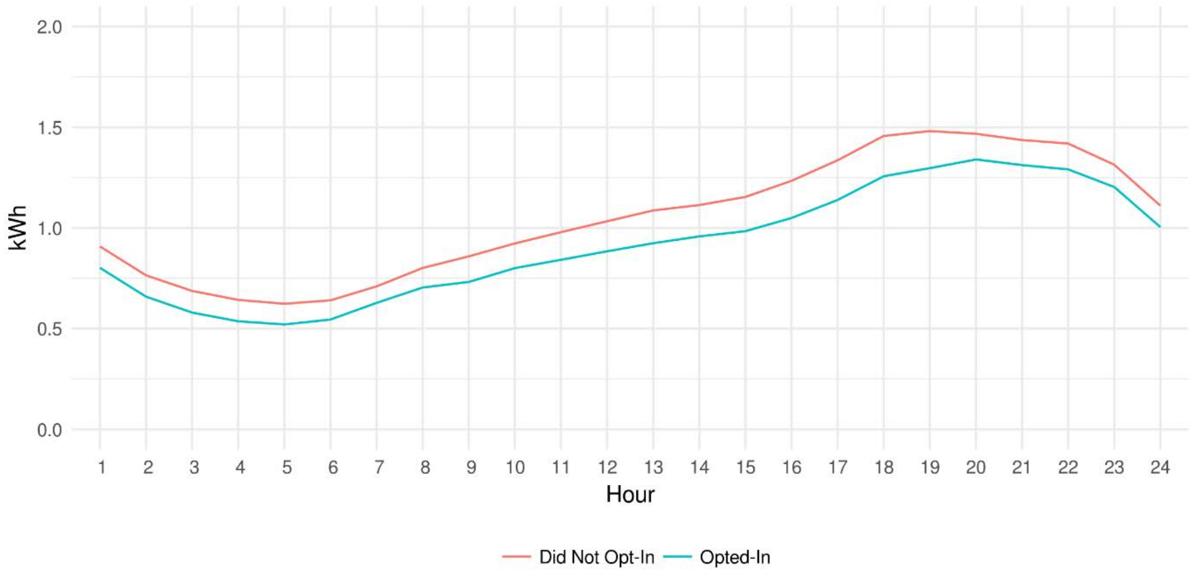
Source: Navigant Analysis

Figure 122. Northern Ontario Wires Rate Only Opt-In Comparison - Shoulder



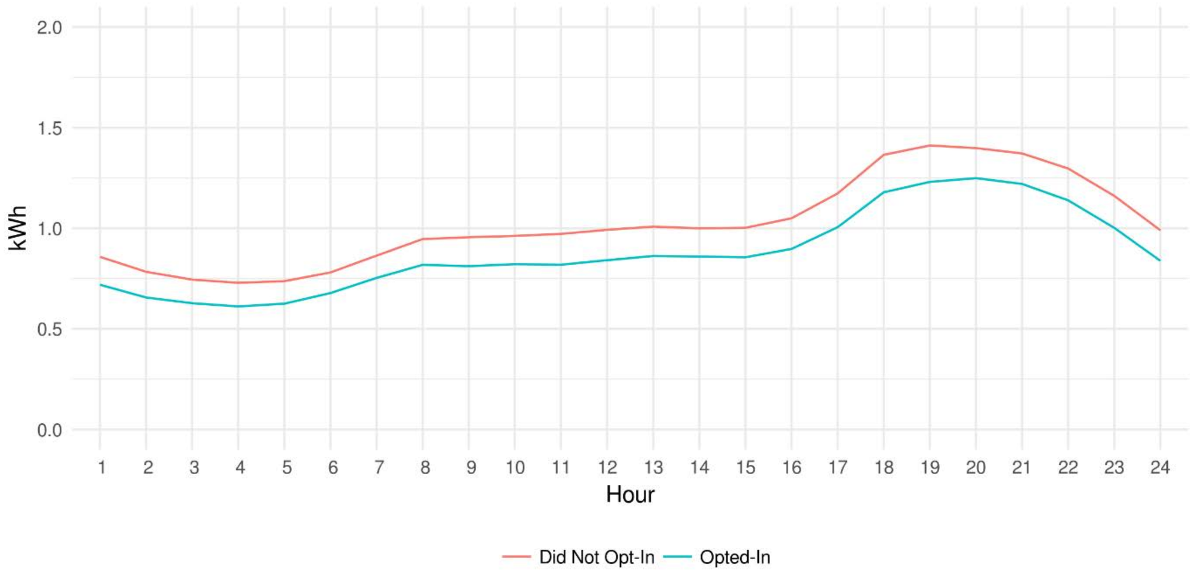
Source: Navigant Analysis

Figure 123. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Summer



