CustomerFirst Regulated Price Plan Pilot Program: Interim Report

Interim Impact and Process Evaluation Report

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TABLE OF CONTENTS

List of Figures

List of Tables

List of Equations

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 prices 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 LDC's.

Table 1. Partner LDC's and TOU Pricing Assignments[1]

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 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.

- **Seasonal** – 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.

In total, there were 1,091 participants that enrolled in the pilot across all LDC's, and the two treatment groups, see Table 2. This represents an overall acceptance rate[2] 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. In total, 82 customers opted out representing 7.5% of participants.

[1] Espanola Regional Hydro Distribution Corp. was originally part of the pilot application. However, this LDC was excluded from the experiment 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.

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

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[3] identifies two types of experimental designs that are deemed to deliver acceptable validity[4]: i). Randomized Control Trial (RCT) or ii). Randomized Encouragement Design (RED). The RCT design effectively employs a recruit and deny strategy which caused concerns for CustomerFirst and partner LDC's with regards to customer satisfaction. Hence, an RED design was implemented for the purpose of this pilot.

For each LDC the study population was determined by screening out the residential customers on a retail contract and screening the remaining residential customers into the study population which was then split into three equally sized groups of which two were encouraged to participate via direct mails incentivizing them with a thermostat either the end of the pilot, creating the Rate Only Treatment Group, or at the start of the pilot, creating the Rate & Enabling Technology Treatment Group. The third group formed the control group and was not encouraged to participate in the pilot.

While the RED is a robust experimental design which is a key to any evaluation, it places restrictions on the type of marketing that can be conducted to enroll customers into the pilot and has had notable impacts on the enrollment numbers and has presented challenges in obtaining statistically significant impacts. Given the challenges associated with low enrollment, based on discussions with CustomerFirst and the OEB, Navigant focused on the Intent to Treat (ITT) impacts which provide an unbiased impact of encouragement.

Navigant used the following data to estimate energy impacts:

- **Tracking Data** – provided by CustomerFirst for the study population for all LDC's 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-period data). For the purpose of this interim report, the program period covers the time from October 1, 2018 to June 30, 2019. It is important to note that this timeframe does not include

[3] https://www.oeb.ca/oeb/_Documents/EB-2016-0201/RPP_Roadmap_Pilot_Plan_Technical_Manual.pdf

[4] 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).

key summer months, July and August, where we could potentially see the largest impacts for the summer season. These months will be included in the final analysis.

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 LDC's 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 to gauge participant motivations and expectations, anticipated benefits, and assess marketing and advertising effectiveness.

Results

Energy Impact Results

Due to the low enrollment, just over one percent, the RED analysis did not yield any statistically significant results with regards to the price impacts of the pilot TOU prices being piloted. The impacts of encouragement, presented in the tables below, have wide confidence bands and are not statistically different from zero for both the ESQ and Seasonal TOU prices. The point estimates are relatively small (typically less than 1% in absolute value) and are statistically indistinguishable from zero. Thus, there is no statistical evidence that impacts vary by treatment type (receiving the thermostat at the start vs. at the end of the pilot), season, or TOU period. As noted above, the interim report timeframe does not cover key summer months of July and August where we could potentially see the most impacts.

Table 3. ESQ Price Energy Impacts – Rate Only

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Greater Sudbury Hydro	Winter	On-Peak	-0.004	-0.33	0.47	43.60
		Mid-Peak	-0.005	-0.46	0.34	57.70
		Off-Peak	-0.004	-0.30	0.50	40.73
North Bay Hydro Distribution Ltd.	Winter	On-Peak	0.000	0.01	0.99	0.59
		Mid-Peak	-0.002	-0.17	0.80	15.40
		Off-Peak	0.002	0.18	0.77	18.16
PUC Services Inc.	Winter	On-Peak	-0.008	-0.58	0.25	70.23
		Mid-Peak	-0.009	-0.72	0.19	80.30
		Off-Peak	-0.005	-0.37	0.45	45.49

Source: Navigant Analysis

Table 4. ESQ Price Energy Impacts – Rate and Enabling Technology

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Greater Sudbury Hydro	Winter	On-Peak	0.003	0.26	0.57	34.88
		Mid-Peak	0.001	0.07	0.88	9.18
		Off-Peak	0.003	0.21	0.64	28.82
Greater Sudbury Hydro	Winter	On-Peak	-0.005	-0.40	0.53	38.60
		Mid-Peak	-0.006	-0.49	0.48	42.70
		Off-Peak	-0.005	-0.41	0.50	41.12
PUC Services Inc.	Winter	On-Peak	-0.007	-0.47	0.35	56.98
		Mid-Peak	-0.009	-0.65	0.23	72.94
		Off-Peak	-0.005	-0.38	0.45	46.17

Source: Navigant Analysis

Table 5. Seasonal Price Energy Impacts – Rate Only

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Northern Ontario Wires	Winter	On-Peak	0.002	0.15	0.91	7.14
		Off-Peak	0.010	0.90	0.47	43.73
	Shoulder	Flat	0.004	0.54	0.65	27.40
Newmarket-Tay Power Distribution Ltd.	Winter	On-Peak	-0.010	-1.06	0.05	121.09
		Off-Peak	-0.007	-0.71	0.16	86.29
	Shoulder	Flat	-0.005	-0.59	0.22	74.35

Source: Navigant Analysis

Table 6. Seasonal Energy Impacts – Rate and Enabling Technology

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Northern Ontario Wires	Winter	On-Peak	0.003	0.30	0.81	14.46
		Off-Peak	0.005	0.42	0.73	20.94
	Shoulder	Flat	-0.001	-0.11	0.92	5.83
Newmarket-Tay Power Distribution Ltd.	Winter	On-Peak	0.004	0.38	0.47	43.69
		Off-Peak	0.002	0.17	0.74	20.59
	Shoulder	Flat	0.001	0.17	0.72	21.73

Source: Navigant Analysis

Process Evaluation Results

The results presented in this section are based on the responses collected from the participant survey, deployed shortly after the pilot commenced, and program manager interviews. Navigant received 435 survey responses from participants across all utilities out of which 408 were complete representing a response rate of thirty seven percent which was higher than expected. Table 7 illustrates the total number of pilot participants and the response rates for each utility.

Table 7. Survey Response Rate

Local Distribution Company	Number of Participants	Completed Surveys	Response Rate
Greater Sudbury Hydro	255	91	36%
North Bay Hydro Distribution Ltd.	158	78	49%
PUC Services Inc.	209	86	41%
Northern Ontario Wires	65	26	40%
Newmarket-Tay Power Distribution Ltd.	404	127	31%
Total	**1091**	**408**	**37%**

Source: Navigant Analysis

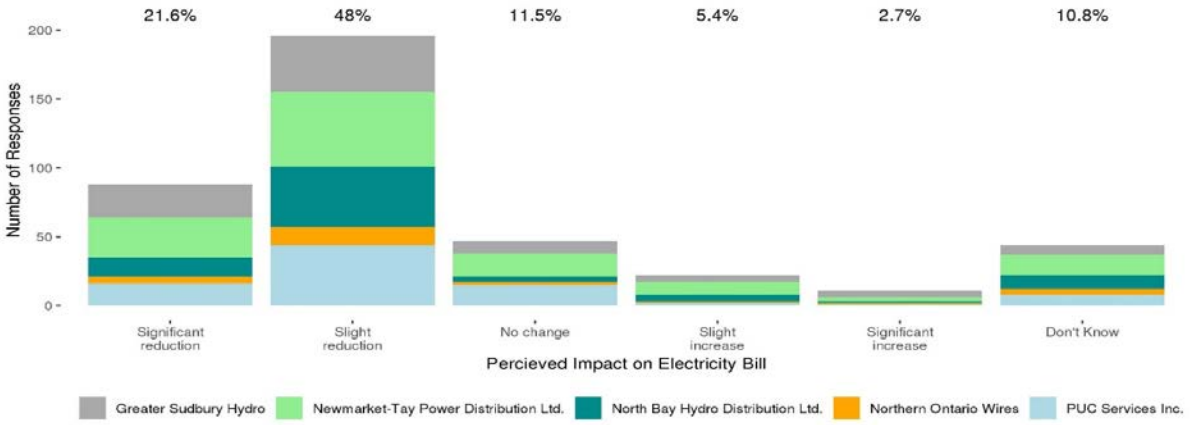
On average there are approximately 2.5 people per household. Twenty six percent of all homes identified that they had an annual household income of less than $50,000[5]. The average age was forty-five to fifty-four years with a four-year college degree being the most common education level. Those working full or part time or going to school represent fifty seven percent of respondents while those at home all day (retired, working from home or staying home with dependents) represent thirty seven 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 believe the pilot will help them achieve this goal. Over seventy percent of respondents believe they will see a decrease, while just eight percent believe they will see an increase and eleven percent believe it will not have any effect while the rest are uncertain of the impacts on their bills, see Figure 1.

[5] 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 1. Perceived Impact on Electricity Bill

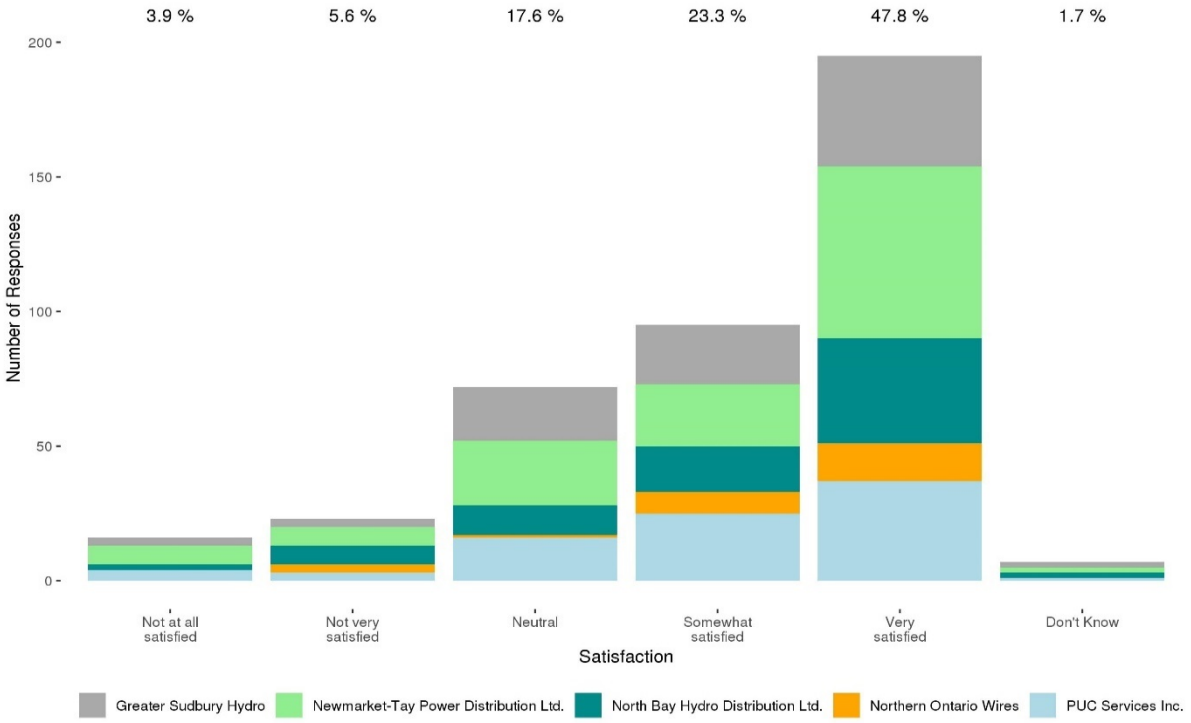


Source: Navigant Analysis

Before the pilot, ninety-one percent of respondents reported that they purposely shifted their consumption patterns to varying degrees. Ninety-four percent of respondents reported that they planned to shift their electricity consumption during the pilot. Common behavioural shifts reported by respondents include doing laundry and running the dishwasher during off-peak times, as well as reducing lighting during on-peak times. All survey respondents stated that they were more aware of TOU prices upon enrolling in the pilot.

The registration or sign-up process required for the pilot was well received by respondents with over seventy one percent of respondents were satisfied while only ten percent were not satisfied as can be seen in Figure 2 below. 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 which could have negatively impacted the enrollment perceptions of some participants. LDC program managers also held the view that the registration window was quite narrow.

Figure 2. Registration Process Satisfaction



Source: Navigant Analysis

Participants were asked about their initial perceptions of the pilot pricing schemes were and whether they were satisfied thus far with the price offering. Initial impressions of the alternate price structures offered through the RPP pilot were received relatively well by respondents with thirty-five percent reported being somewhat satisfied, seventeen percent being very satisfied and less than ten percent being unsatisfied When interviewed about the pilots, the LDC program managers indicated that the incentives, namely the decrease in the off-peak price did not offset the increase in on-peak and mid-peak prices and 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 this is what the pilot is intended to test.

Conclusion and Recommendations

Navigant conducted an impact evaluation as well as a process evaluation as part of the interim analysis and the key learnings and recommendations that have are:

1. **Positive Impressions with Pilot Enrollment but 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 of why customers were being transferred would greatly aid in easing customer concerns.

LDC program managers reported that some customers experienced delays in call backs of up to four or five days and also held the view that the registration window was quite narrow. Providing a wider enrollment window could improve enrollment and 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.

2. Explore Quasi-Experimental Design

The RED is a robust experimental design which is a key to any evaluation. However, the restrictions it places on the type of marketing that can be done has had serious impacts on the enrollment and the associated challenges with drawing meaningful insights from the RED. For the final analysis and report, Navigant will explore a quasi-experimental design, matching analysis[6], that was proposed as a contingency approach in the event that the RED results are not precise enough, matching analysis.

The matching analysis involves the development of a control group with similar patterns of consumption to the participant group in the pre-treatment period. Effectively, it involves finding an ideal or matched control for each participant from the control group that exhibits a consumption pattern in the pre-period that is most similar to that particular participant. Navigant will also explore pooling the LDC's that have been assigned the same pilot pricing scheme to potentially improve the precision of the results[7].

As noted in section 2.1, a quasi-experimental design, such as matching analysis, is commonly used as a contingency plan in the event that the randomized experimental design does not yield reasonably precise estimates. This approach can potentially reduce the variation in the data as we no longer include the entire residential population and balance 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. Hence, given the challenges encountered with the RED due to low enrollment, this is the next logical step and will be explored in the final analysis.

3. Accounting 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.

[6] Navigant has previously used this approach to evaluate the energy and demand impacts of the Alectra (PowerStream) Advantage Power Pricing and Residential Energy Management programs.

As noted in section 2.1, this was proposed as a contingency approach in the event that the RED results are not precise enough but due to the challenges in receiving the hourly data for the entire residential population for five LDC's and the timelines for submitting the interim report; CustomerFirst and Navigant proposed to the OEB that the contingency approach (matching) be conducted for the final analysis to prevent further delays with regards to the interim report.

[7] As tested with the RED, Navigant will also explore if additional variable interactions coupled with matching and pooling the LDC's yields any benefit. Navigant will also consider explicitly modelling weather, particularly when the LDC's are pooled as there may be some differences in weather across LDC's, to explore potential improvements to the impact estimates.

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 8. Program design and management was undertaken by CustomerFirst, while program elements such as implementing the new prices were undertaken by the LDC's.

Table 8. Partner LDC's and TOU Pricing Assignments[8]

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

[8] Espanola Regional Hydro Distribution Corp. 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.

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 Price

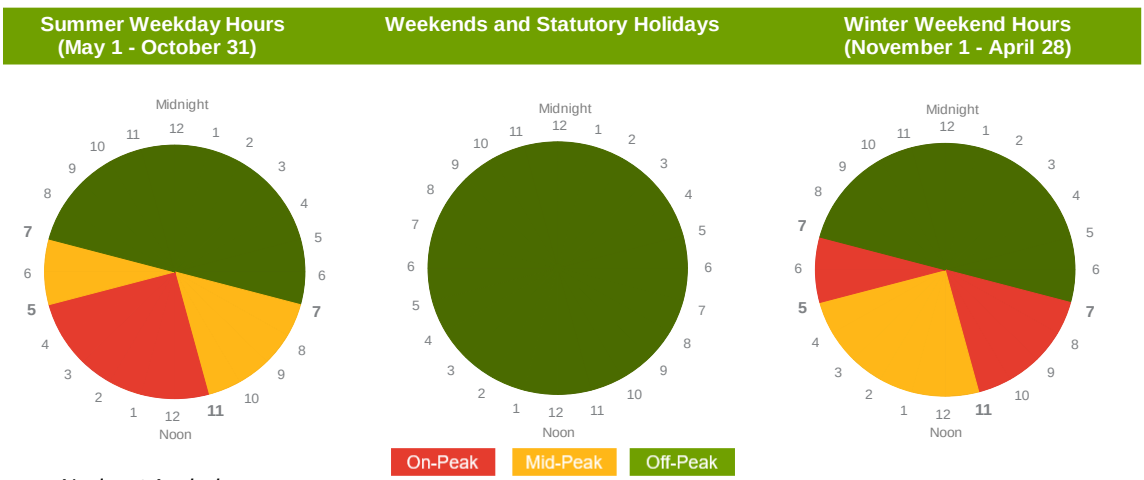
The ESQ price is based on the existing TOU structure (two seasons – summer/winter, three TOU periods – on-peak/mid-peak/off-peak), but with a greater differential between off-peak, mid-peak and on-peak prices, see Table 9. The ESQ price offers participants a lower off-peak price as compared to the existing TOU prices, but higher mid-peak and on-peak prices. The definitions of the TOU periods remain the same, see Figure 3.

Table 9. Enhanced Status Quo (ESQ) Price Comparison

Effective Date	Time of Use Period	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[9], Navigant Analysis

Figure 3. Enhanced Status Quo (ESQ) TOU Period Definitions



Source: Navigant Analysis

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

1.2.2 Seasonal TOU Price

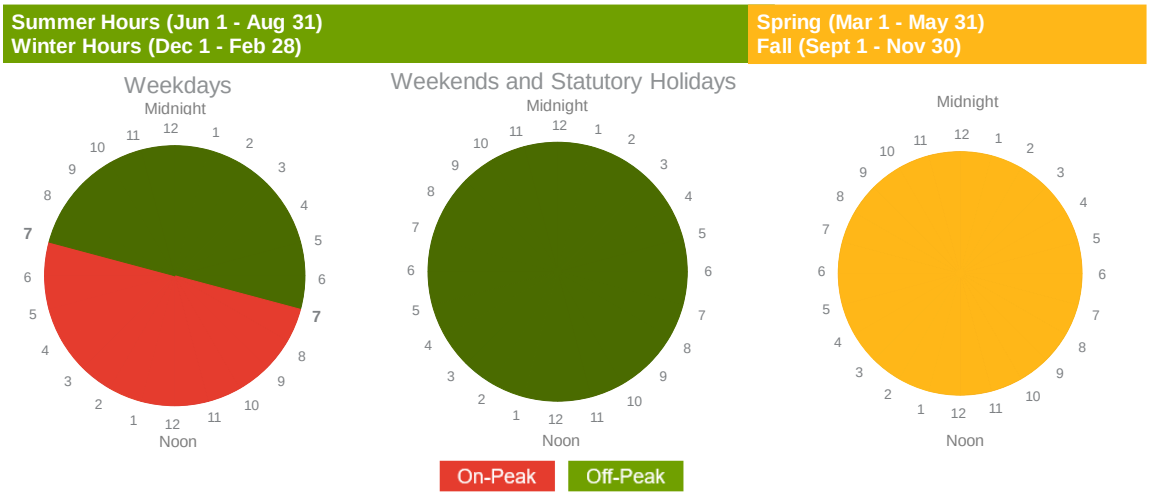
The Seasonal TOU price eliminates the mid-peak period during the summer and winter seasons while offering a flat price during the spring and fall seasons. The hours that would have been in the mid-peak are incorporated into the on-peak period effectively lengthening the duration of the on-peak period. The new TOU period definitions and pilot prices are shown below in Figure 4 and Table 10 respectively.

Table 10. Seasonal TOU Price Comparison

Effective Date	Time of Use Period	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[10], Navigant Analysis

Figure 4. Seasonal TOU Period Definitions



Source: Navigant Analysis

[10] 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 LDC's, and the two treatment groups, see Table 11. This represents an overall acceptance rate[11] of 1.26%. The ESQ and the Seasonal price structures had 622 and 469 participants, an acceptance rate of one and two percent respectively. Customers were encouraged 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. 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 12.[12]

Table 11. Enrollment Summary[13]

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

Table 12. 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

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

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

[13] 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.

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 events, for each of the pilot rates:

1. ESQ Price Ex-Post Impacts by LDC, Season and TOU Period for:
    a. Rate Only Treatment Group
    b. Rate and Enabling Technology Treatment Group
2. Seasonal Price Ex-Post Impacts by LDC, 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 the pilot;
- gauge how customers plan to modify their behaviour through participation in the pilot and as well as how these behaviours changed during the pilot period;
- identify participant demographics and characteristics; and
- from the perspective of partner LDC's 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 a more detailed technical description of the approach, including model specifications. 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.
- **Data Used to Estimate Price Impacts** – describes the data used to estimate price impacts.
- **Process Evaluation Methodology** – describes the approach used to evaluate qualitative aspects of the program.

2.1 Experimental Design

The OEB Pilot Plan Technical Manual[14] identifies two types of experimental designs that are deemed to deliver acceptable validity[15]: i). Randomized Control Trial (RCT) or ii). Randomized Encouragement Design (RED). The RCT design effectively employs a recruit and deny strategy which caused concerns for CustomerFirst and partner LDC's with regards to customer satisfaction. Hence, an RED design was proposed for the purpose of this pilot.

As part of the EM&V plan, a quasi-experimental approach that involves matching was also proposed as a contingency plan in the event that the RED results have large variances and are not precise enough. However, due to the challenges in receiving the hourly data for the entire residential population for five LDC's and the timelines for submitting the interim report; CustomerFirst and Navigant proposed and received approval from the OEB that the contingency approach (matching) be conducted for the final analysis to prevent further delays with regards to the interim report.

A quasi-experimental approach, such as matching, is commonly used as a contingency plan in the event that the randomized experimental design does not yield reasonably precise estimates. The tradeoff between the RED and matching approach is that of bias vs. variance. The advantage of the RED is that its structure provides an opportunity to address omitted variable bias and self-selection bias, which is discussed further in section 2.1.1, but can have large variances (most notably when the proportion of customers who enroll in the program is low). Matching analysis has also been adopted in other RPP pilots such as those conducted by Alectra[16] and Oshawa PUC[17].

The quasi-experimental design will yield 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 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.