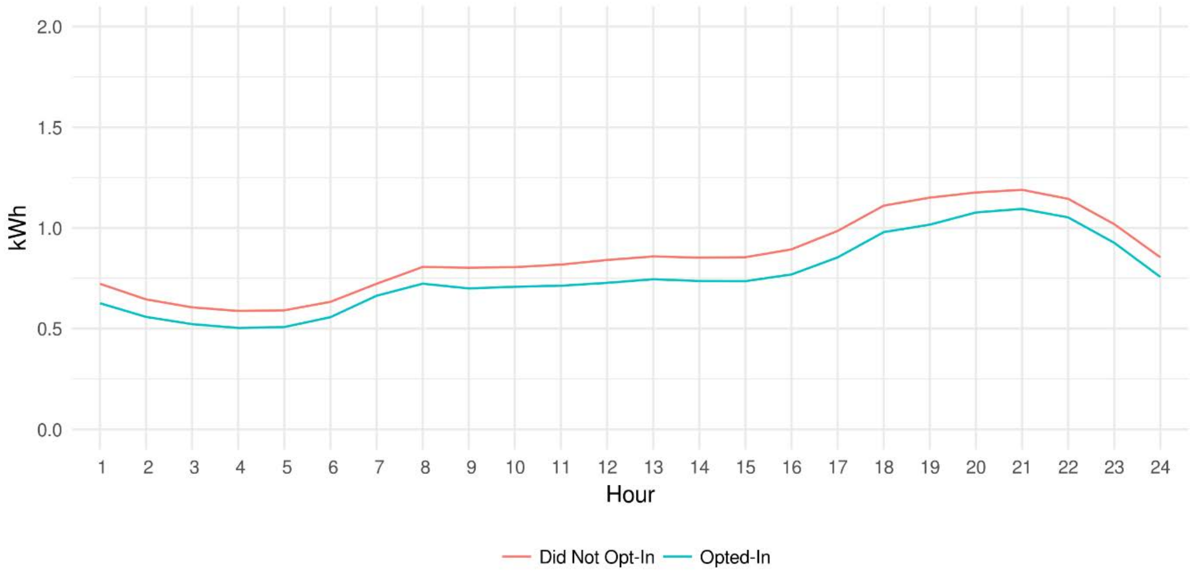
Source: Navigant Analysis

Figure 124. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Winter



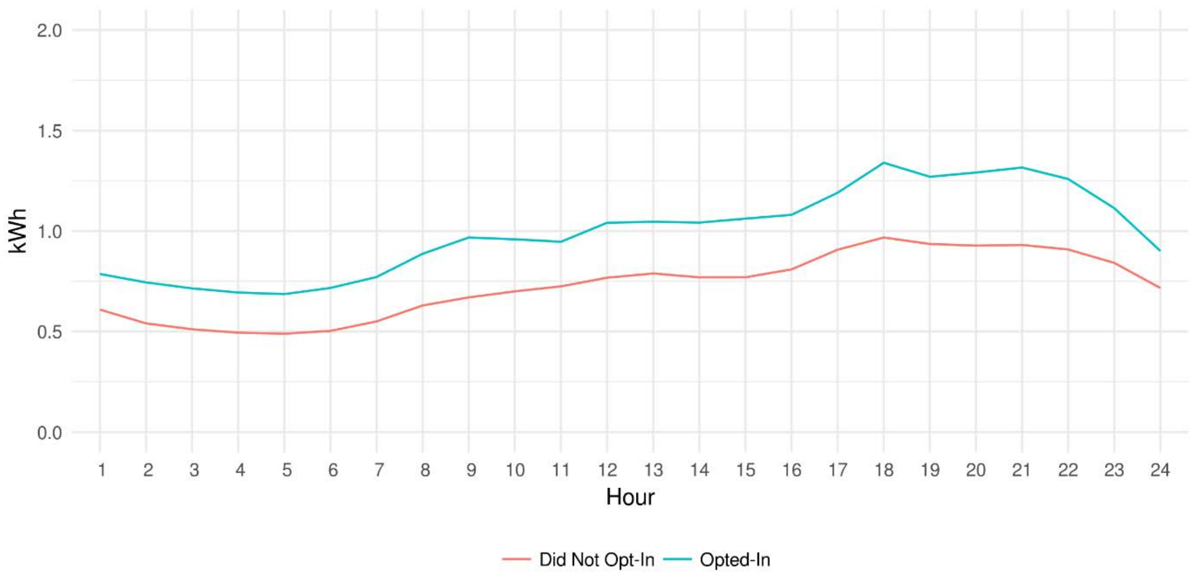
Source: Navigant Analysis

Figure 125. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Shoulder



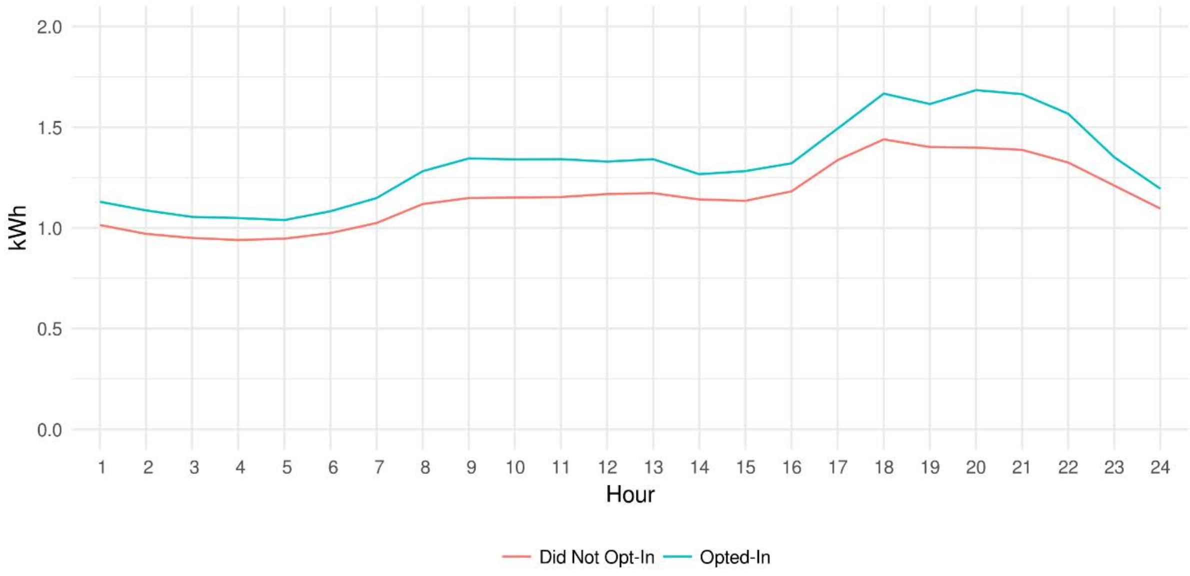
Source: Navigant Analysis

Figure 126. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Summer



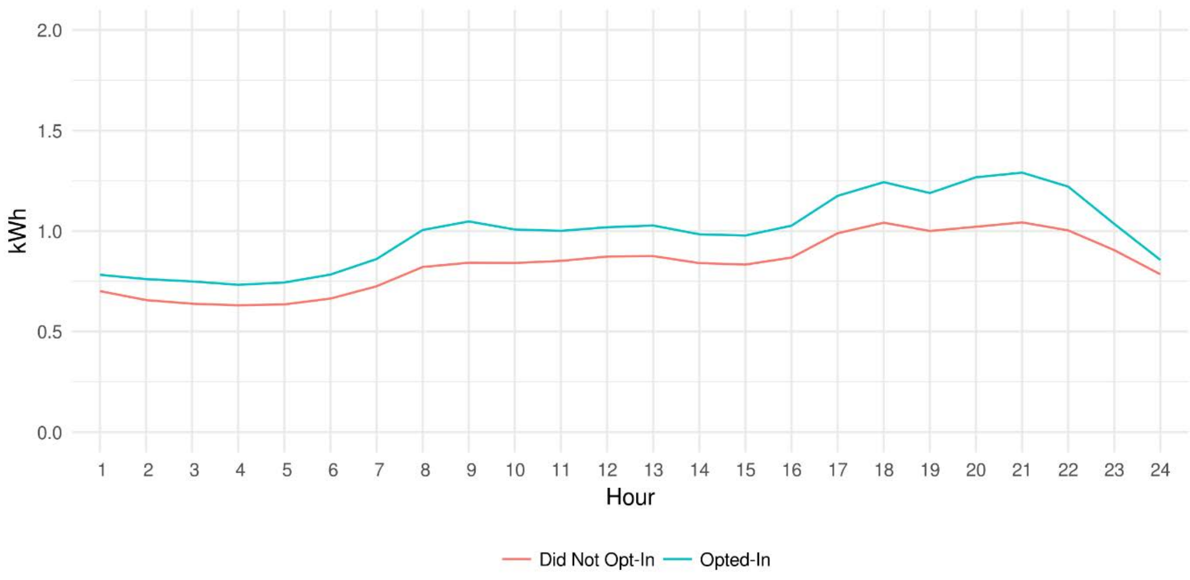
Source: Navigant Analysis

Figure 127. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Winter