[14] https://www.oeb.ca/oeb/_Documents/EB-2016-0201/RPP_Roadmap_Pilot_Plan_Technical_Manual.pdf

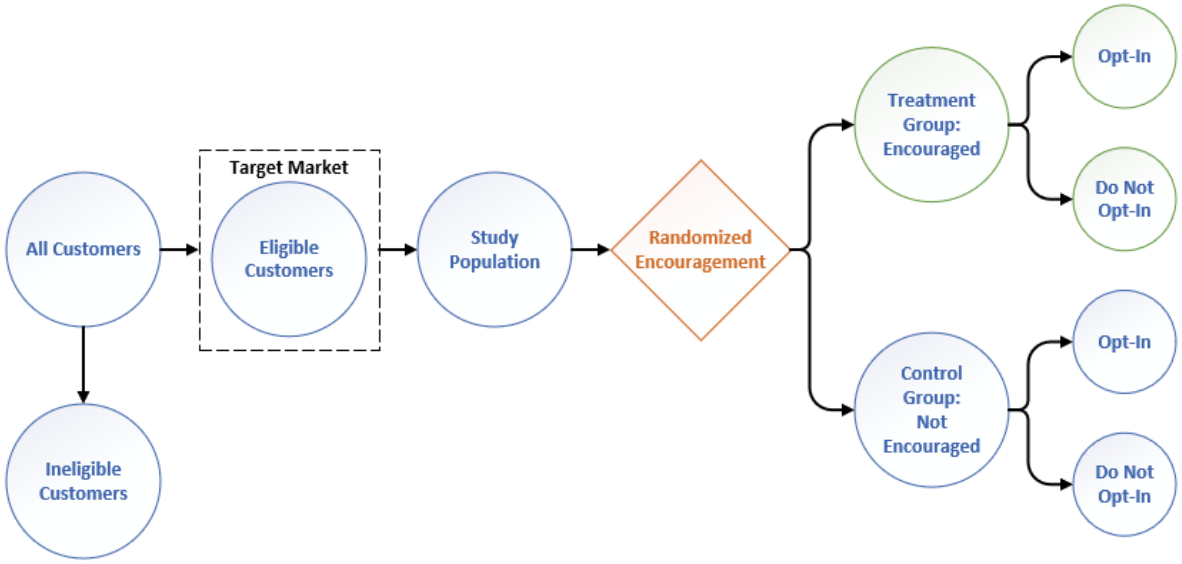
[15] In the absence of an experimental design, there exists the possibility that program participation is correlated with the error term (omitted variable bias) as the type of customer who would enroll in an opt-in program is, by the very act of enrolling, different than the type of customer who would 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).

[16] Alectra Interim Report - https://www.oeb.ca/sites/default/files/rpp-alectra-interim-report-20190409.pdf

[17] Oshawa PUC Interim Report - https://www.oeb.ca/sites/default/files/Oshawa-PUC-RPP-Pilot-Mid-Year-Results-Report.pdf

2.1.1 Overview of a Randomized Encouragement Design

Figure 5. General Illustration of an RED



Source: Navigant Analysis

Figure 5 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 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[18] 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

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

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 13.[19] 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 RPP rates and are charged using a different rate structure (usually a flat rate[20]) by their retailer and hence were screened out.

Table 13. Partner LDC's 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

[19] The assignments of the LDC's 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.

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

thermostat at the end of the pilot and hence were encouraged to participate in the price only program.

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 program.

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.

2.2 Estimating Energy Impacts

Navigant used a post program lagged dependent variable model to estimate program impacts applied to a panel dataset. The model effectively compares the hourly consumption during the post-period for customers in the treatment and control groups to estimate savings. Any differences in usage prior to enrollment are controlled for via the lagged dependent variable. A separate regression was run for each LDC, treatment group and season.

To estimate the impact of program participation, i.e. the intervention on compliers or the treatment effect on the treated (TOT), Navigant employed an instrumental variables (IV) approach. The IV approach uses the random assignment of customers who receive encouragement as an instrument for the customer's decision to accept the intervention, i.e. to participate in the pilot.

The IV approach involves a two stage least squares regression specification, see Appendix A.1. Due to the low enrollment, the first stage regression produced a weak instrument and as a result the impacts provided by the main (second stage) regression were not robust and hence not presented.

Given the challenges with estimating the TOT impacts due to low enrollment, based on discussions with CustomerFirst and the OEB, Navigant focused on the Intent to Treat (ITT) impacts which provides an unbiased impact of encouragement. Navigant used the same post program lagged dependent variable model with one difference, the first stage regression to create the instrumental variable is no longer required. The model specification is discussed in more detail in section 2.2.1.

2.2.1 Estimating ITT Impacts

The model specification is presented in Equation 1. The dependent variable is the customer's hourly energy use after the start of the program, also known as a post program regression (PPR) model. The explanatory variables include dummy variables for the month, day of the week and hour to account for weather[21] and other temporal effects; a customer's average hourly energy use in the week of the pre-program year; and an indicator for program encouragement.

[21] Treatment and control customers receive the same weather.

Equation 1. Post Program Regression Model to Estimate ITT Impacts[22]

$$kWh_{i,t} = \sum_{n=1}^{12} \alpha_n \bullet Month_{n,i,t} + \sum_{n=1}^{24} \beta_n \bullet Hour_{n,i,t} + \sum_{n=1}^{7} \delta_n \bullet DOW_{n,i,t} + \sum_{n=1}^{TOU} \tau_n \bullet TOUPeriod_{n,i,t} + \theta \bullet kWhLag_{i,t} + \sum_{n=1}^{TOU} \gamma_n \bullet Encouraged_{i,t} \bullet TOUPeriod_{n,i,t} + \varepsilon_{i,t}$$

Where:

i: subscript to indicate an individual customer.

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

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

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

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

$DOW_{n,i,t}$: a set of binary variables taking a value of 1 when $day\ of\ week(t) = n$ 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. Lags were taken separately for weekdays and weekends as the consumption profiles can be different.[23]

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

[22] As noted for the 2SLS model in Appendix A.1, Navigant did explore additional interactions such as month and hour and month and day of the week but noted that it did not improve the impact estimates of participation and hence kept the model simple.

[23] 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.

2.3 Data Used to Estimate Price Impacts

Navigant used the following data to estimate price impacts:

- Tracking Data
- Study Population Hourly Consumption Data

2.3.1.1 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);
- 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 14 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 14. 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

Local Distribution Company	Randomized Group	Study Population
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 LDC's and the two enrollment groups. 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.

2.3.1.2 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-period data). For the purpose of this interim report, the program period covers the time from October 1, 2018 to June 30, 2019. It is important to note that this timeframe does not include key summer months such as July and August which could potentially see the largest impacts for the summer season. However, these months will be included in the final analysis.

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.

In total, hourly data was not available for approximately three percent of customers. Any zero consumption values were removed for a customer so as not to confound the impact estimates.[24] Approximately one and a half percent of the total observations had zero values. Some customers had duplicate consumption values reported for the same timeframe and were excluded from the analyses as it was unclear which values indicated true consumption. In total, three and a half percent of customers were removed as a result duplicate consumption values for the same timeframe. Upon completing the data cleaning, a total 1063 participants remained and were used in the analysis.

2.4 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.

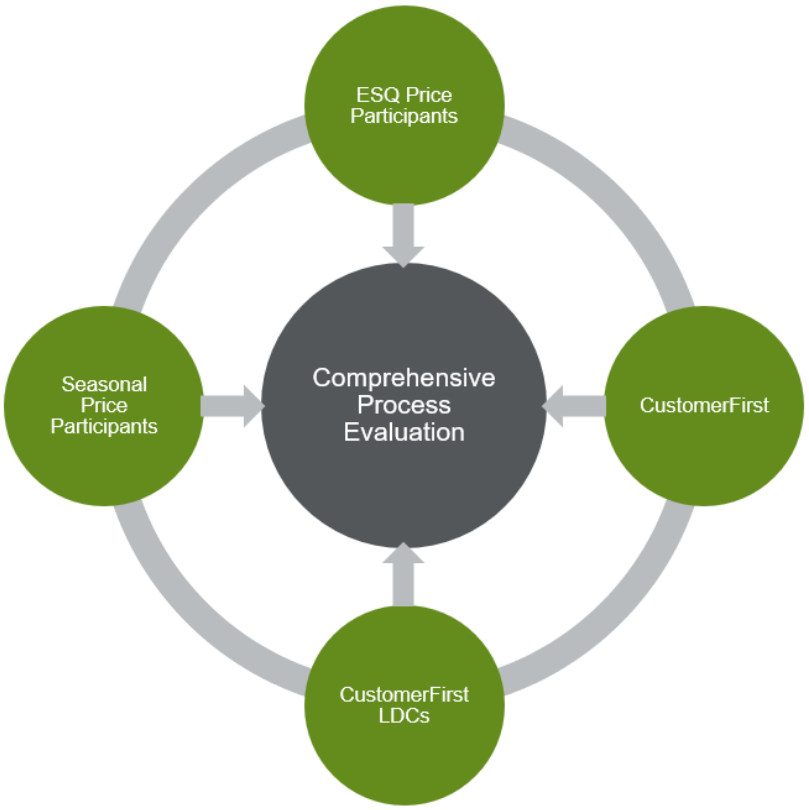
2.4.1 Research Approach

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

[24] In some cases, missing values appeared to be denoted by zeros.

non-quantitative programmatic impacts. Figure 6 describes the primary research targets from which Navigant collected the information necessary to understand these programmatic impacts.

Figure 6. Process Evaluation – Primary Research Targets



Source: Navigant

To collect the information from all program stakeholders, as demonstrated in Table 15, Navigant conducted both online surveys and interviews. The results of the interviews and the first participant survey are presented in section 3.2.

In order to complete the primary research efforts described in Table 15, 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 15. 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 LDC's	Telephone interviews	- Telephone interviews completed with Program Managers[25] from all LDC's participating in the RPP pilot. o Interviews completed in January 2019.
ESQ Price Participants	Online survey	- Online surveys that all RPP pilot participants enrolled in the ESQ price are requested to complete. o First survey completed in December 2018 shortly after the pilot was rolled out.
Seasonal TOU Participants	Online survey	- Online surveys that all RPP pilot participants enrolled in the Seasonal price are requested to complete. o First survey completed in December 2018 shortly after the pilot was rolled out.

Source: Navigant

2.4.2 CustomerFirst and LDC Interviews

Telephone interviews were completed with the program managers from CustomerFirst and all partner LDC's 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 LDC's 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.

[25] The program managers from the LDC's are the most knowledgeable about the pilot and hence they were selected for interviews.

2.4.3 Participant Surveys

To capture customer feedback on the effectiveness of the pilot, Navigant developed online surveys for all participants. Figure 7 below highlights the various aspects of the pilot assessed through participant surveys to gain:

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

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

Figure 7. Participant Survey Overview

Source: Navigant

As part of the interim report, the first survey was conducted and analyzed. Survey 1 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.

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 LDC and treatment group by Season and TOU Period.
- **Process Evaluation Results** – presents the results of the first participant survey and the interviews with LDC and CustomerFirst program managers.

3.1 Energy Impact Results

As discussed in section 2.2, given the challenges with estimating the treatment effect on the treated (TOT) impacts due to low enrollment, the Intent to Treat (ITT) impacts (which provides an unbiased impact of encouragement) are presented in this section.

Key Findings:

- Due to the low enrollment, the RED analysis did not yield statistically significant results with regards to the price impacts of the TOU prices being piloted. The impacts of encouragement have wide confidence bands and are not statistically different from zero for both the ESQ and Seasonal TOU prices.[26]
    - The overall magnitude of the ITT impacts may seem low. However, this is to be expected as only a portion of the customers who are encouraged opt-in (and are hence subject to the new price), which is a very small percentage in this case as seen in section 1.3.[27]
    - Results are not statistically different from zero. The key to understanding this lies in the large standard errors and the resulting wide confidence bands. No definitive conclusions can be drawn from the RED impact analysis. The confidence bands indicate that impacts of encouragement can range from an increase of up to 0.03 kWh to a savings of up to 0.03 kWh.[28]

The ITT price impacts are presented for completeness for the ESQ and Seasonal pilot pricing plans for each LDC, by season and TOU period, for each treatment group – Rate Only and Rate and Enabling Technology in the subsections that follow.

[26] Another factor to note is that the impacts from the RPP pilot are expected to be smaller than impacts from customers switching from a flat or tiered rate structure to a TOU rate structure. Relatively small impacts require larger sample sizes (or in the case of an RED, a higher enrollment rate) to obtain statistically significant results.

[27] If the ITT impacts were to be scaled by the percent of encouraged customers who opted in to estimate the TOT impacts, we would see much higher savings estimates. (This is also a valid approach for estimating impacts, see NREL Protocols - https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwjosJylt_7lAhXkQd8KHTsZDd0QFjAAegQIAxAC&url=https%3A%2F%2Fwww.nrel.gov%2Fdocs%2Ffy17osti%2F68573.pdf&usg=AOvVaw32e8C3fuW5PKb86uUx6kX-)

[28] For illustrative purposes, using an average opt-in rate of 1.5% to scale the ITT impacts, we would see TOT impacts that range from an increase in consumption of 2 kWh (0.03 / 1.5%) to a savings of 2 kWh (-0.03 / 1.5%). For reference purposes, it is important to note that the average consumption is around 1 kWh. This illustration also sheds additional light on the challenges associated with estimating impacts in an RED with low enrollment and why the TOT impacts from the instrumental variables approach were not reported.

3.1.1 ESQ Energy Impacts

3.1.1.1 Rate Only Impacts

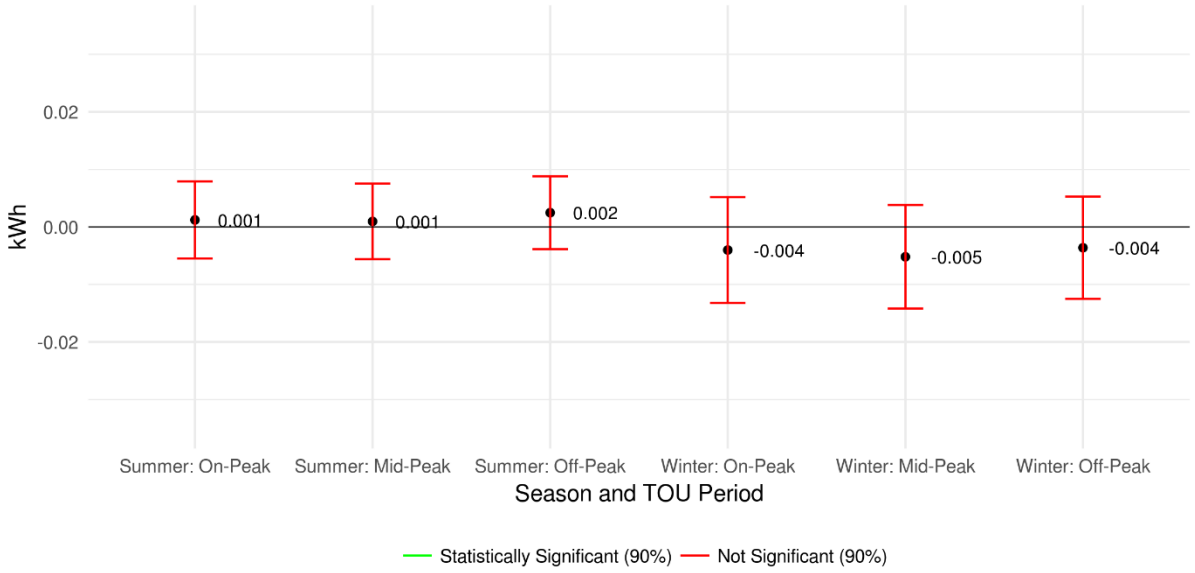
Table 16 summarizes the impact findings for each LDC by season and TOU period. Figure 8, Figure 9 and Figure 10 present a graphical view of the impacts for Greater Sudbury Hydro, North Bay Hydro Distribution Ltd. and PUC Services Inc. respectively.

Table 16. ESQ Price Energy Impacts – Rate Only

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Greater Sudbury Hydro	Summer	On-Peak	0.001	0.17	0.76	18.21
		Mid-Peak	0.001	0.12	0.81	14.56
		Off-Peak	0.002	0.32	0.52	39.17
	Winter	On-Peak	-0.004	-0.33	0.47	43.60
		Mid-Peak	-0.005	-0.46	0.34	57.70
		Off-Peak	-0.004	-0.30	0.50	40.73
North Bay Hydro Distribution Ltd.	Summer	On-Peak	-0.002	-0.20	0.78	17.30
		Mid-Peak	0.000	0.04	0.95	3.72
		Off-Peak	0.004	0.40	0.54	36.99
	Winter	On-Peak	0.000	0.01	0.99	0.59
		Mid-Peak	-0.002	-0.17	0.80	15.40
		Off-Peak	0.002	0.18	0.77	18.16
PUC Services Inc.	Summer	On-Peak	-0.008	-0.98	0.10	100.01
		Mid-Peak	-0.006	-0.72	0.22	75.14
		Off-Peak	-0.005	-0.56	0.30	63.09
	Winter	On-Peak	-0.008	-0.58	0.25	70.23
		Mid-Peak	-0.009	-0.72	0.19	80.30
		Off-Peak	-0.005	-0.37	0.45	45.49

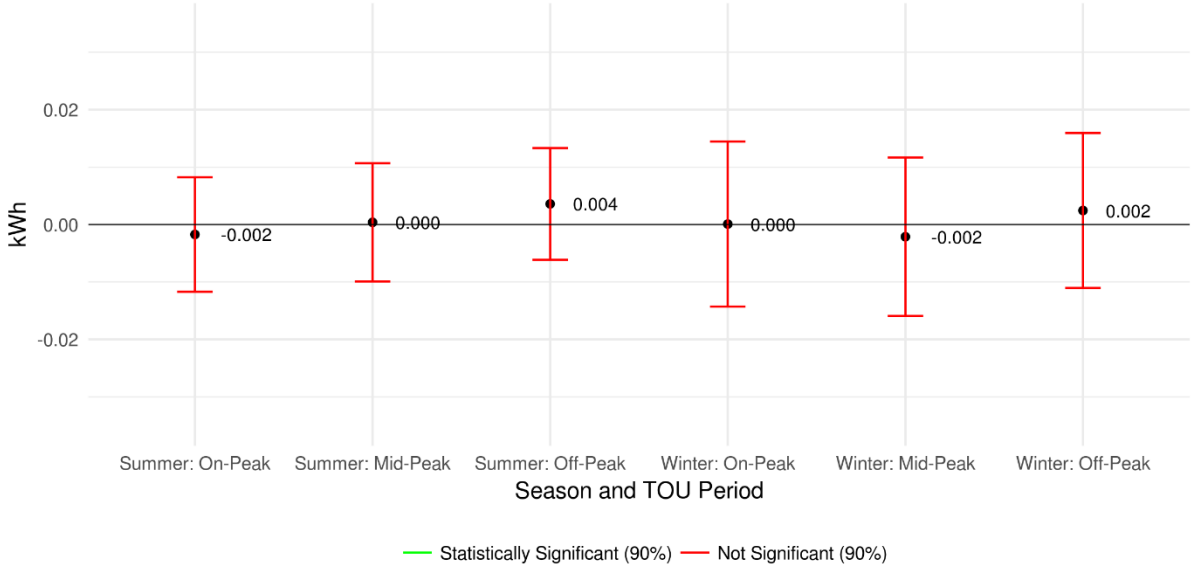
Source: Navigant Analysis

Figure 8. Greater Sudbury Hydro Rate Only ITT Impacts



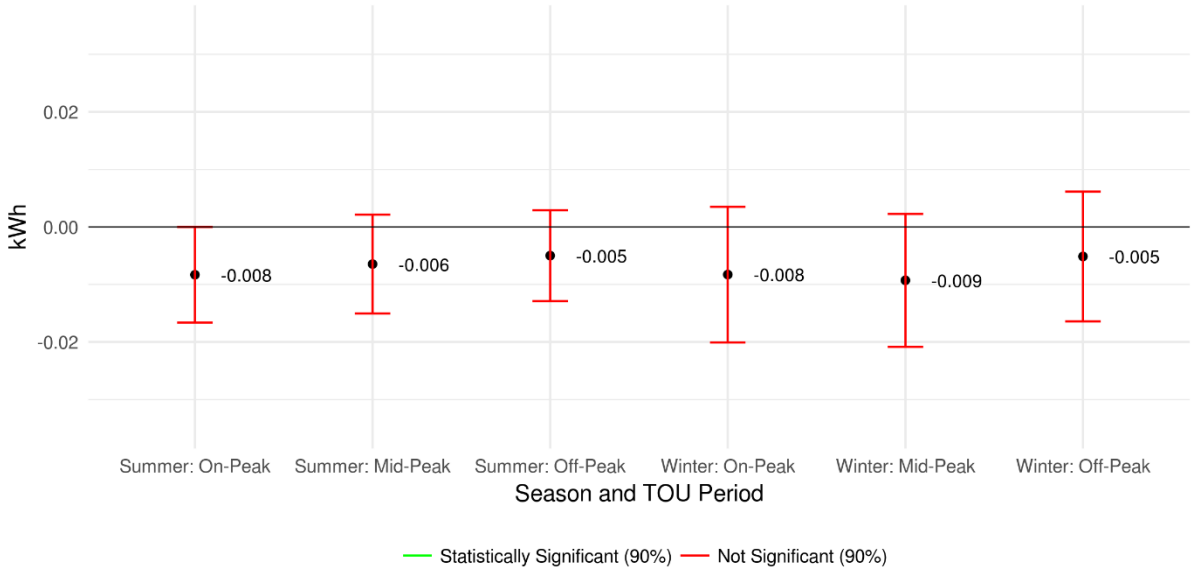
Source: Navigant Analysis

Figure 9. North Bay Hydro Distribution Ltd. Rate Only ITT Impacts



Source: Navigant Analysis

Figure 10. PUC Services Inc. Rate Only ITT Impacts



Source: Navigant Analysis

3.1.1.2 Rate and Enabling Technology Impacts

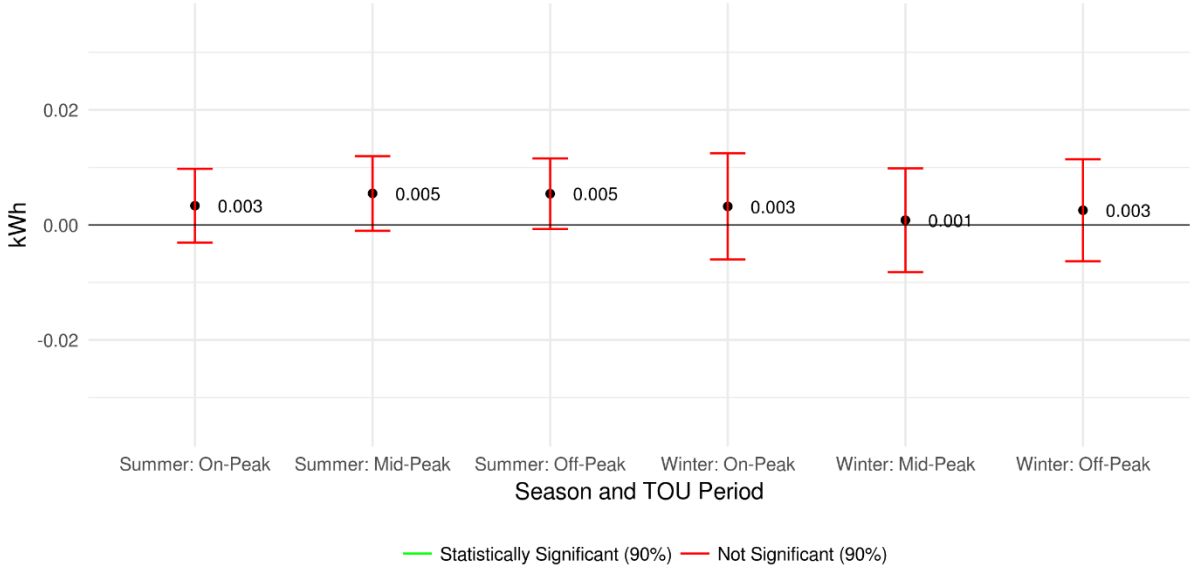
Table 17 summarizes the impact findings for each LDC by season and TOU period. Figure 11, Figure 12 and Figure 13 present a graphical view of the impacts for Greater Sudbury Hydro, North Bay Hydro Distribution Ltd. and PUC Services Inc. respectively.

Table 17. ESQ Price Energy Impacts – Rate and Enabling Technology

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Greater Sudbury Hydro	Summer	On-Peak	0.003	0.44	0.39	52.16
		Mid-Peak	0.005	0.68	0.16	84.49
		Off-Peak	0.005	0.68	0.15	88.31
	Winter	On-Peak	0.003	0.26	0.57	34.88
		Mid-Peak	0.001	0.07	0.88	9.18
		Off-Peak	0.003	0.21	0.64	28.82
North Bay Hydro Distribution Ltd.	Summer	On-Peak	-0.008	-0.96	0.16	85.22
		Mid-Peak	-0.007	-0.74	0.28	66.23
		Off-Peak	-0.002	-0.25	0.69	23.87
	Winter	On-Peak	-0.005	-0.40	0.53	38.60
		Mid-Peak	-0.006	-0.49	0.48	42.70
		Off-Peak	-0.005	-0.41	0.50	41.12
PUC Services Inc.	Summer	On-Peak	-0.003	-0.35	0.56	35.50
		Mid-Peak	-0.003	-0.34	0.56	35.03
		Off-Peak	-0.002	-0.23	0.68	25.13
	Winter	On-Peak	-0.007	-0.47	0.35	56.98
		Mid-Peak	-0.009	-0.65	0.23	72.94
		Off-Peak	-0.005	-0.38	0.45	46.17

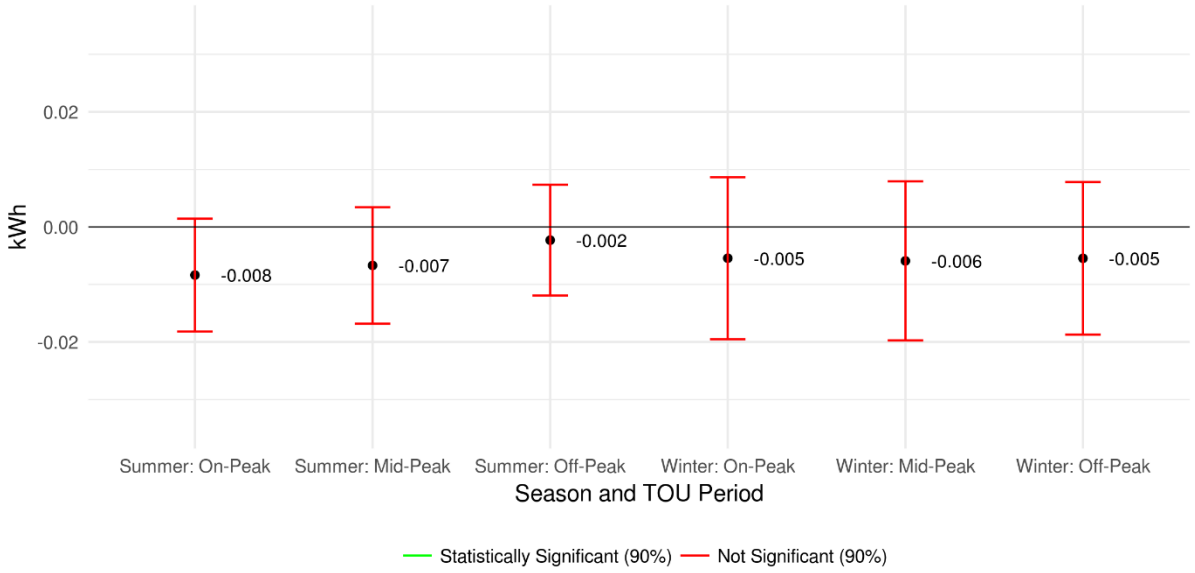
Source: Navigant Analysis

Figure 11. Greater Sudbury Hydro Rate & Enabling Technology ITT Impacts



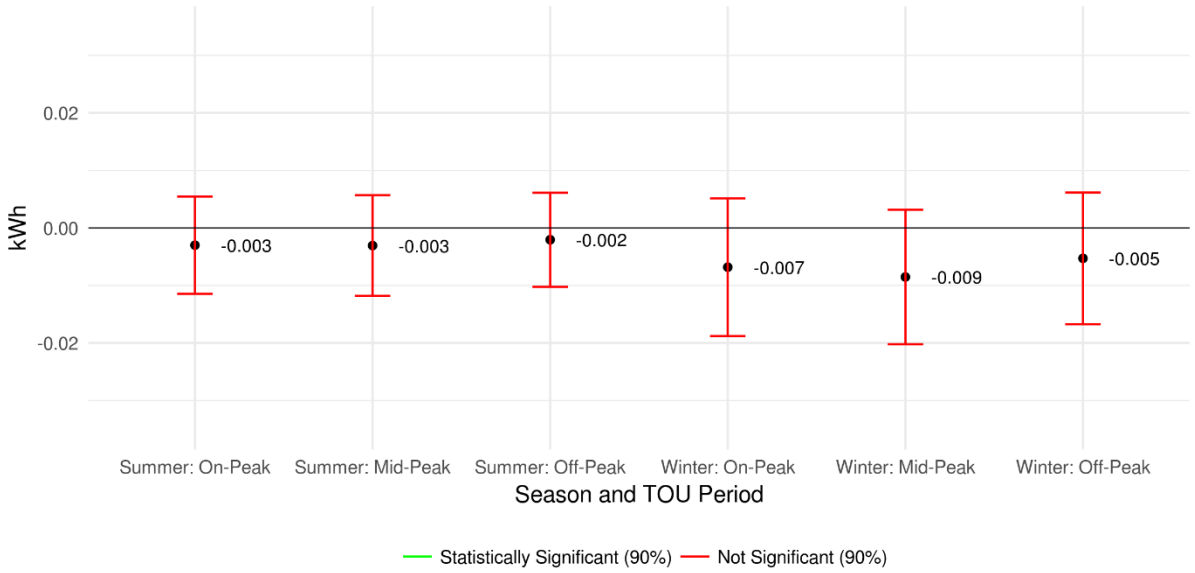
Source: Navigant Analysis

Figure 12. North Bay Hydro Distribution Ltd. Rate & Enabling Technology ITT Impacts



Source: Navigant Analysis

Figure 13. PUC Services Inc. Rate & Enabling Technology ITT Impacts



Source: Navigant Analysis

3.1.2 Seasonal Energy Impacts

3.1.2.1 Rate Only Impacts

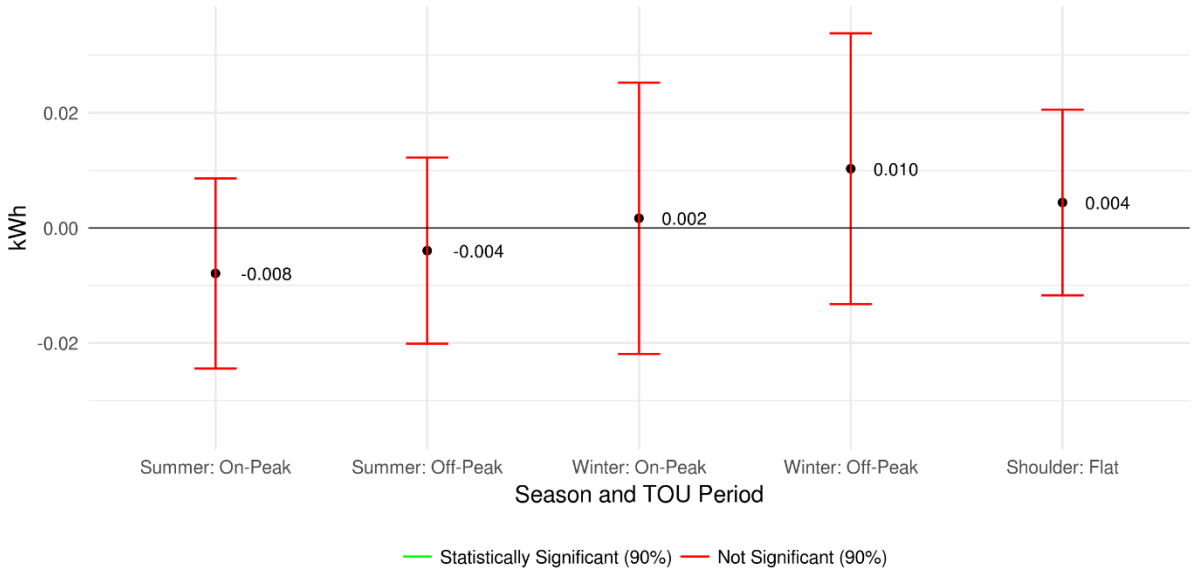
Table 18 summarizes the impact findings for each LDC by season and TOU period. Figure 14 and Figure 15 present a graphical view of the impacts for Northern Ontario Wires and Newmarket-Tay Power Distribution Ltd. respectively.

Table 18. Seasonal Price Energy Impacts – Rate Only

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Northern Ontario Wires	Summer	On-Peak	-0.008	-1.13	0.43	47.83
		Off-Peak	-0.004	-0.56	0.69	24.42
	Winter	On-Peak	0.002	0.15	0.91	7.14
		Off-Peak	0.010	0.90	0.47	43.73
	Shoulder	Flat	0.004	0.54	0.65	27.40
Newmarket-Tay Power Distribution Ltd.	Summer	On-Peak	-0.007	-0.72	0.18	82.12
		Off-Peak	-0.007	-0.60	0.23	72.91
	Winter	On-Peak	-0.010	-1.06	0.05	121.09
		Off-Peak	-0.007	-0.71	0.16	86.29
	Shoulder	Flat	-0.005	-0.59	0.22	74.35

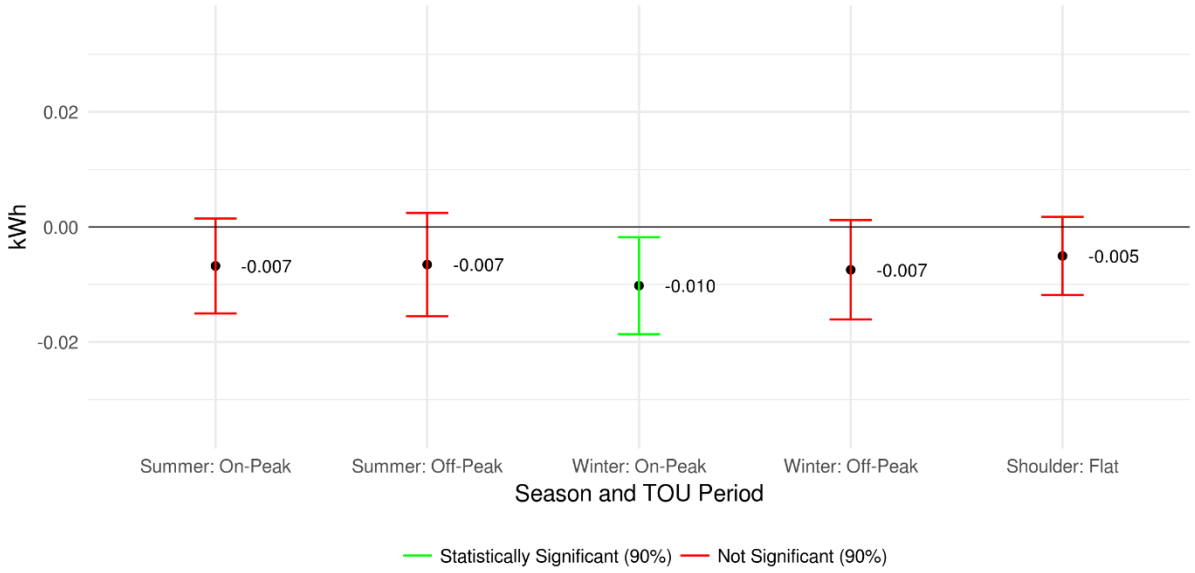
Source: Navigant Analysis

Figure 14. Northern Ontario Wires Rate Only ITT Impacts



Source: Navigant Analysis

Figure 15. Newmarket-Tay Power Distribution Ltd. Rate Only ITT Impacts



Source: Navigant Analysis

3.1.2.2 Rate and Enabling Technology Impacts

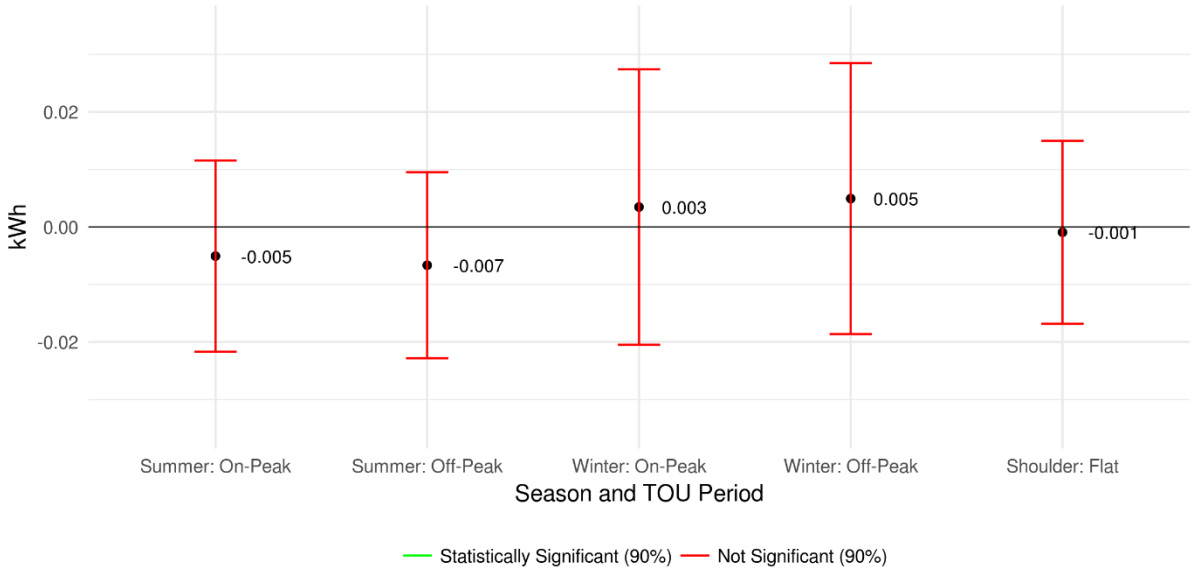
Table 19 summarizes the impact findings for each LDC by season and TOU period. Figure 16and Figure 17 present a graphical view of the impacts for Northern Ontario Wires and Newmarket-Tay Power Distribution Ltd. respectively.

Table 19. Seasonal Price Energy Impacts – Rate and Enabling Technology

Local Distribution Company	Season	TOU Period	Impact Estimate (kWh)	Percent Impact	P-value	Relative Precision ± % (90% confidence)
Northern Ontario Wires	Summer	On-Peak	-0.005	-0.69	0.62	30.49
		Off-Peak	-0.007	-0.91	0.50	41.17
	Winter	On-Peak	0.003	0.30	0.81	14.46
		Off-Peak	0.005	0.42	0.73	20.94
	Shoulder	Flat	-0.001	-0.11	0.92	5.83
Newmarket-Tay Power Distribution Ltd.	Summer	On-Peak	-0.002	-0.16	0.76	18.54
		Off-Peak	-0.005	-0.46	0.34	58.30
	Winter	On-Peak	0.004	0.38	0.47	43.69
		Off-Peak	0.002	0.17	0.74	20.52
	Shoulder	Flat	0.001	0.17	0.72	21.73

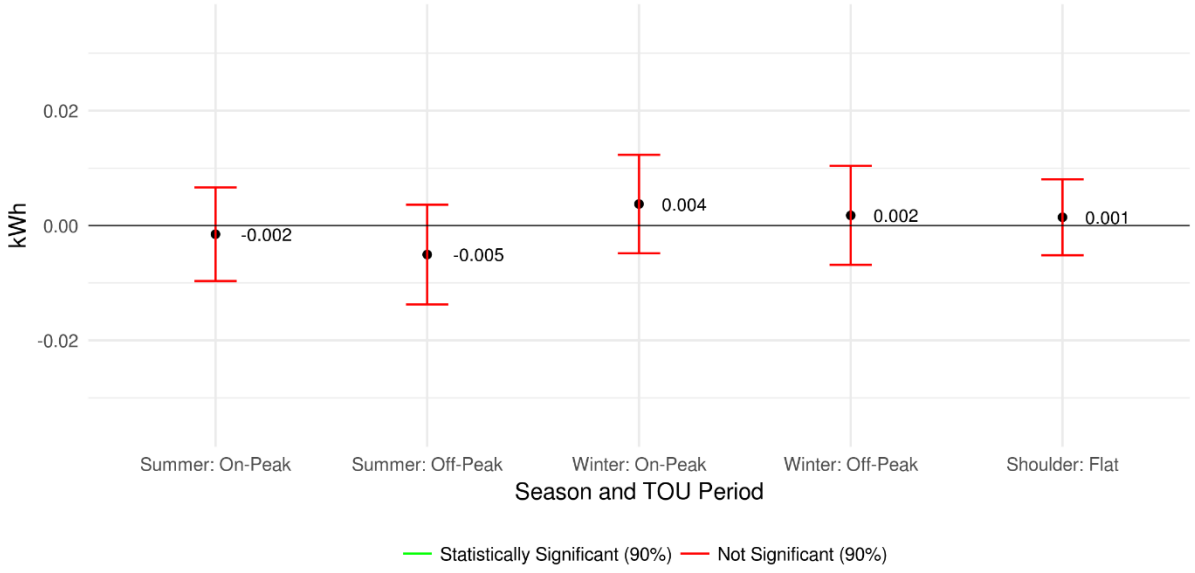
Source: Navigant Analysis

Figure 16. Northern Ontario Wires Rate & Enabling Technology ITT Impacts



Source: Navigant Analysis

Figure 17. Newmarket-Tay Power Distribution Ltd. Rate & Enabling Technology ITT Impacts



Source: Navigant Analysis

3.1.3 Price Elasticity

Due to the RED impacts being statistically indistinguishable from zero, the price elasticities associated with the impacts presented above have not been reported.[29] The price elasticities will be addressed in the final report.

[29] This decision was made after discussions with the OEB and CustomerFirst.

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, the treatment group was restricted to those who opted-in as only they would receive the pilot prices. 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 20 and Table 21 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 each pricing scheme is less than 0.5 percent and there are no notable differences between the two treatment groups.

Table 20. Revenue Adequacy – ESQ Price

Local Distribution Company	Treatment	$/kWh Status Quo	$/kWh ESQ	Change
Greater Sudbury Hydro	Rate Only	$0.081	$0.079	-1.61%
	Rate & Enabling Technology	$0.081	$0.080	-1.40%
	Control	$0.082	$0.083	0.81%
North Bay Hydro Distribution Ltd.	Rate Only	$0.082	$0.082	0.39%
	Rate & Enabling Technology	$0.082	$0.081	-0.22%
	Control	$0.082	$0.083	1.04%
PUC Services Inc.	Rate Only	$0.082	$0.083	0.71%
	Rate & Enabling Technology	$0.082	$0.082	0.04%
	Control	$0.082	$0.083	1.07%

Source: Navigant Analysis

Table 21. Revenue Adequacy – Seasonal Price

Local Distribution Company	Treatment	$/kWh Status Quo	$/kWh Seasonal	Change
Northern Ontario Wires	Rate Only	$0.082	$0.081	-0.51%
	Rate & Enabling Technology	$0.081	$0.081	-0.36%
	Control	$0.082	$0.082	-0.72%
Newmarket-Tay Power Distribution Ltd.	Rate Only	$0.081	$0.081	-0.43%
	Rate & Enabling Technology	$0.081	$0.081	-0.33%
	Control	$0.081	$0.081	-0.39%

Source: Navigant Analysis

3.1.5 Opt-In Analysis

Given the low enrollment and the associated challenges with obtaining conclusive price impacts from the RED analysis, Navigant also 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. While this cannot provide insight into the impact of the pilot prices, it may 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 in Appendix C.

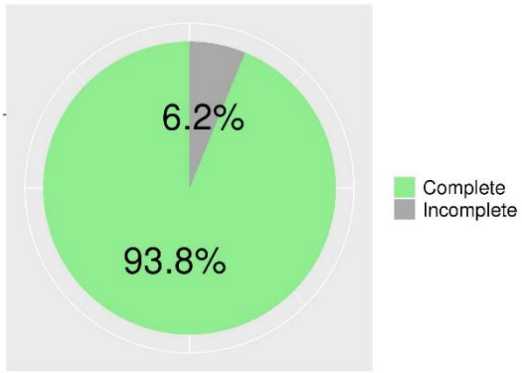
- **ESQ Price**: While the load shapes of those who opted-in were not notably different from those who did not, Navigant noted that those customers who opted-in had slightly higher consumption levels in the off-peak and slightly lower in the on-peak and at times mid-peak periods. This trend was more 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).

3.2 Process Evaluation Results

Overall, Navigant received 435 survey responses from participants across all utilities. Twenty-seven incomplete surveys were excluded from the analyses. These include seven respondents who did not finish all relevant questions and twenty respondents who did not recall signing up for the RPP pilot thereby excluding erroneous responses. Figure 18 below shows the breakdown of complete vs. incomplete surveys.

Figure 18. Completed Survey Responses



Source: Navigant Analysis

The total number of complete survey responses is 408[30]. Table 22 below illustrates the total number of pilot participants and the response rates for each utility. The survey response rate was higher than anticipated and is sufficient to draw reliable conclusions. Navigant also completed interviews with each of the participating LDC's as well as CustomerFirst staff which are also discussed below.