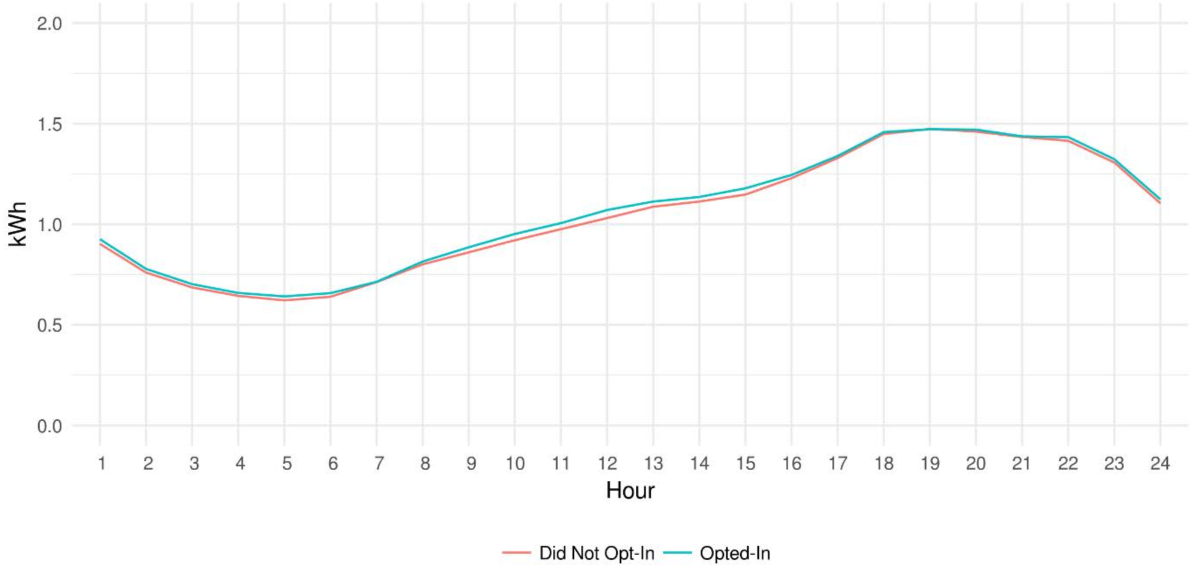
Source: Navigant Analysis

Figure 128. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Shoulder



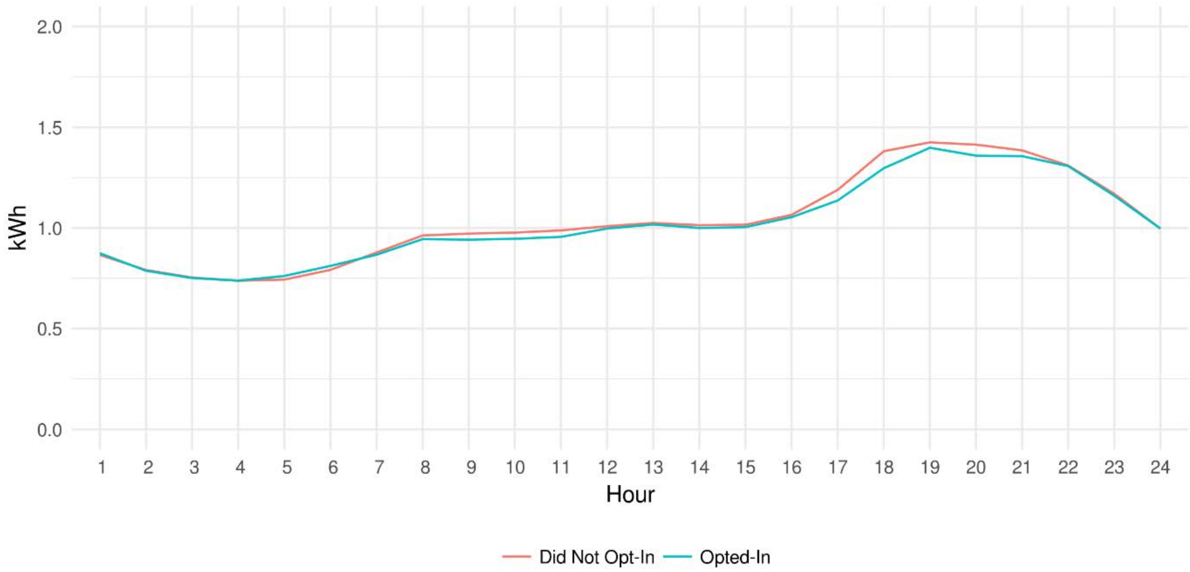
Source: Navigant Analysis

Figure 129. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Summer



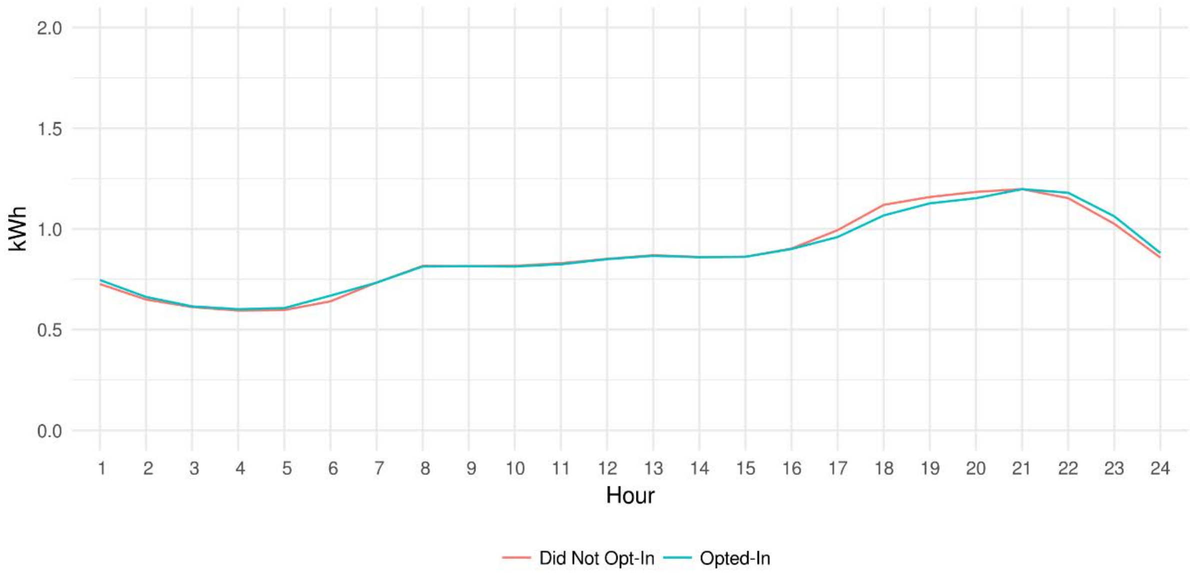
Source: Navigant Analysis

Figure 130. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Winter



Source: Navigant Analysis

Figure 131. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Shoulder



Source: Navigant Analysis

APPENDIX D. PARTICIPANT COMMUNICATION SAMPLES

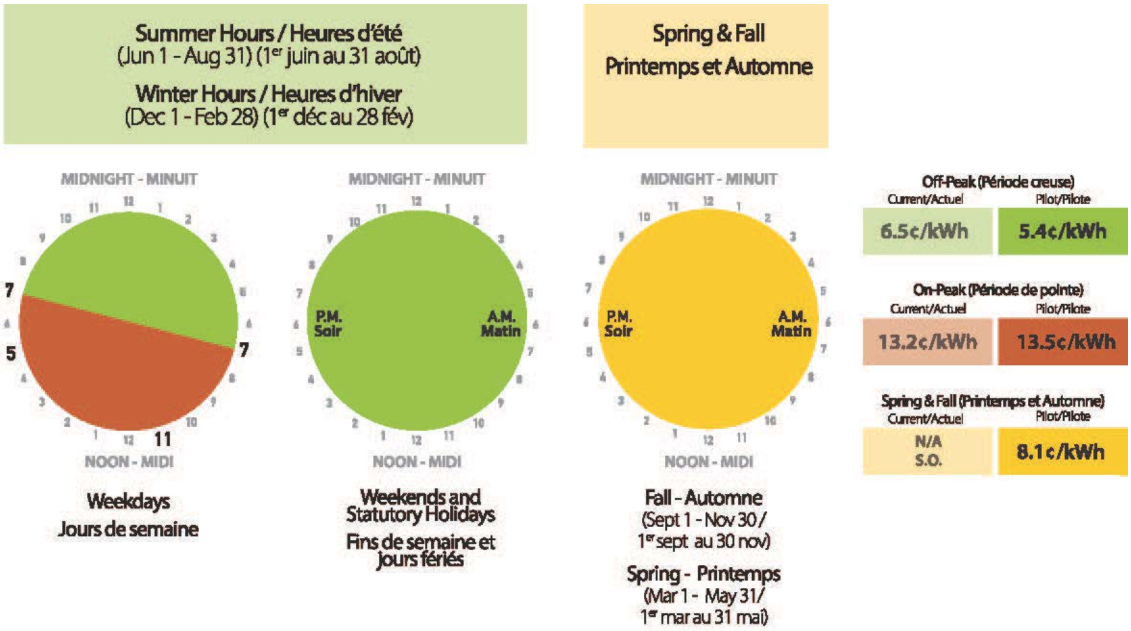
D.1 Enrollment Confirmation Email – Seasonal Price – Rate Only Treatment

Hi

Thank you for completing and returning the Participant Application Form.

This email confirms that you have been successfully enrolled in the Time-Of-Use Pilot Program.