Table 22. Survey Response Rate

Local Distribution Company	Number of Participants	Completed Surveys	Response Rate
Greater Sudbury Hydro	255	91	36%
North Bay Hydro Distribution Ltd.	158	78	49%
PUC Services Inc.	209	86	41%
Northern Ontario Wires	65	26	40%
Newmarket-Tay Power Distribution Ltd.	404	127	31%
Total	**1091**	**408**	**37%**

Source: Navigant Analysis

3.2.1 Participant Demographics and Characteristics

Various participant demographics were collected from the survey. From these results, Navigant identified the following statistics:

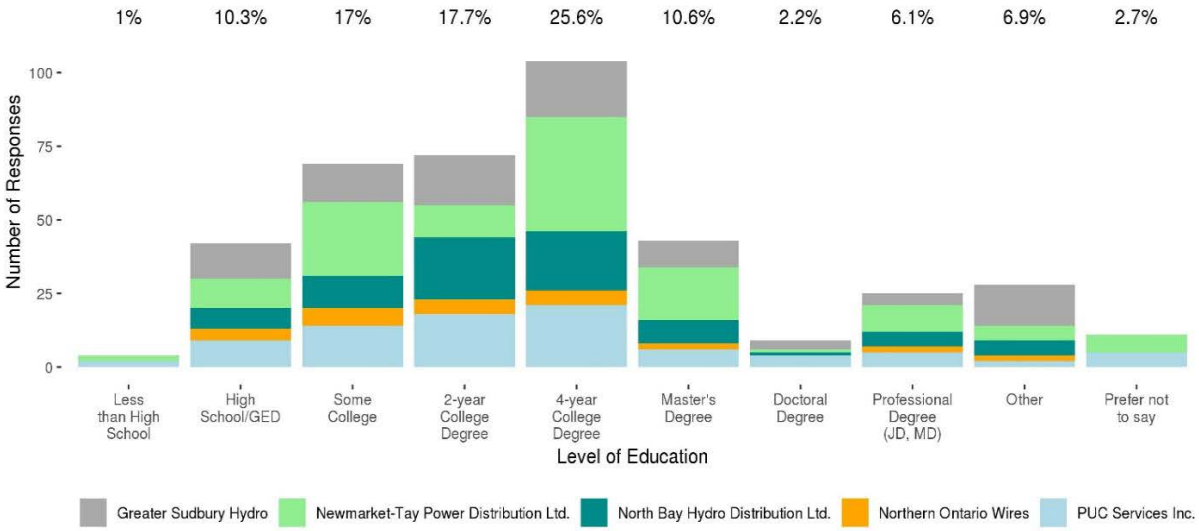
- There are approximately 2.5 people per household across all utilities.
- Twenty six percent of all homes were identified with an annual household income of less than $50,000.[31]
- The average age of survey respondents was found to be in the range of forty-five to fifty-four years old.

The most common education level identified was a four-year college degree with twenty six percent of the survey population holding this kind of degree. The distribution of education levels can be further explored in Figure 19 below. Those with an annual income under $50,000, a higher proportion have attended some college rather than having obtained a four year or master's degree.

[30] Four hundred thirty-seven responses less the twenty-seven that were excluded.

[31] 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.

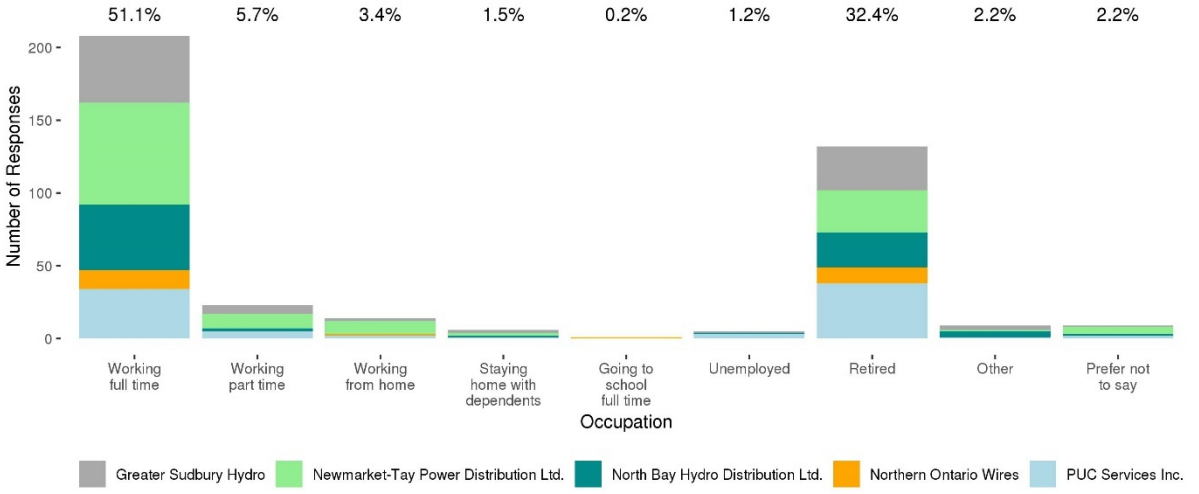
Figure 19. Education Levels



Source: Navigant Analysis

Those working full or part time or going to school represent fifty seven percent of respondents while those who are at home all day, on account of being retired, working from home or staying home with dependents, represent thirty seven percent of respondents. Figure 20 shows a breakdown of the various occupation types for each utility. In general, those who are working from home could potentially have less opportunity to shift their consumption since they are likely in the home during 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.

Figure 20. Occupation Types

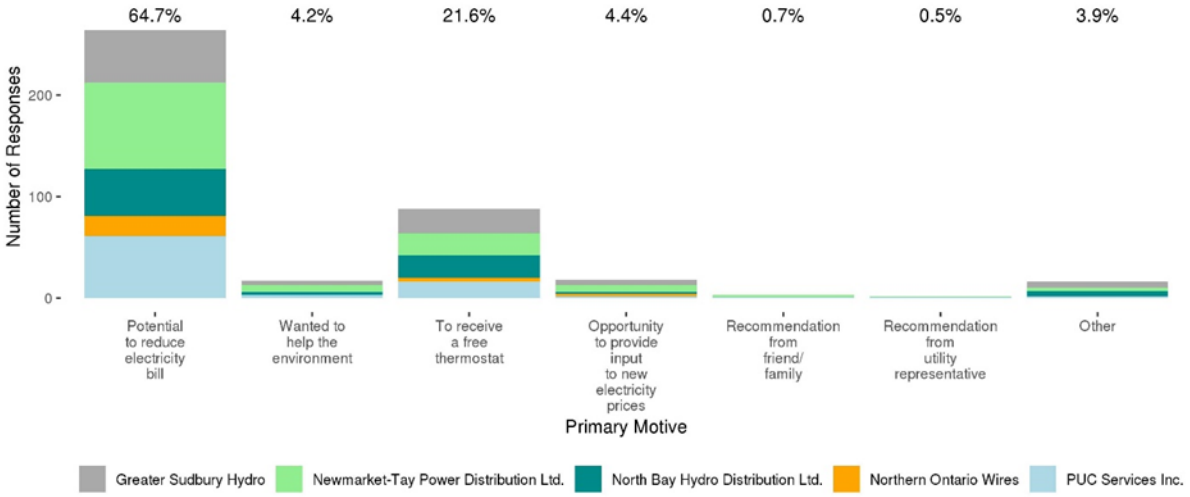


Source: Navigant Analysis

3.2.2 Participation Motives

Interviews with LDC's 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. Overall, sixty-five percent of survey respondents indicated that their primary motivation to participate in the pilot was to reduce their electricity bill[32], while twenty-two percent wanted to receive a free thermostat. The distribution of primary participant motives can be seen in Figure 22 below. It should be noted that some respondents specified "All of the above" in the "Other: please describe" category.

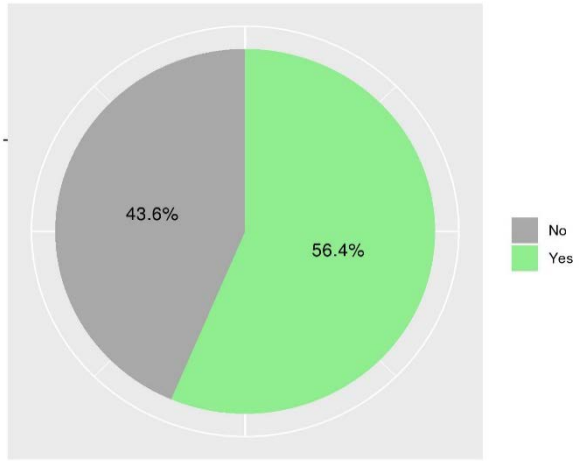
Figure 21. Primary Motives for Participation



Source: Navigant Analysis

Over half of all respondents indicated that they had a secondary motive for participation as seen in Figure 23 below.

Figure 22. Secondary Motive for Participation

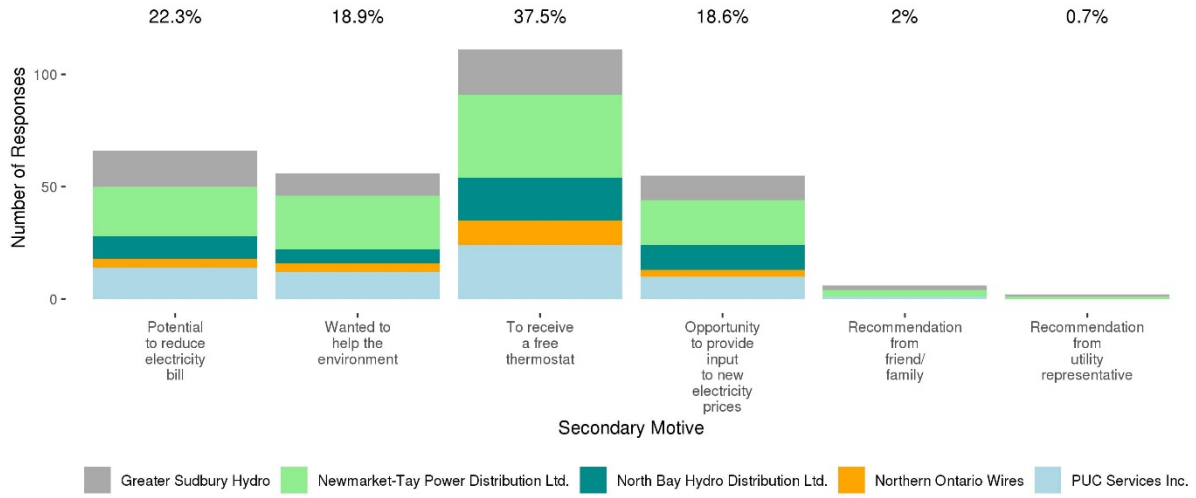


Source: Navigant Analysis

[32] 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.

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 23.

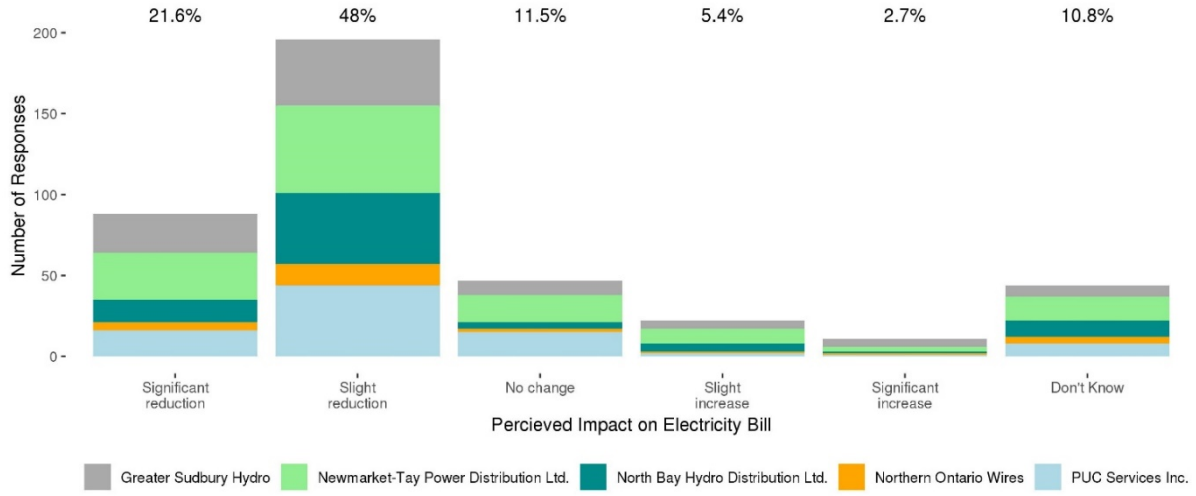
Figure 23. Secondary Motives for Participation



Source: Navigant Analysis

Consistent with respondent motives to reduce electricity bills, most respondents believed the pilot will help them achieve this goal. Over seventy percent of respondents believed they would see a decrease, while just eight percent believe they will see an increase and eleven percent believe it will not have any effect while the rest are uncertain of the impacts on their bills, see Figure 24.

Figure 24. Perceived Impact on Electricity Bill



Source: Navigant Analysis

3.2.3 Behavioural Changes

Participants 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 26. This varied across the participating utilities as seen in Figure 27. 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.

Figure 25. Awareness of Time of Use Rates before RPP Pilot

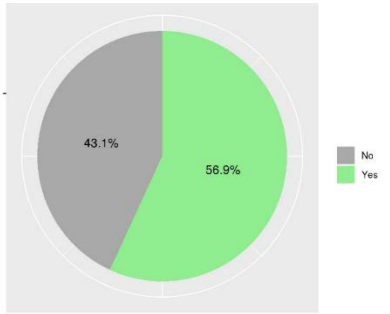
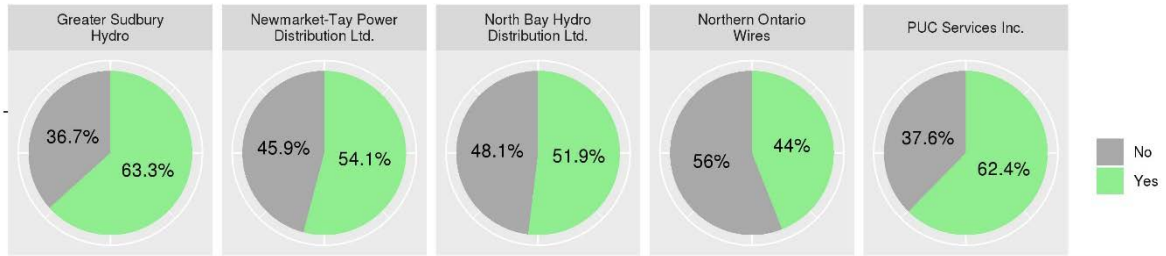


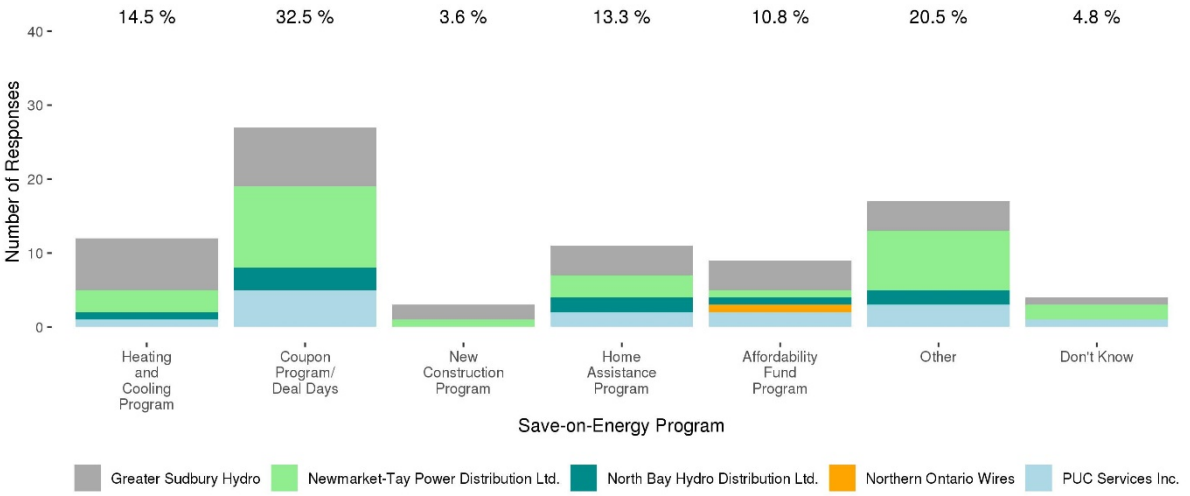
Figure 26. Awareness of Time of Use Rates before RPP Pilot by Utility



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 28.

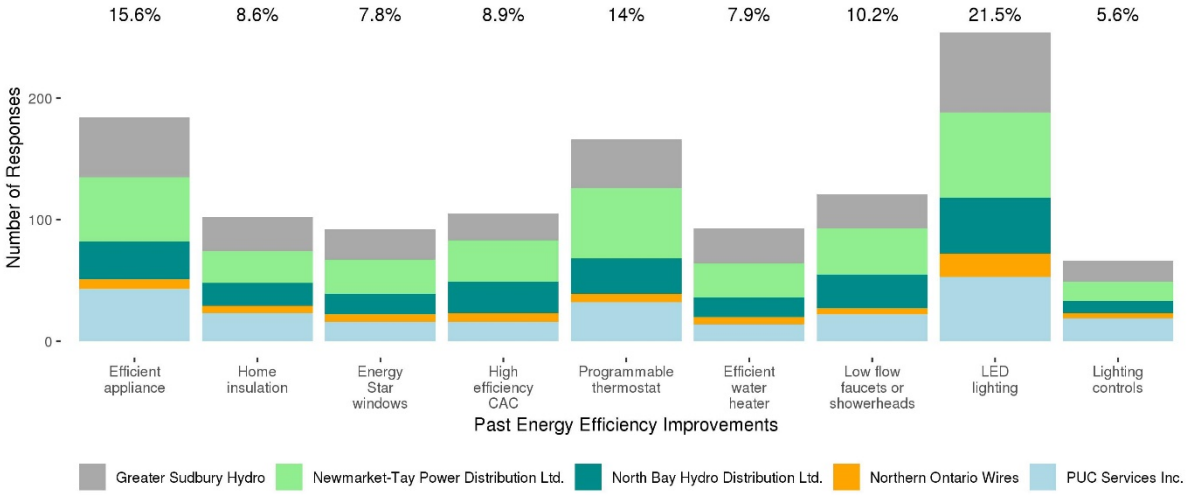
Figure 27. Participation in Save-on-Energy Programs before RPP pilot



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 29.

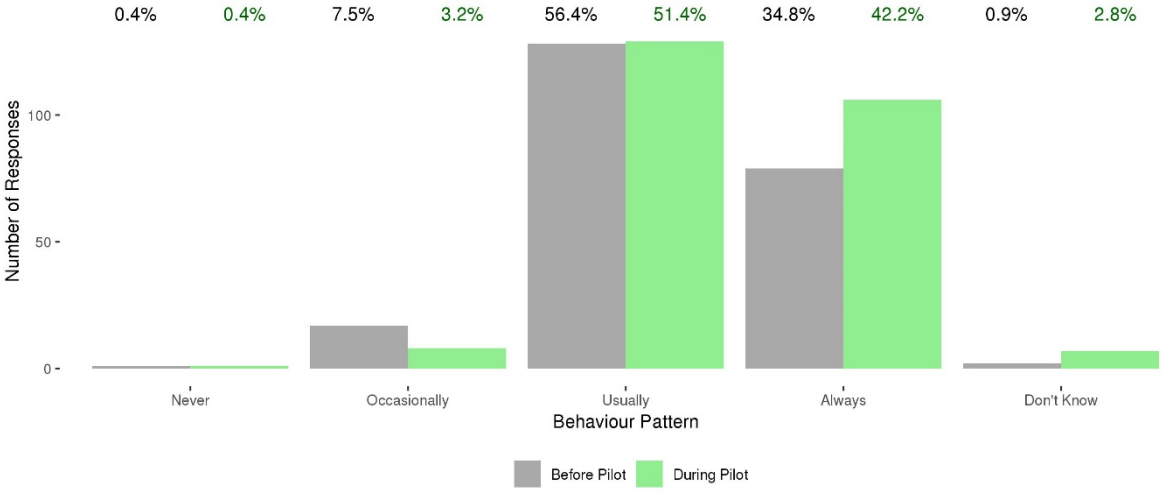
Figure 28. Pre-Pilot Energy Efficiency Improvements



Source: Navigant Analysis

Survey 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. Before the pilot, ninety-one percent of respondents said that they purposely 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 30. 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 behavior.

Figure 29. Electricity Consumption Behavioural Patterns Before and Planned for During Pilot Pilot

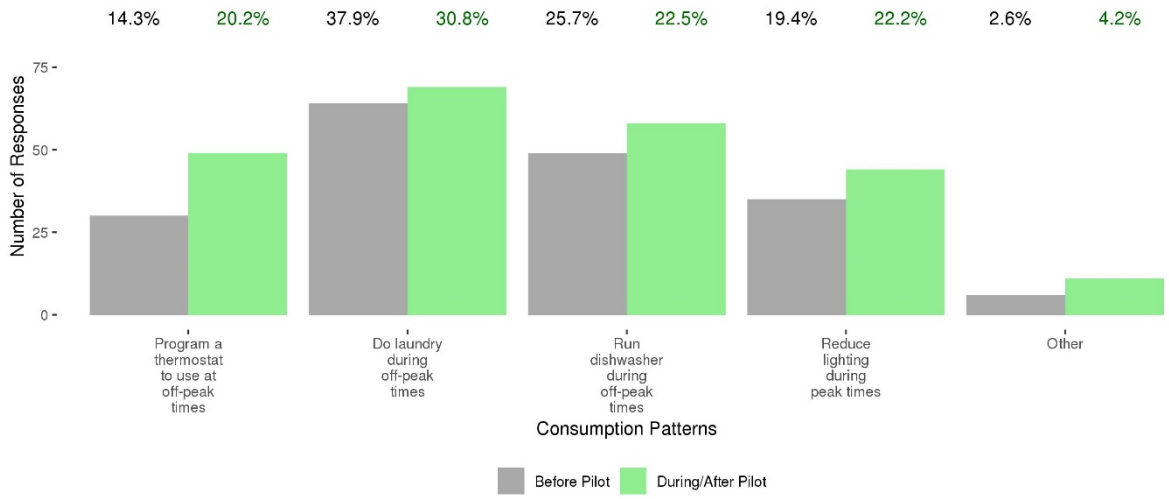


Source: Navigant Analysis

Common planned behavioural shifts include doing laundry and running the dishwasher during off-peak times, as well as reducing lighting during on-peak times. The changes in behaviour that participants plan to implement throughout the pilot can be seen in Figure 31 below. It should be noted

that the largest increase is observed in programing a thermostat to automatically shift consumption to off-peak periods.

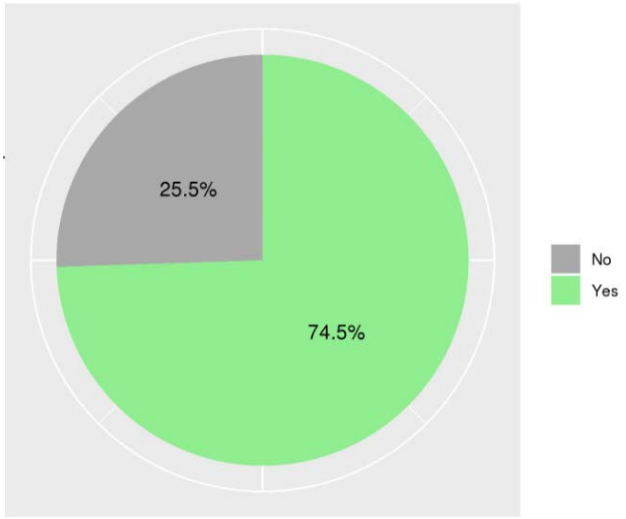
Figure 30. Change in Consumption Patterns Before and Planned for During Pilot



Source: Navigant Analysis

Since the survey was conducted shortly after the pilot started, participants were asked if they became more aware of the TOU prices since enrollment and through their participation thus far. Program participation has increased awareness of TOU prices to a hundred percent and seventy-four percent of survey respondents plan to change their electricity consumption patterns as seen in Figure 32.

Figure 31. Plan to Change Consumptions Patterns

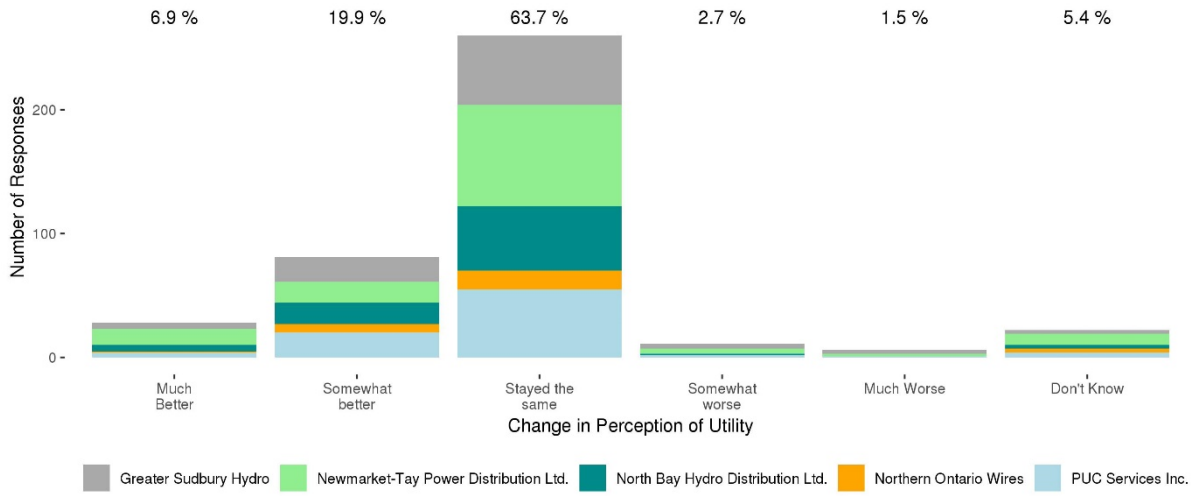


Source: Navigant Analysis

3.2.4 Customer Satisfaction

Enrolling in the RPP pilot has not had significant impacts on customers perception of their LDC. 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. Aggregated results by utility can be seen in Figure 33 below.

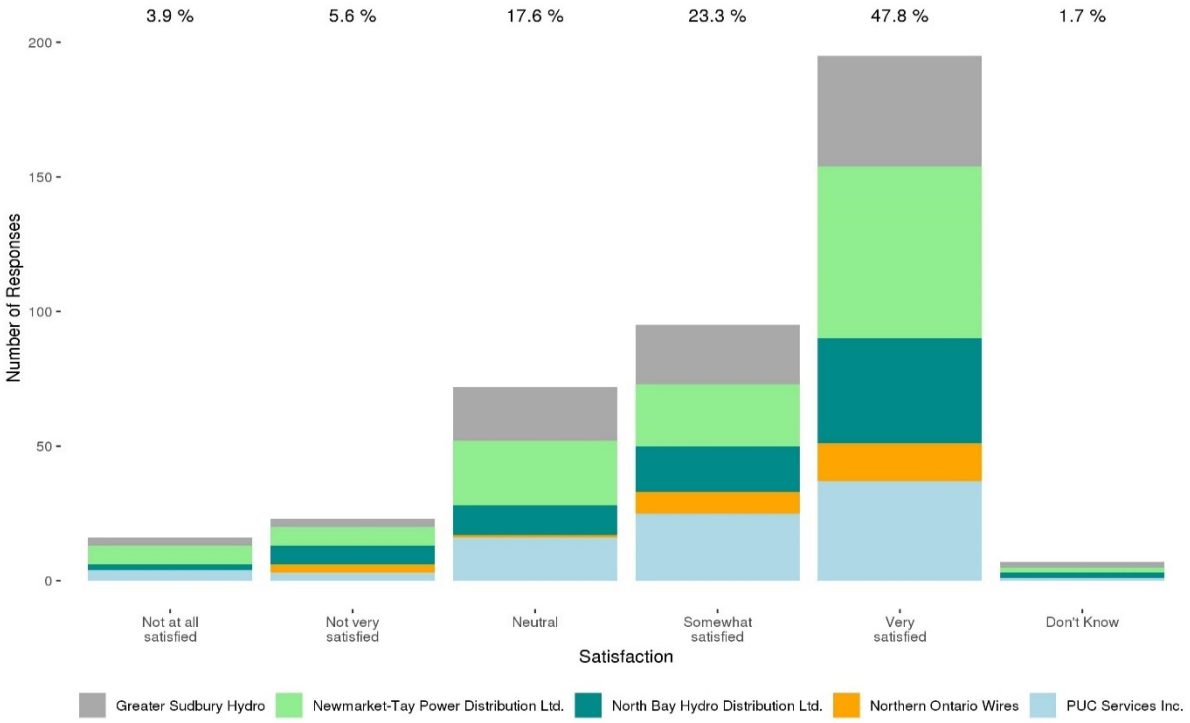
Figure 32. LDC Perception Post Enrollment



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 33 below. 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.

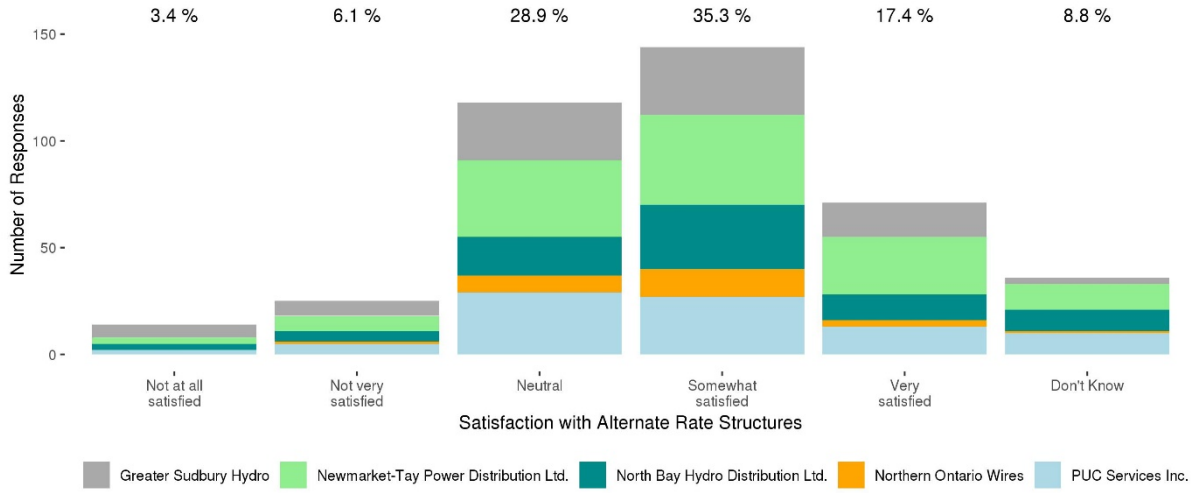
Figure 33. Registration Process Satisfaction



Source: Navigant Analysis

Participants 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 with thirty-five percent reported being somewhat satisfied, seventeen percent being very satisfied and less than ten percent being unsatisfied as can be seen in detail in Figure 35 below. 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 and 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.

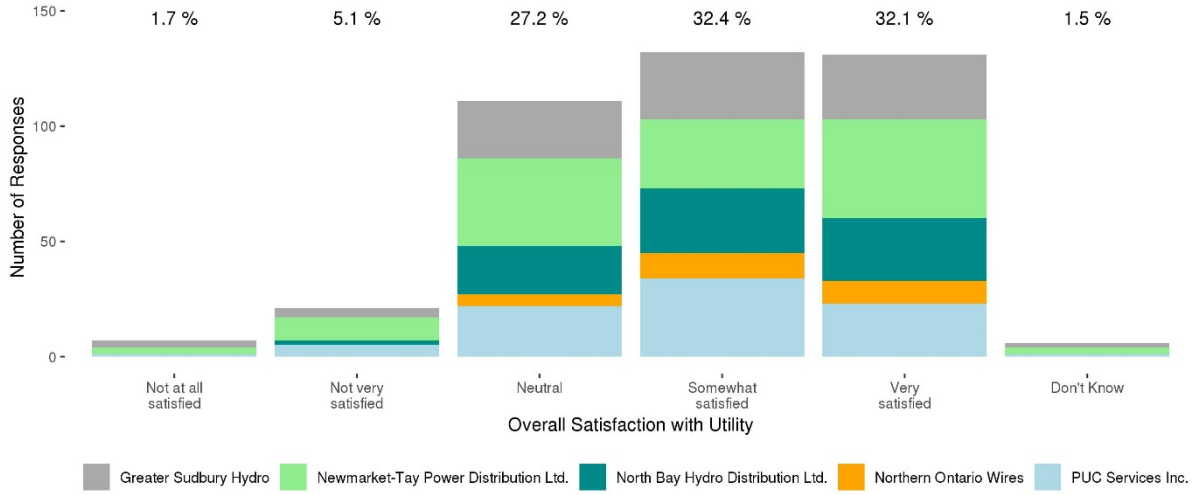
Figure 34. Initial Perception of Alternate Rate Structures



Source: Navigant Analysis

Figure 36 reveals that most respondents, over sixty percent, reported being satisfied with their utility overall while less than ten percent reported being unsatisfied.

Figure 35. Overall Respondent Satisfaction with Utility



Source: Navigant Analysis

3.2.5 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[33]. However, this was a requirement of the RED experimental design.

The first set of direct mails were sent out in July with the plan to close enrollments by the end of August.[34] 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.

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)[35] 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.

[33] 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.

[34] 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.

[35] 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, have been piloted across five local distribution companies with each distributor being assigned a 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. They were encouraged with a thermostat at the end of the pilot (rate only treatment) or at the beginning of the pilot (rate and enabling technology treatment).

At this interim evaluation point, there are some key learning that have emerged based on the analysis conducted as part of this interim report:

1. **Positive Impressions with Pilot Enrollment but 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 of why customers were being transferred would greatly aid in easing customer concerns.

LDC program managers reported that some customers experienced delays in call backs of up to four or five days and also held the view that the registration window was quite narrow. Providing a wider enrollment window could improve enrollment and 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.

2. **Explore Quasi-Experimental Design**

The RED is a robust experimental design which is a key to any evaluation. However, the restrictions it places on the type of marketing that can be done has had serious impacts on the enrollment and the associated challenges with drawing meaningful insights from the robust experimental design of the RED. For the final analysis and report, Navigant will explore a quasi-experimental design, matching analysis[36], that was proposed as a contingency approach in the event that the RED results are not precise enough, matching analysis.

The matching analysis involves the development of a control group with similar patterns of consumption to the participant group in the pre-treatment period. Effectively, it involves finding an ideal or matched control for each participant from the control group that exhibits a consumption pattern in the pre-period that is most similar to that particular participant. Navigant will also explore pooling the LDC's that have been assigned the same pilot pricing scheme to potentially improve the precision of the results[37].

As noted in section 2.1, a quasi-experimental design, such as matching analysis, is commonly used as a contingency plan in the event that the randomized experimental design does not yield reasonably precise estimates. This approach can potentially reduce the variation in the data as we no longer

[36] Navigant has previously used this approach to evaluate the energy and demand impacts of the Alectra (PowerStream) Advantage Power Pricing and Residential Energy Management programs.

As noted in section 2.1, this was proposed as a contingency approach in the event that the RED results are not precise enough but due to the challenges in receiving the hourly data for the entire residential population for five LDC's and the timelines for submitting the interim report; CustomerFirst and Navigant proposed to the OEB that the contingency approach (matching) be conducted for the final analysis to prevent further delays with regards to the interim report.

[37] As tested with the RED, Navigant will also explore if additional variable interactions coupled with matching and pooling the LDC's yields any benefit. Navigant will also consider explicitly modelling weather, particularly when the LDC's are pooled as there may be some differences in weather across LDC's, to explore potential improvements to the impact estimates.

include the entire residential population and balance 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. Hence, given the challenges encountered with the RED due to low enrollment, this is the next logical step and will be explored in the final analysis.

3. Accounting 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. METHODOLOGY: ADDITIONAL DETAIL

A.1 Instrumental Variables Approach to Estimate TOT Impacts

Navigant used a post program lagged dependent variable model to estimate program impacts applied to a panel dataset. The model effectively compares the hourly consumption of the customers who opted-in to the pilot (accepted the intervention) to those who did not to estimate savings. Any differences in usage prior to enrollment are controlled for via the lagged dependent variable. A separate regression was run for each LDC, treatment group and season. The two stage least squares (2SLS) regression specification to estimate TOT impacts is presented in Equation 2.

The first stage equation effectively creates the instrumental variable for participation in the pilot (accepting the intervention) that is correlated with participation (the more effective the encouragement, the higher the correlation), and yet by virtue of the fact that it is random, it is not correlated with unobservable variables affecting participation. By design, the first stage regression also includes the covariates from the main equation.

The dependent variable is the customer's hourly energy use after the start of the program, also known as a post program regression model (PPR) model. The explanatory variables include dummy variables for the month, day of the week and hour to account for weather[38] and other temporal effects; a customer's average hourly energy use in the week of the pre-program year; and an indicator for program participation.

Equation 2. Post Program Regression Instrumental Variable Model to Estimate TOT Impacts[39]

$$Stage\,1: IV$$

$$Participant_{i,t} = \sum_{n=1}^{12} \alpha_n \bullet Month_{n,i,t} + \sum_{n=1}^{24} \beta_n \bullet Hour_{n,i,t} + \sum_{n=1}^{7} \delta_n \bullet DOW_{n,i,t} + \sum_{n=1}^{TOU} \tau_n \bullet TOUPeriod_{n,i,t} + \theta \bullet kWhLag_{i,t} + \gamma \bullet Encouraged_{i,t} + \varepsilon_{i,t}$$

$$Stage\,2: Main\,Eqn$$

$$kWh_{i,t} = \sum_{n=1}^{12} \alpha_n \bullet Month_{n,i,t} + \sum_{n=1}^{24} \beta_n \bullet Hour_{n,i,t} + \sum_{n=1}^{7} \delta_n \bullet DOW_{n,i,t} + \sum_{n=1}^{TOU} \tau_n \bullet TOUPeriod_{n,i,t} + \theta \bullet kWhLag_{i,t} + \sum_{n=1}^{TOU} \gamma_n \bullet \widehat{Participant_{i,t}} \bullet TOUPeriod_{n,i,t} + \varepsilon_{i,t}$$

Where:

[38] Treatment and control customers receive the same weather.

[39] Navigant did explore additional interactions such as month and hour and month and day of the week but noted that it did not improve the impact estimates of participation and hence kept the model simple.

i: subscript to indicate an individual customer

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

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

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

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

$DOW_{n,i,t}$: a set of binary variables taking a value of 1 when $day\ of\ week(t) = n$ 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. Lags were taken separately for weekdays and weekends.[40]

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

$Participant_{i,t}$: a binary variable taking the value of 1 if a customer accepted the intervention and 0 otherwise.

$\widehat{Participant}_{i,t}$: the Instrumental Variable which is the predicted value from the first stage regression.

Upon running these models, Navigant noted that the point estimates were large, representing at times nearly half or more of all of the hourly consumption, with wide confidence bands. Given this, Navigant conducted further investigations which revealed that due to the low enrollment, the first stage regression was producing a weak instrument meaning that it was not accurately predicting participation. Hence, the impacts provided by the main (second stage) regression were not robust and as expected had wide confidence bands.

[40] 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.

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

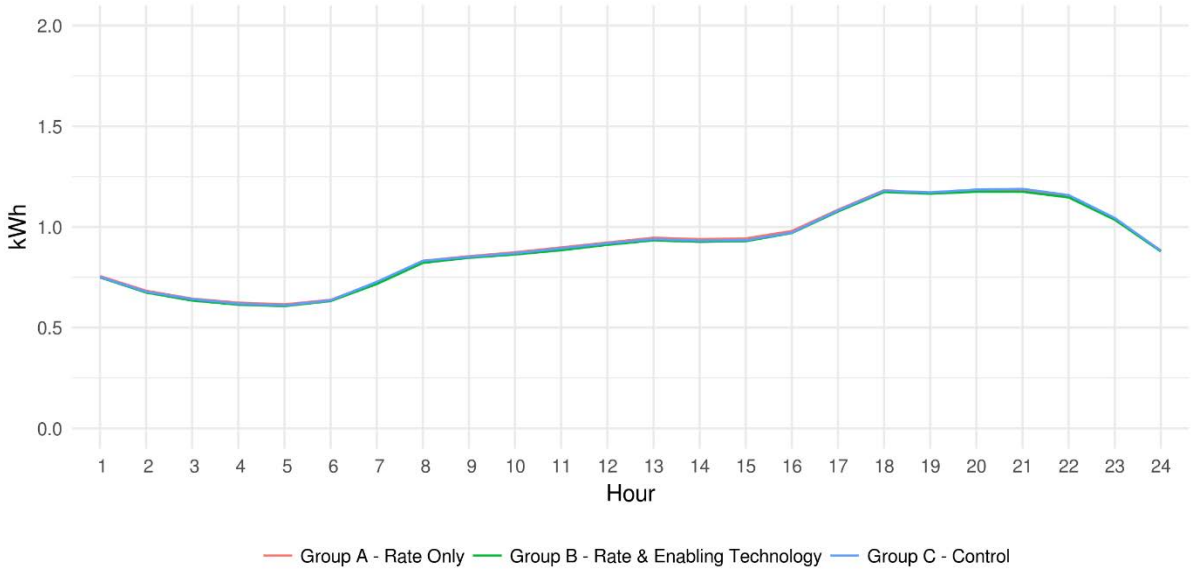
Figure 36. Greater Sudbury Hydro Pre-Period Comparison by Treatment Group - Summer

Source: Navigant Analysis

Figure 37. Greater Sudbury Hydro Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

Figure 38. North Bay Hydro Distribution Ltd. Pre-Period Comparison by Treatment Group - Summer

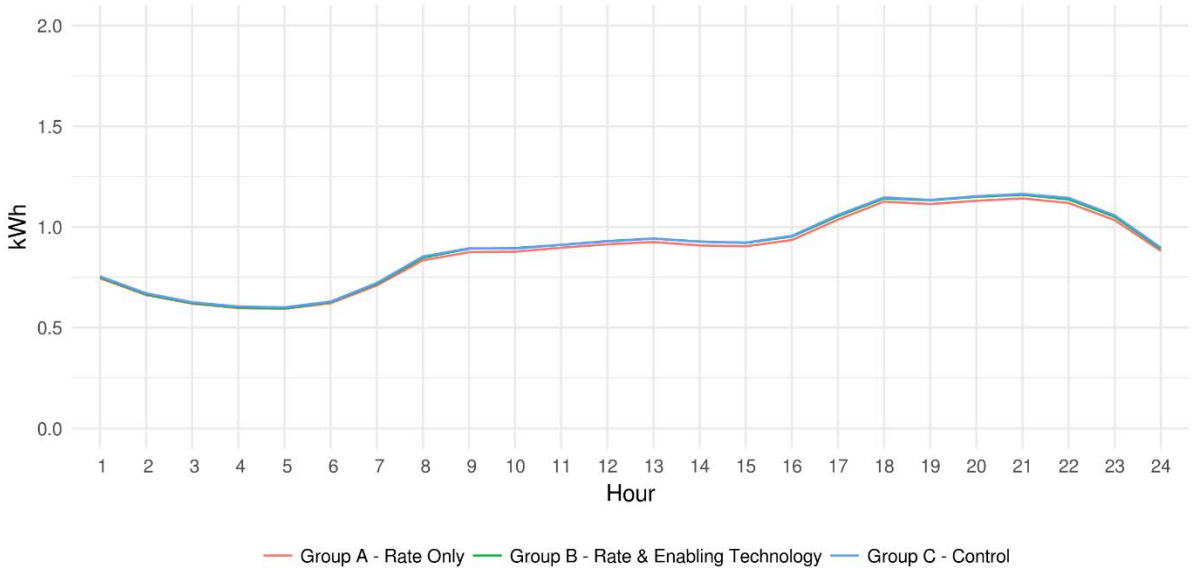


Source: Navigant Analysis

Figure 39. North Bay Hydro Distribution Ltd. Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