The electricity Time-of-Use rates for the pilot will begin on **October 1st, 2018 and continue until August 31st, 2019**. You may opt-out of these rates at any time and you will be returned to the current Time-of-Use pricing structure. The Time-of-Use rates for the pilot will be as follows:



Throughout the pilot, we will periodically email you energy-savings tips that is catered to allow you to take full advantage of your new electricity pricing structure. Please ensure that you have marked this email address as “Safe” in order to avoid emails from this address being sent into the junk or spam folders.

Near the end of the pilot, we will contact you to set up an appointment at a mutually convenient day and time to have your FREE thermostat installed! Installation charges are on us!

We would like to once again express our deepest gratitude for your participation in this exciting new pilot and we look forward to providing you with the opportunity to realize savings on your hydro bill. If you have any further questions about the pilot, please feel free to contact me via email at toupilot@customerfirstinc.com, or via phone at **1.833.55PILOT.**

Regards,

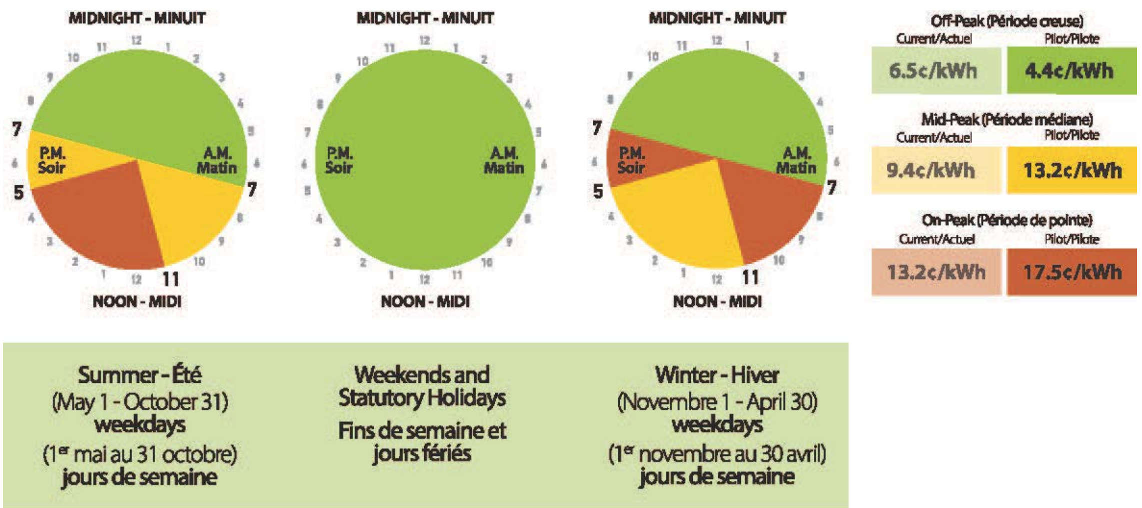
D.2 Enrollment Confirmation Email – ESQ Price – Rate & Enabling Technology Treatment

Hi

Thank you for completing and returning the Participant Application Form.

This email confirms that you have been successfully enrolled in the Time-Of-Use Pilot Program.

The electricity Time-of-Use rates for the pilot will begin on **October 1st, 2018 and continue until August 31st, 2019**. You may opt-out of these rates at any time and you will be returned to the current Time-of-Use pricing structure. The Time-of-Use rates for the pilot will be as follows:



We will contact you via phone shortly to set up an installation appointment with your local utility to have your free programmable thermostat installed. Installation charges are on us!

Throughout the pilot, we will periodically email you energy-savings tips that is catered to allow you to take full advantage of your new electricity pricing structure. Please ensure that you have marked this email address as "Safe" in order to avoid emails from this address being sent into the junk or spam folders.

We would like to once again express our deepest gratitude for your participation in this exciting new pilot and we look forward to providing you with the opportunity to realize savings on your hydro bill. If you have any further questions about the pilot, please feel free to contact me via email at toupilot@customerfirstinc.com, or via phone at **1.833.55PILOT.**

Regards,