Figure 40. PUC Services Inc. Pre-Period Comparison by Treatment Group - Summer



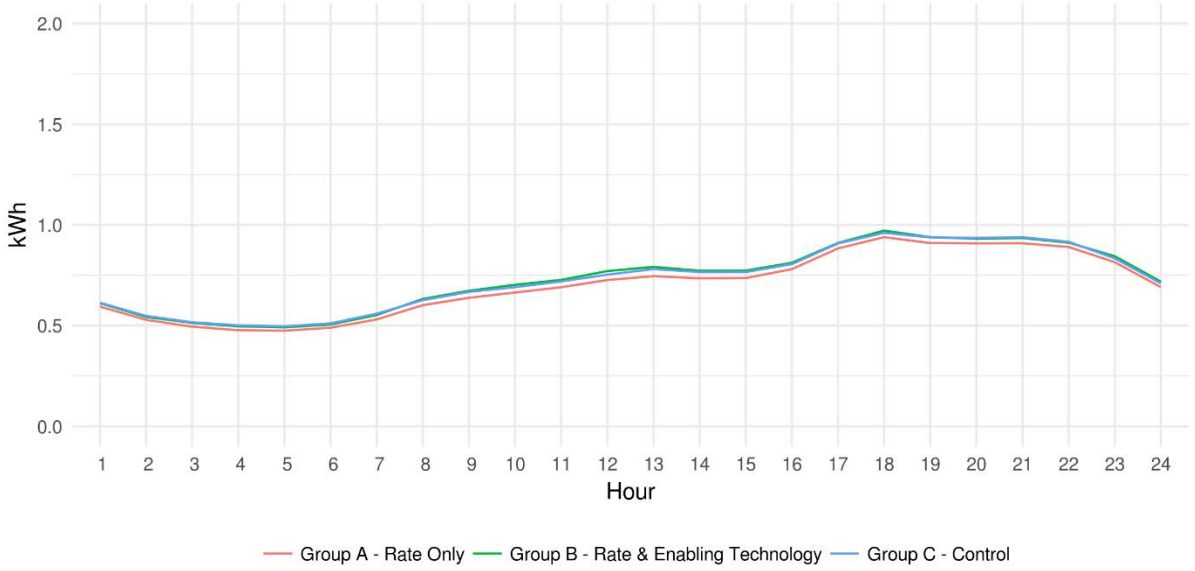
Source: Navigant Analysis

Figure 41. PUC Services Inc. Pre-Period Comparison by Treatment Group - Winter

Source: Navigant Analysis

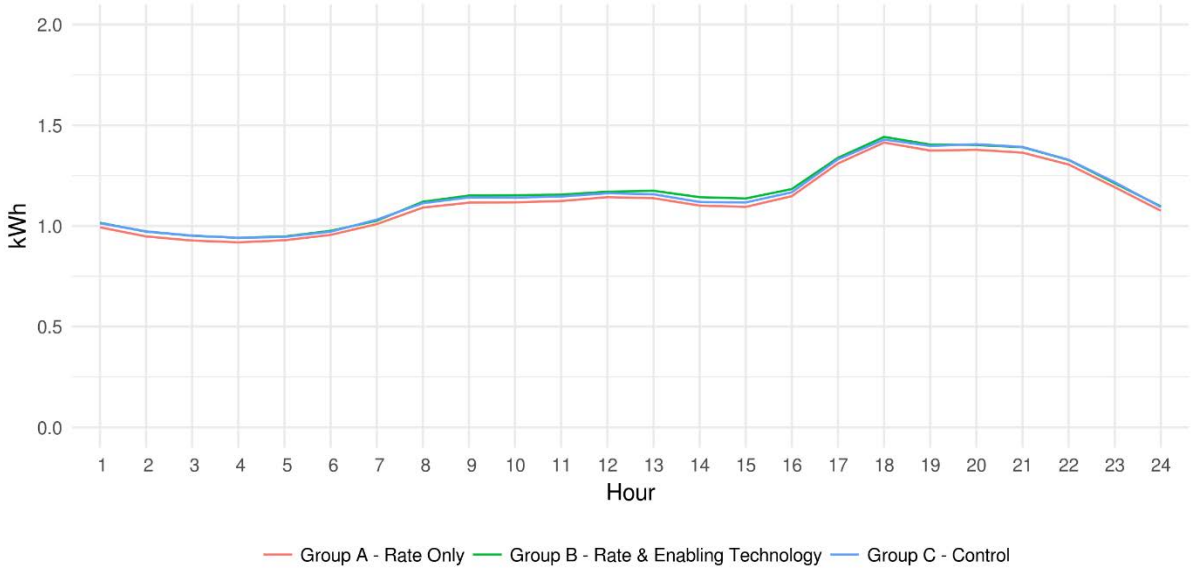
B.2 Seasonal Price Distributor Load Profiles

Figure 42. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Summer



Source: Navigant Analysis

Figure 43. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Winter

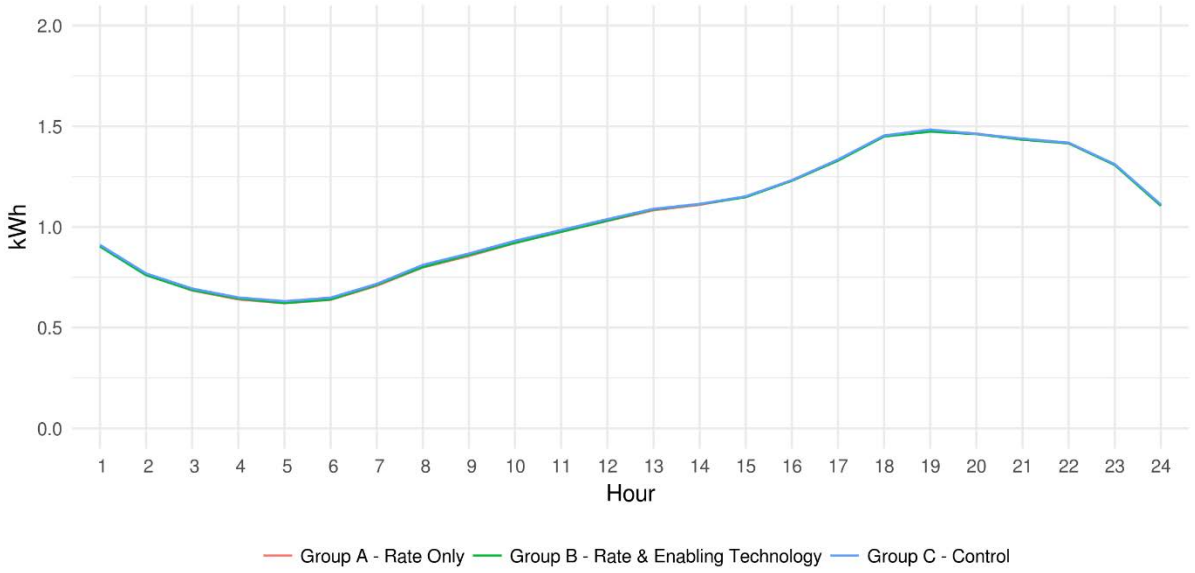


Source: Navigant Analysis

Figure 44. Northern Ontario Wires Pre-Period Comparison by Treatment Group - Shoulder

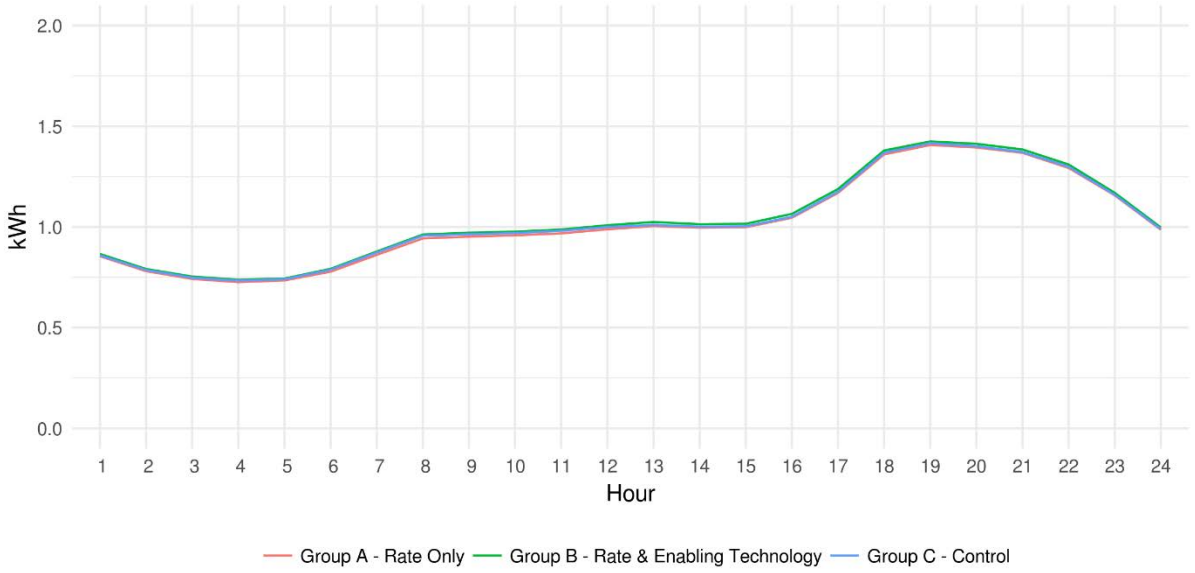
Source: Navigant Analysis

Figure 45. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Summer



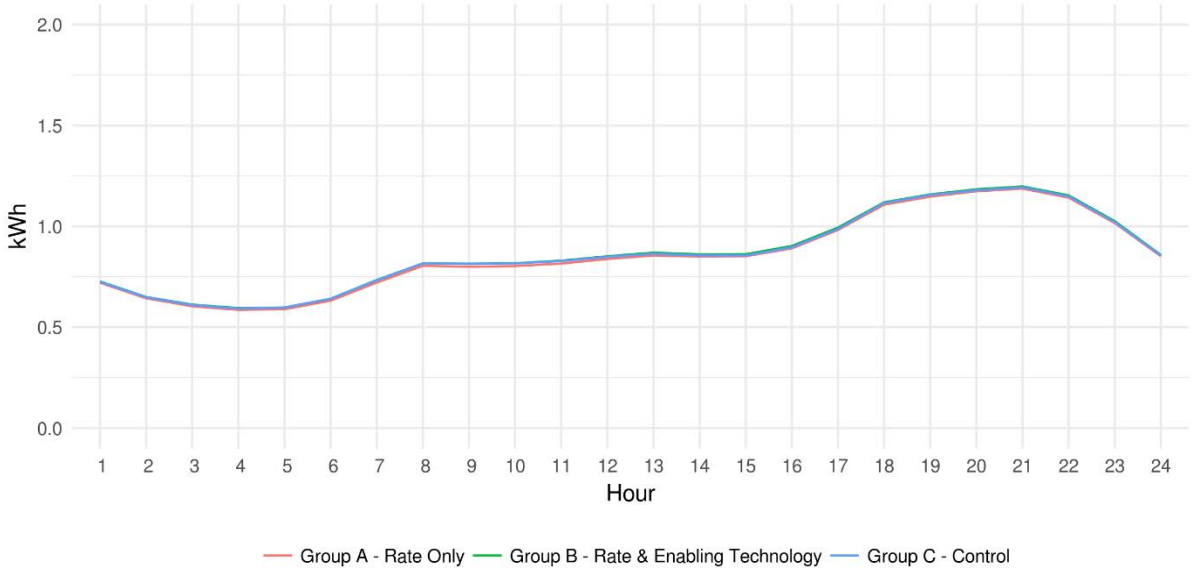
Source: Navigant Analysis

Figure 46. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Winter



Source: Navigant Analysis

Figure 47. Newmarket-Tay Power Distribution Ltd. Pre-Period Comparison by Treatment Group - Shoulder



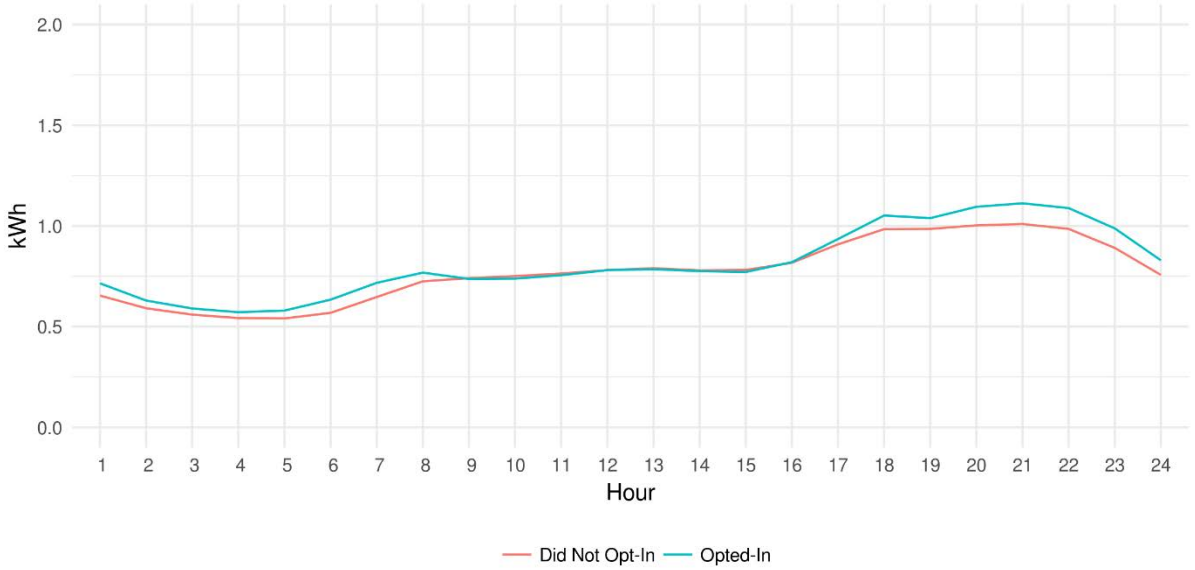
Source: Navigant Analysis

APPENDIX C. OPT-IN ANALYSIS: DETAILS

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

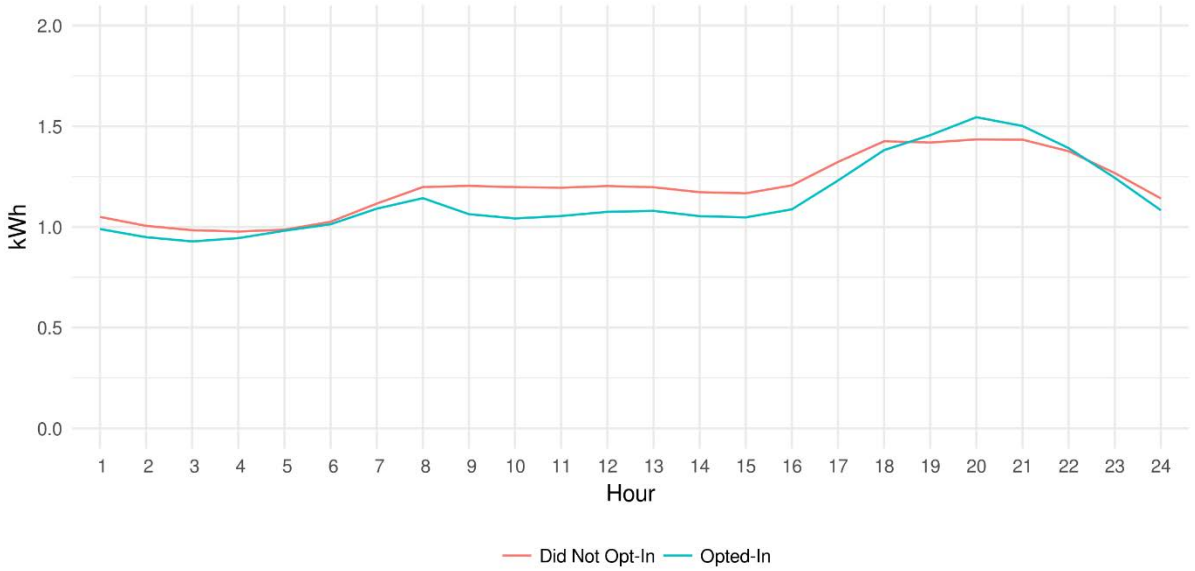
C.1 ESQ Price Distributor Load Profiles

Figure 48. Greater Sudbury Hydro Rate Only Opt-In Comparison - Summer



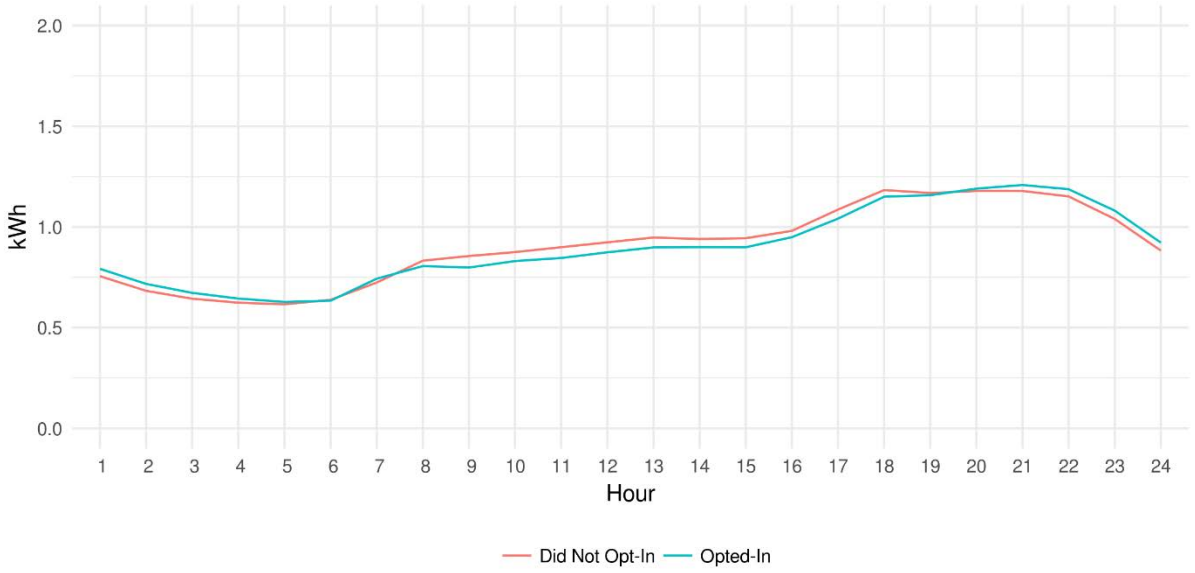
Source: Navigant Analysis

Figure 49. Greater Sudbury Hydro Rate Only Opt-In Comparison - Winter



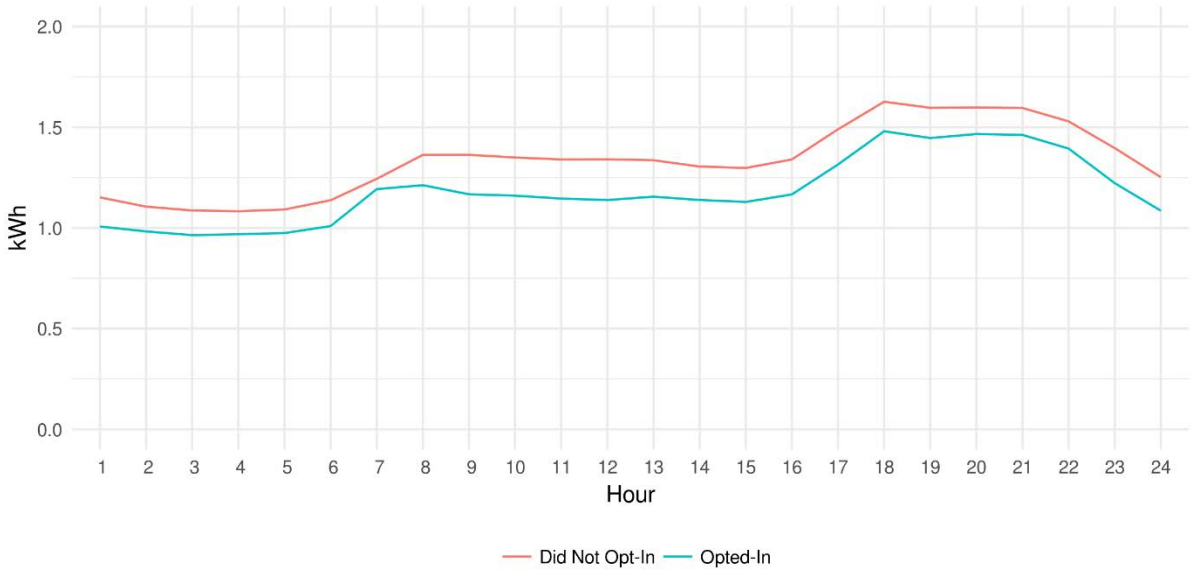
Source: Navigant Analysis

Figure 50. North Bay Hydro Distribution Ltd. Rate Only Opt-In Comparison - Summer



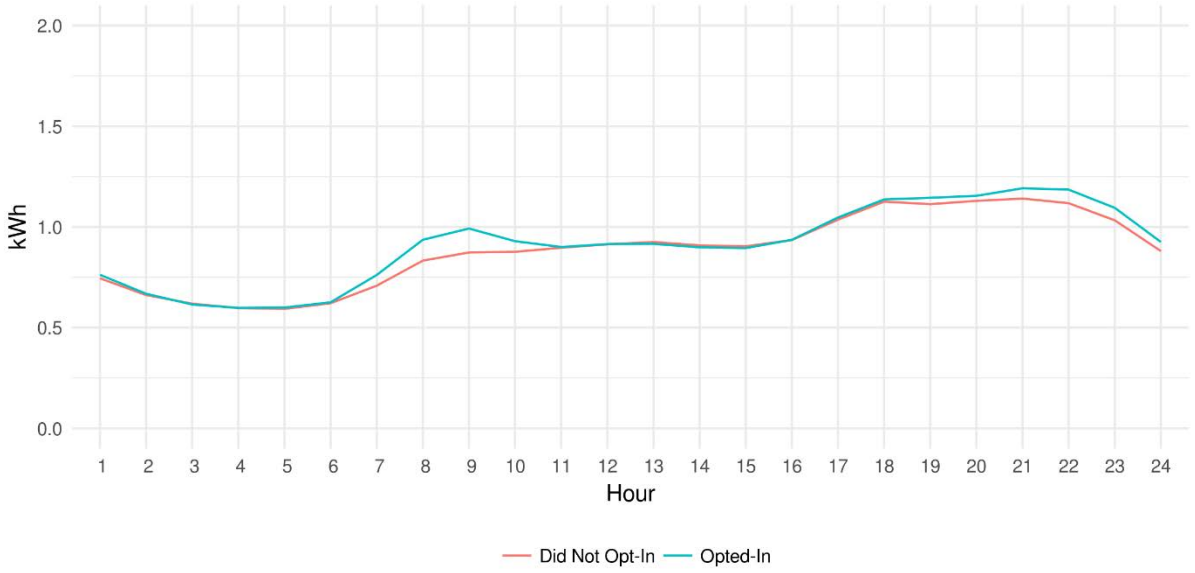
Source: Navigant Analysis

Figure 51. North Bay Hydro Distribution Ltd. Rate Only Opt-In Comparison - Winter



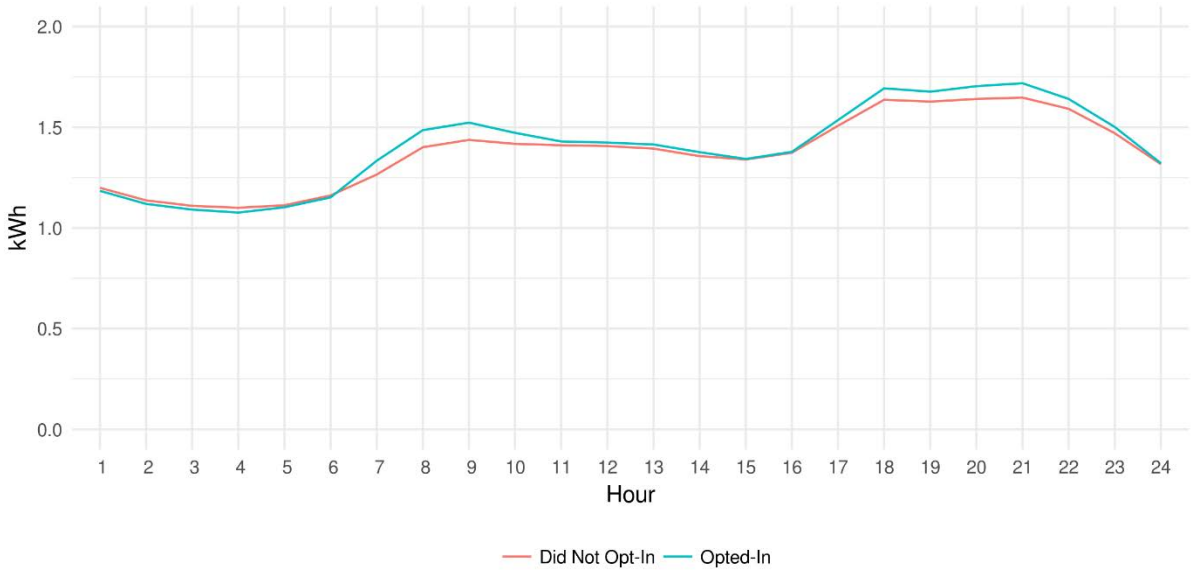
Source: Navigant Analysis

Figure 52. PUC Services Inc. Rate Only Opt-In Comparison - Summer



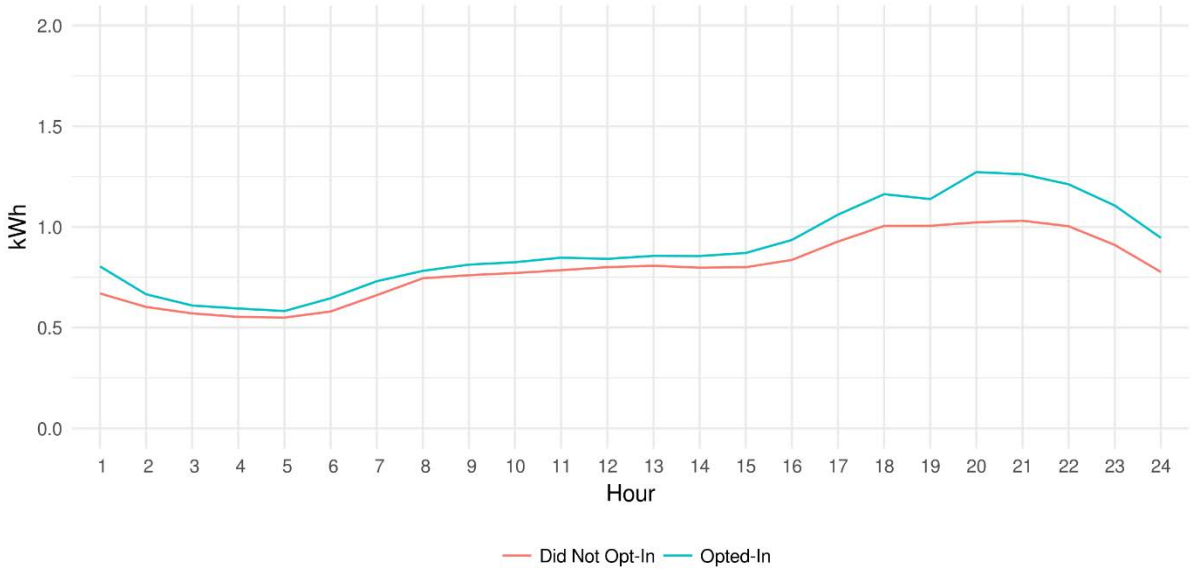
Source: Navigant Analysis

Figure 53. PUC Services Inc. Rate Only Opt-In Comparison - Winter



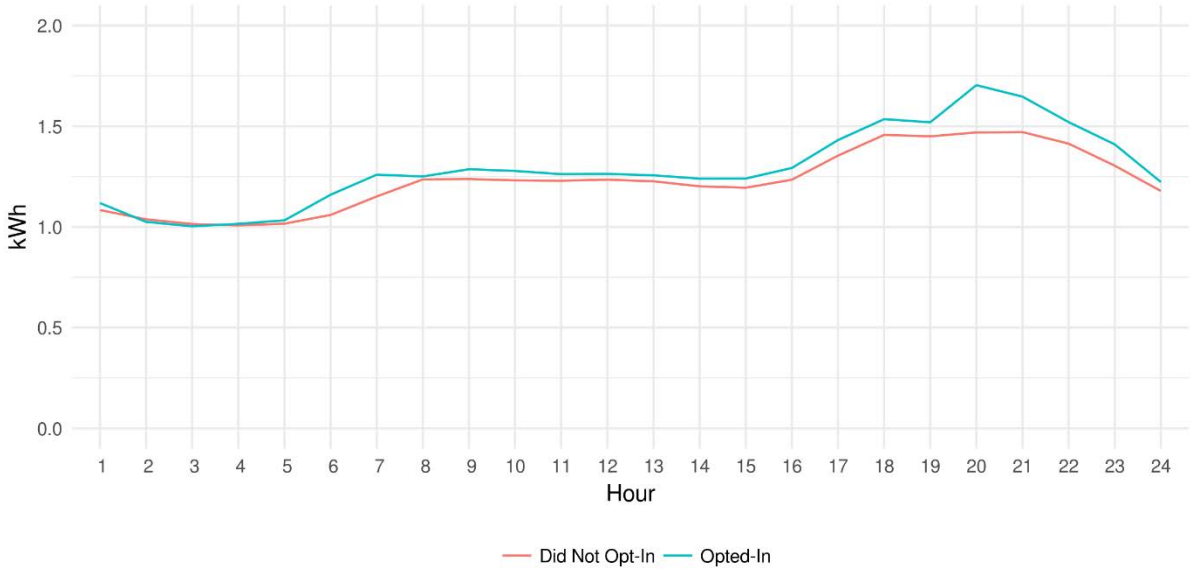
Source: Navigant Analysis

Figure 54. Greater Sudbury Hydro Rate and Enabling Technology Opt-In Comparison - Summer



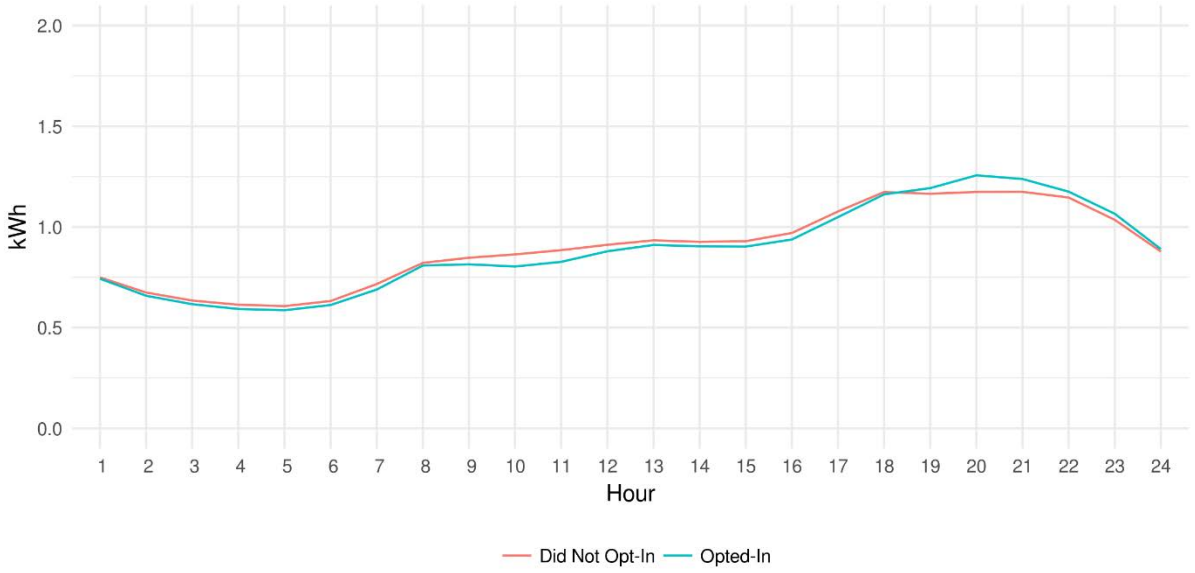
Source: Navigant Analysis

Figure 55. Greater Sudbury Hydro Rate and Enabling Technology Opt-In Comparison - Winter



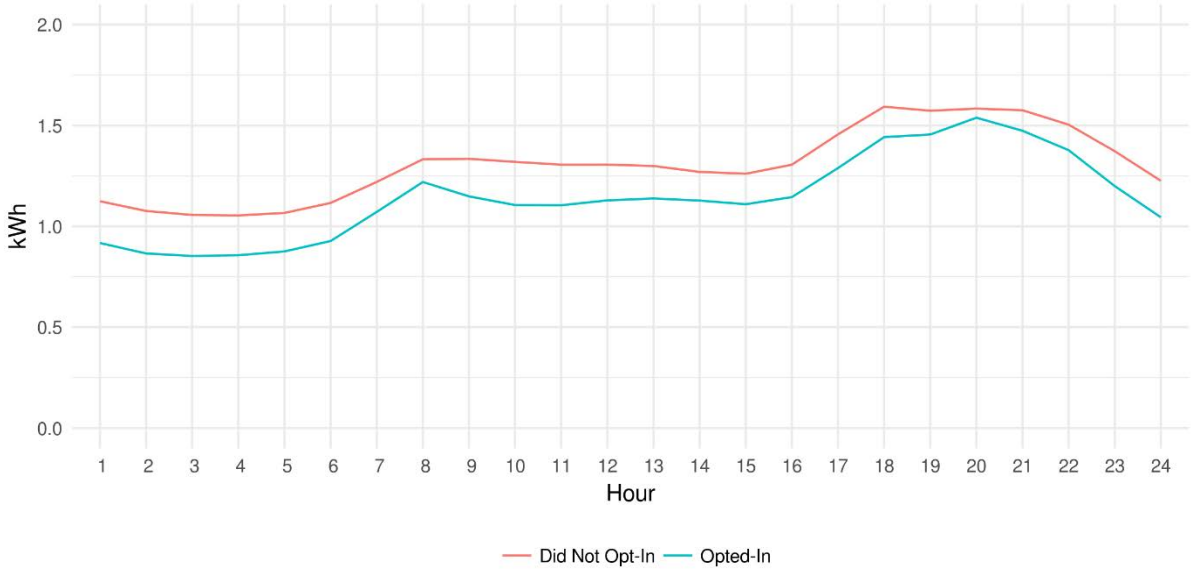
Source: Navigant Analysis

Figure 56. North Bay Hydro Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Summer



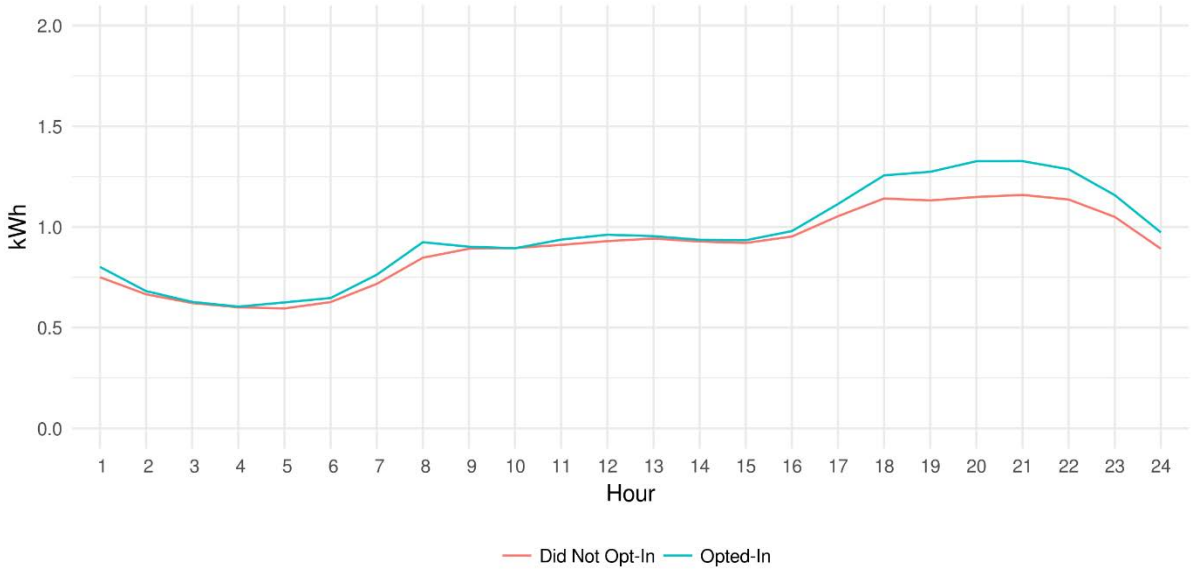
Source: Navigant Analysis

Figure 57. North Bay Hydro Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Winter



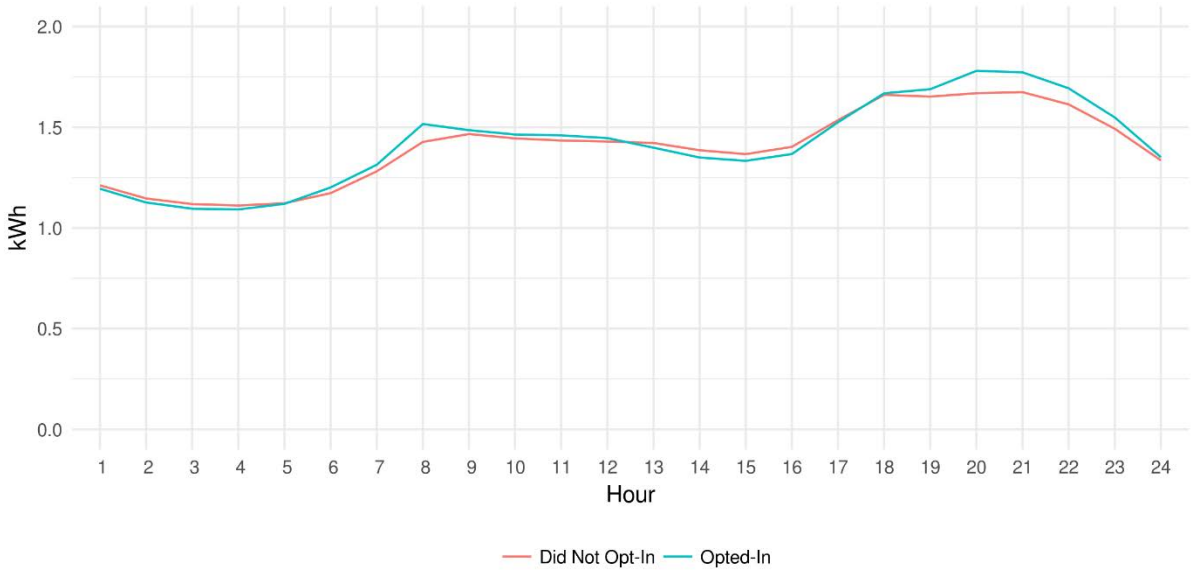
Source: Navigant Analysis

Figure 58. PUC Services Inc. Rate and Enabling Technology Opt-In Comparison - Summer



Source: Navigant Analysis

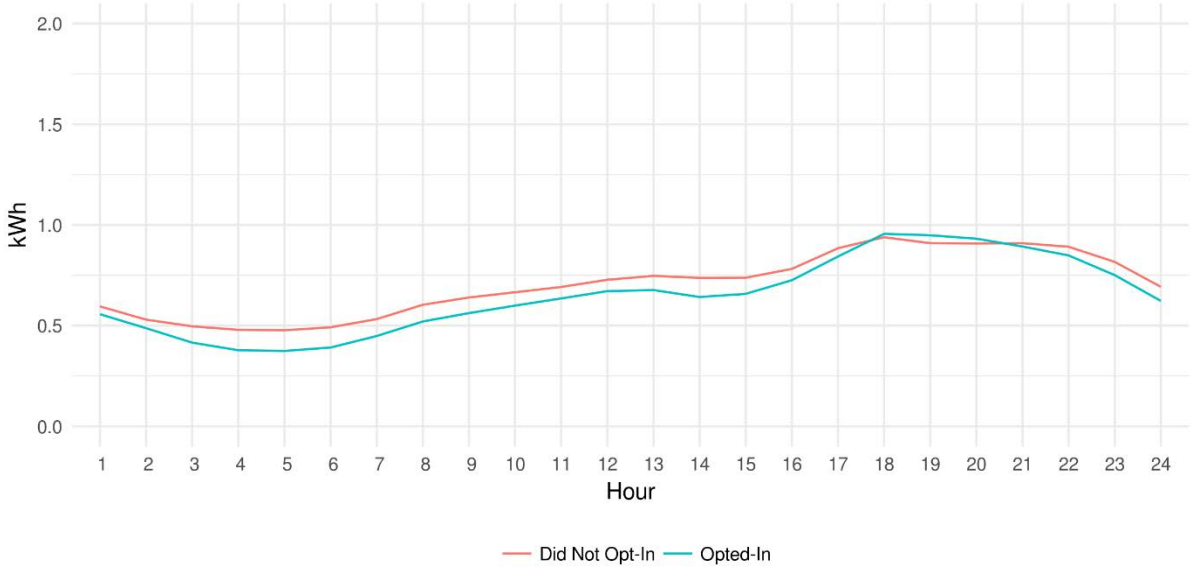
Figure 59. PUC Services Inc. Rate and Enabling Technology Opt-In Comparison - Winter



Source: Navigant Analysis

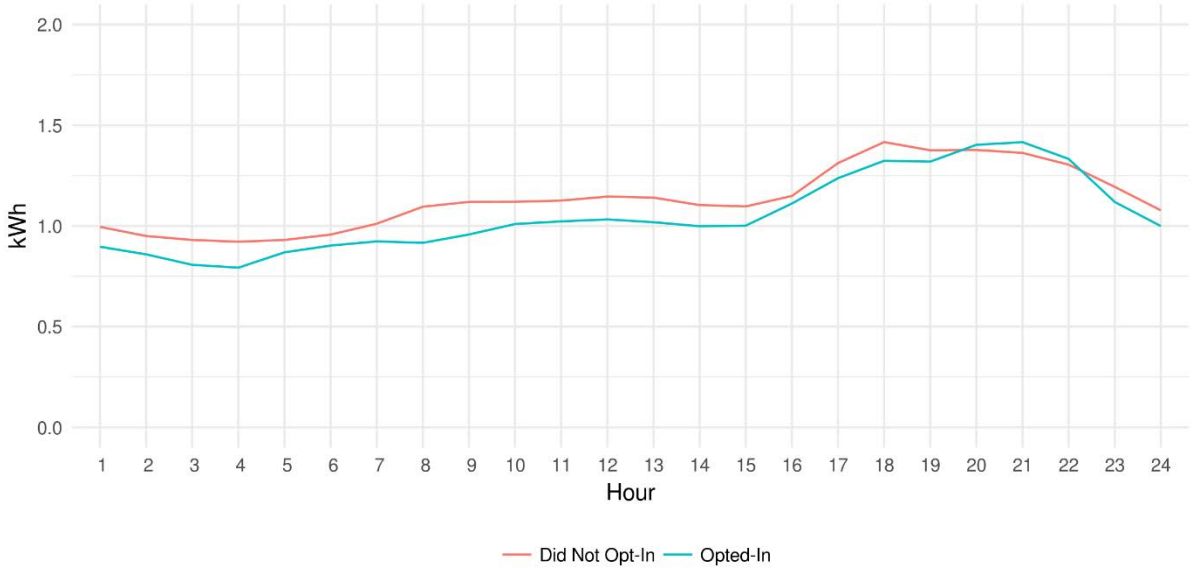
C.2 Seasonal Price Distributor Load Profiles

Figure 60. Northern Ontario Wires Rate Only Opt-In Comparison - Summer



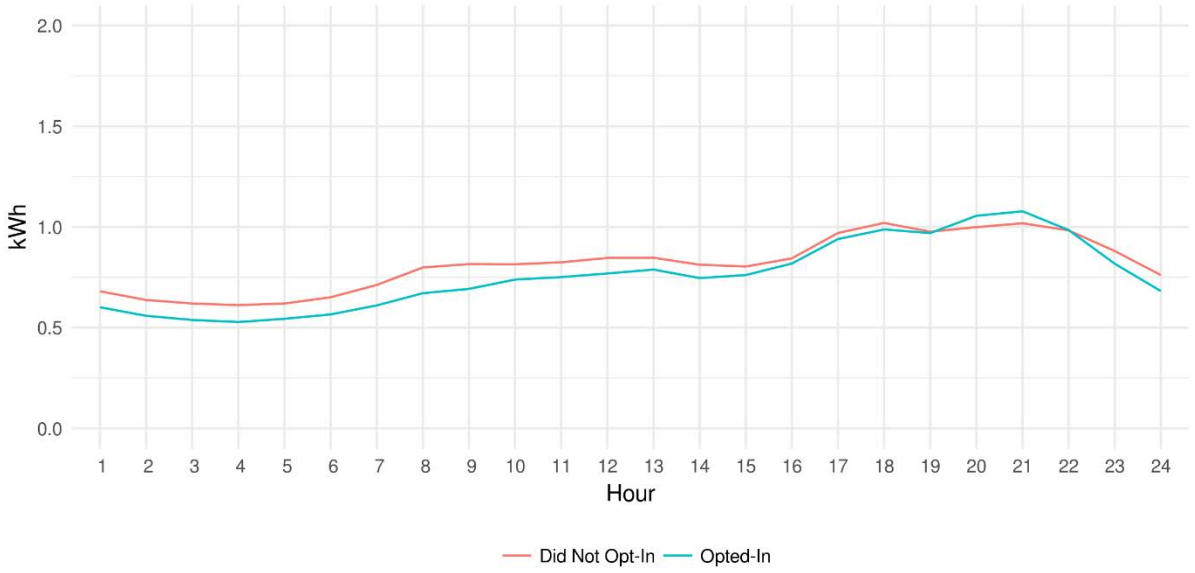
Source: Navigant Analysis

Figure 61. Northern Ontario Wires Rate Only Opt-In Comparison - Winter



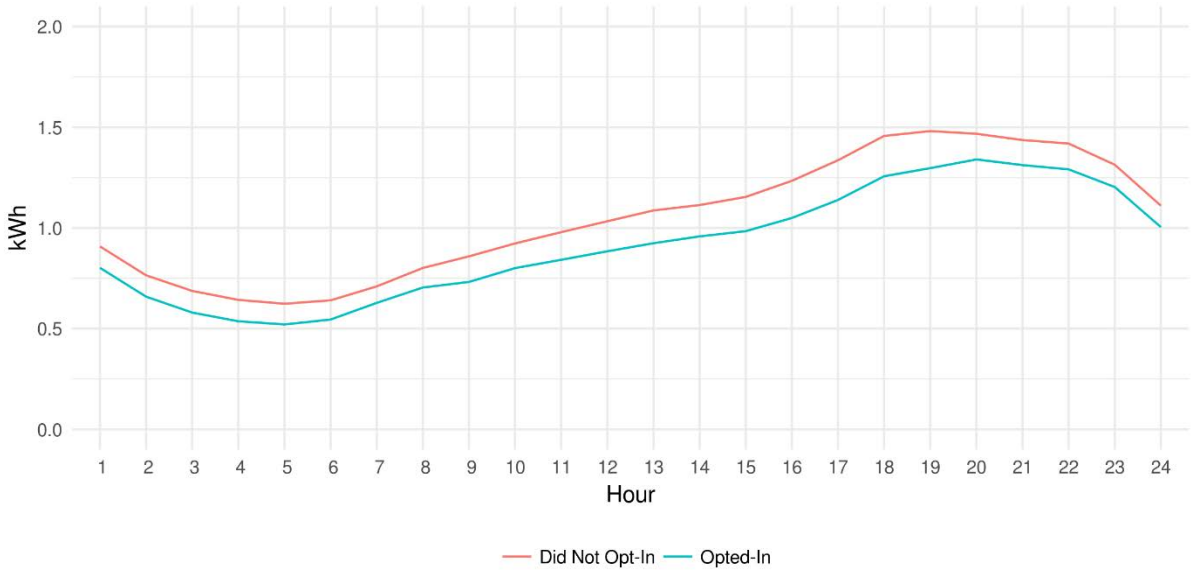
Source: Navigant Analysis

Figure 62. Northern Ontario Wires Rate Only Opt-In Comparison - Shoulder



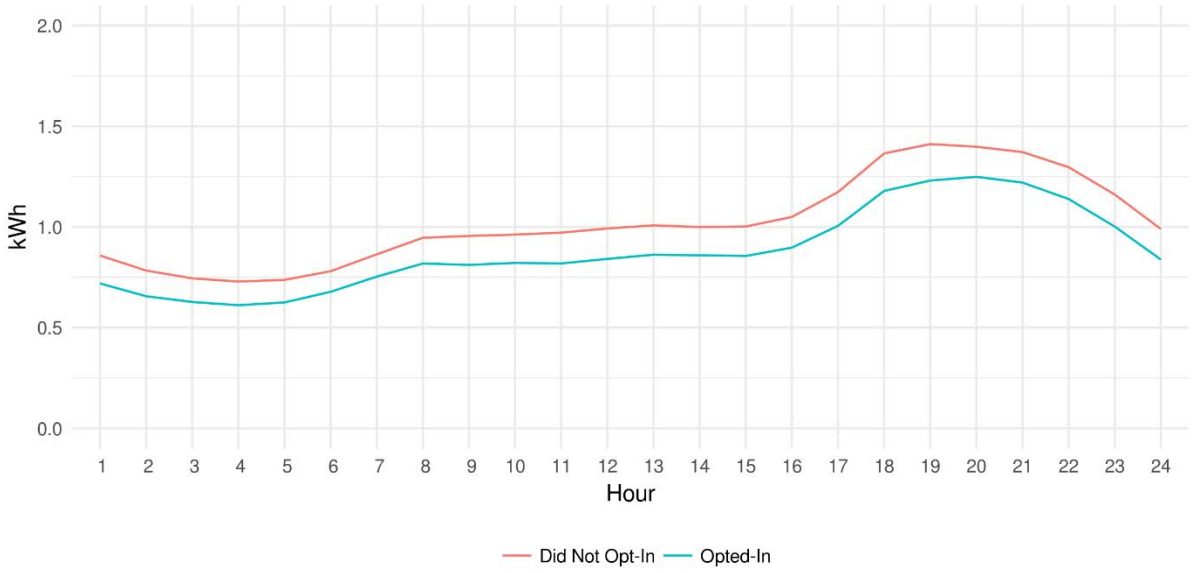
Source: Navigant Analysis

Figure 63. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Summer



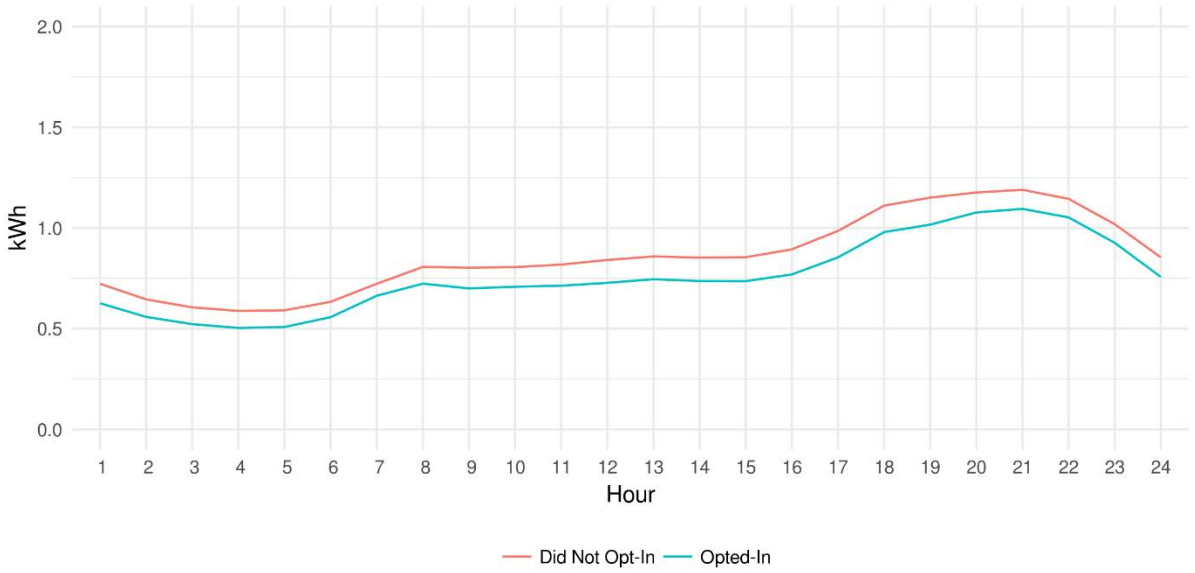
Source: Navigant Analysis

Figure 64. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Winter



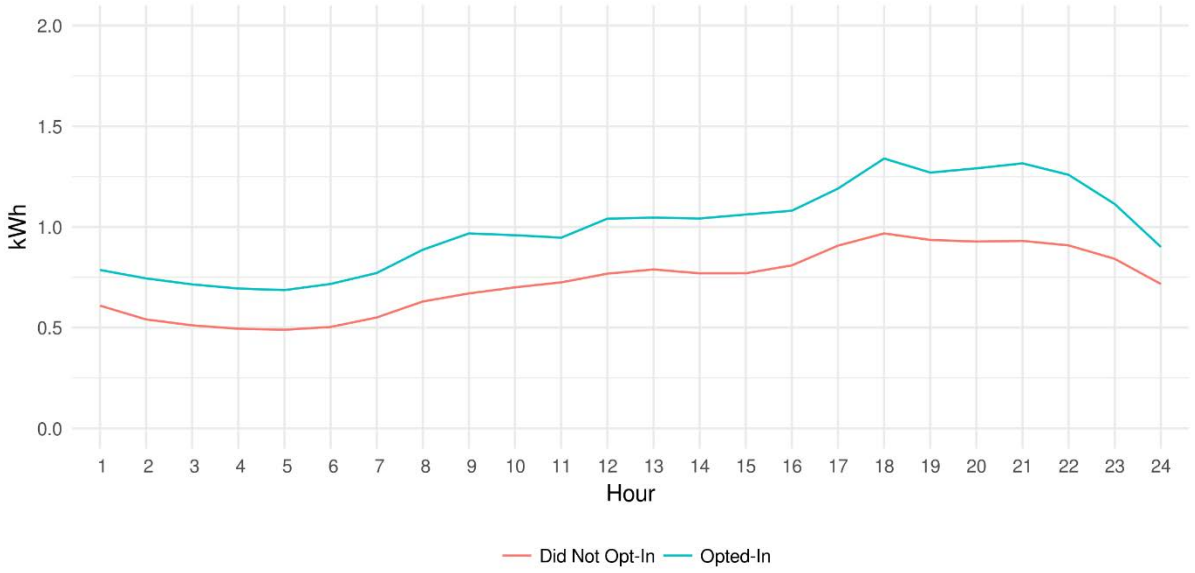
Source: Navigant Analysis

Figure 65. Newmarket-Tay Power Distribution Ltd. Rate Only Opt-In Comparison - Shoulder



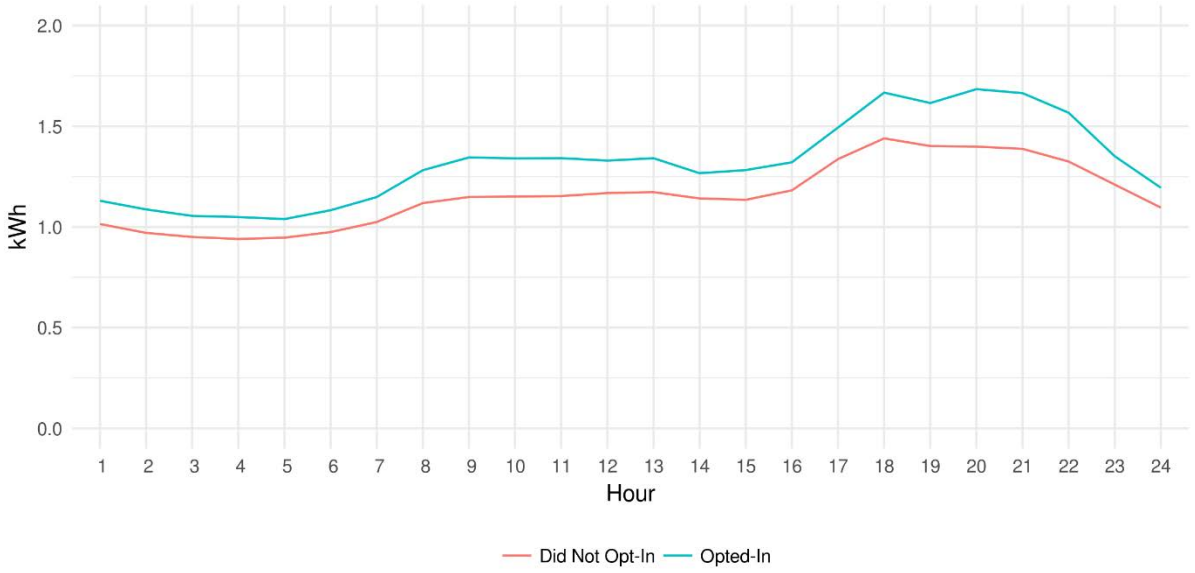
Source: Navigant Analysis

Figure 66. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Summer



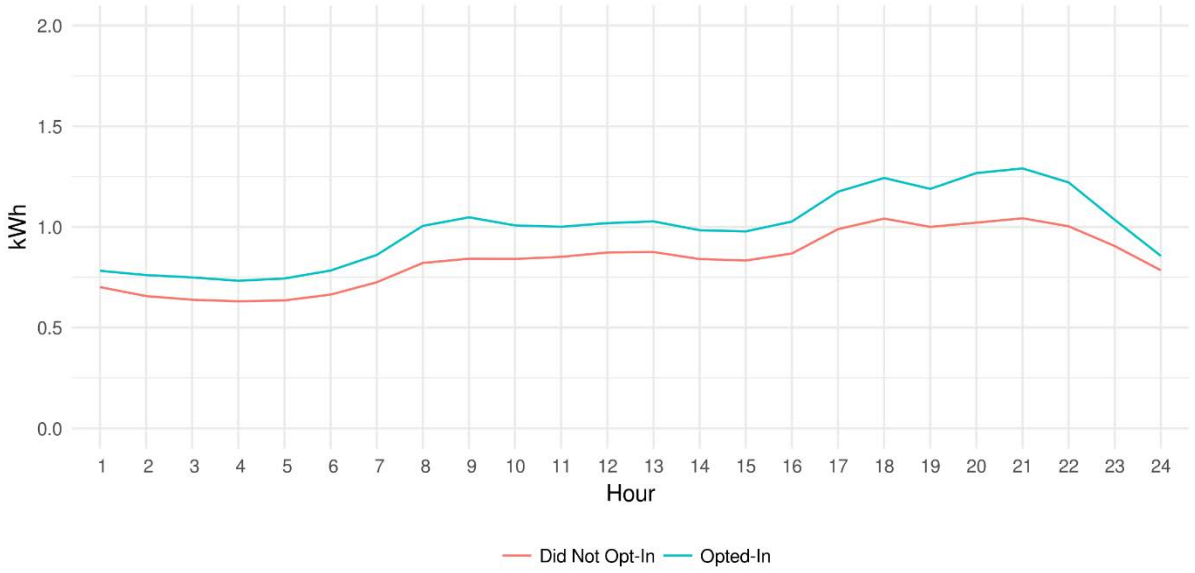
Source: Navigant Analysis

Figure 67. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Winter



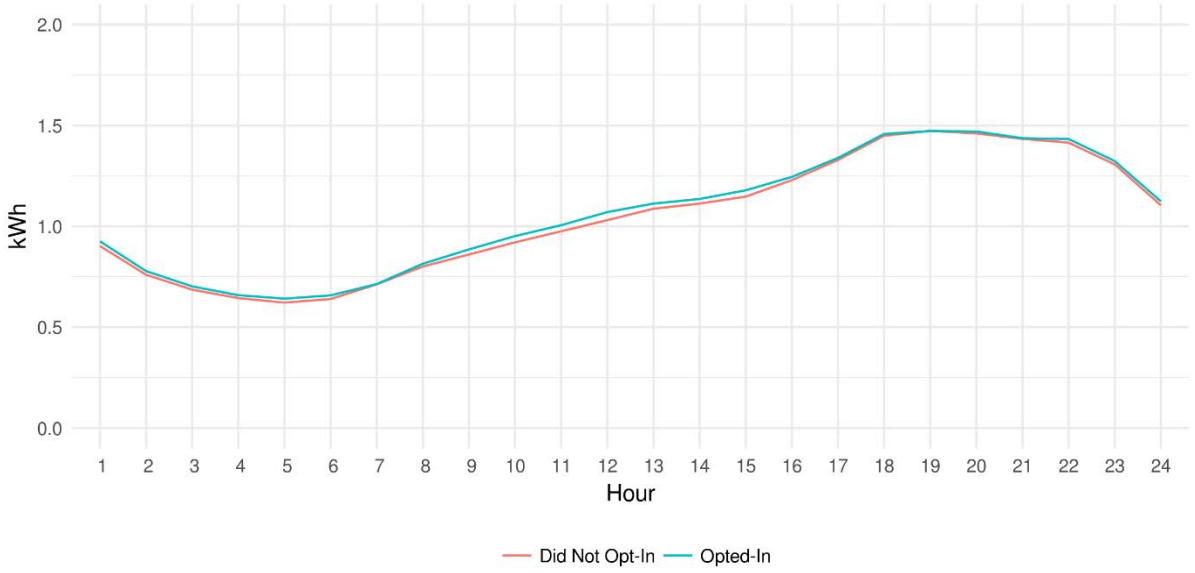
Source: Navigant Analysis

Figure 68. Northern Ontario Wires Rate and Enabling Technology Opt-In Comparison - Shoulder



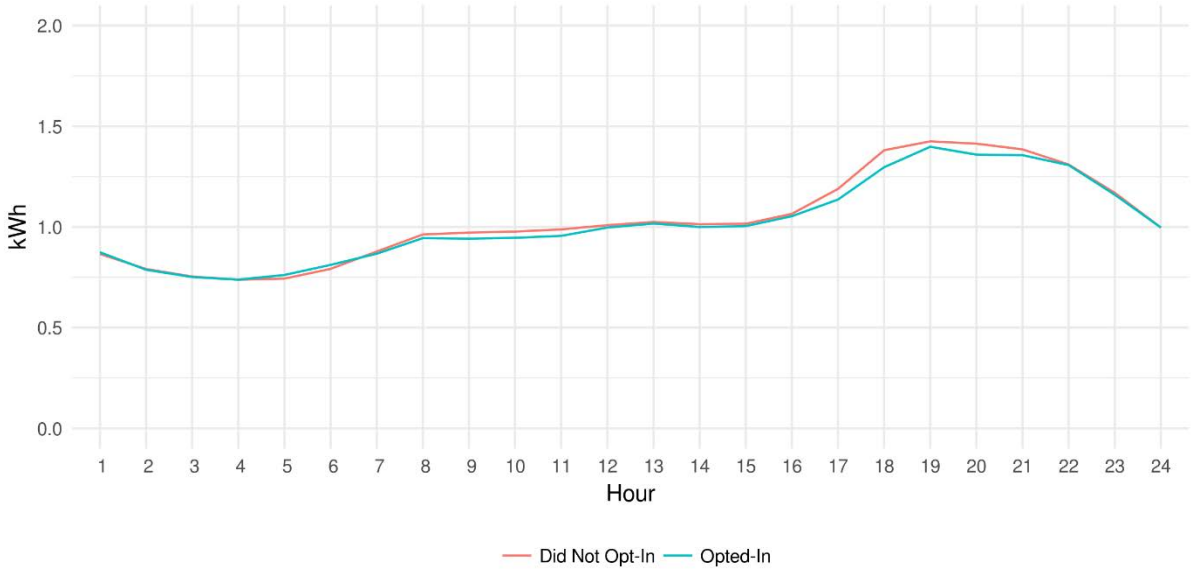
Source: Navigant Analysis

Figure 69. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Summer



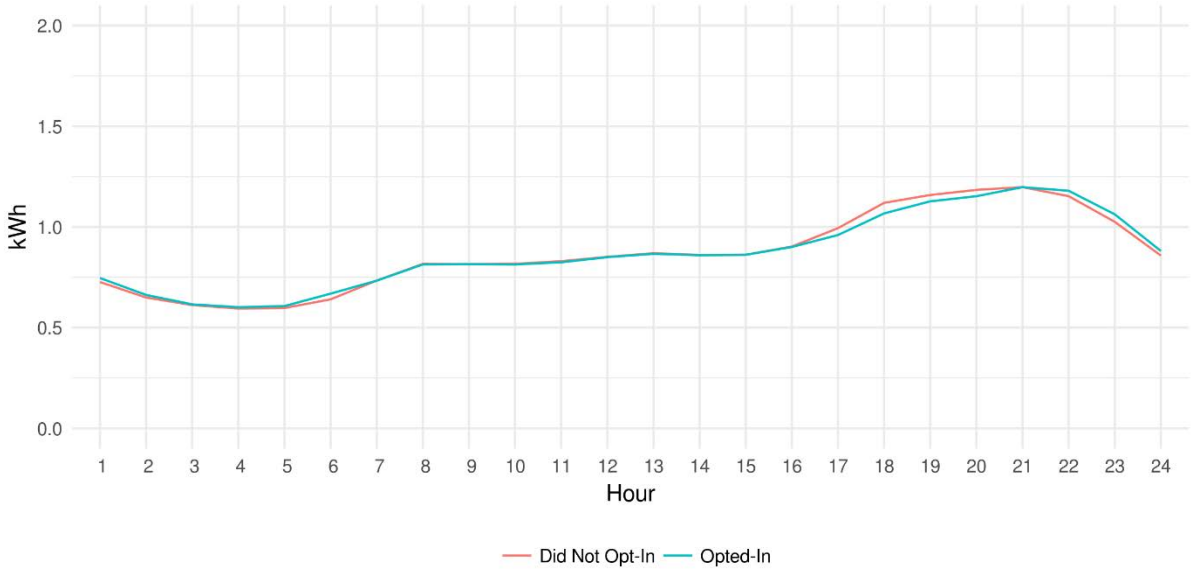
Source: Navigant Analysis

Figure 70. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Winter



Source: Navigant Analysis

Figure 71. Newmarket-Tay Power Distribution Ltd. Rate and Enabling Technology Opt-In Comparison - Shoulder



Source: Navigant Analysis

APPENDIX D. PARTICIPANT COMMUNICATION SAMPLES

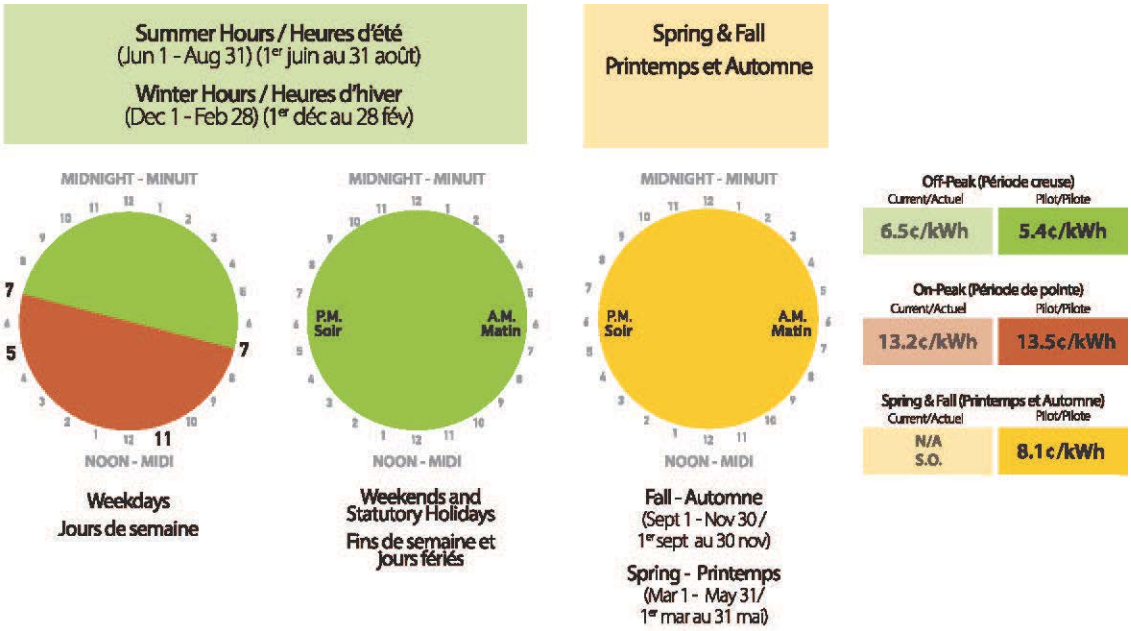
D.1 Enrollment Confirmation Email – Seasonal Price – Rate Only Treatment

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,

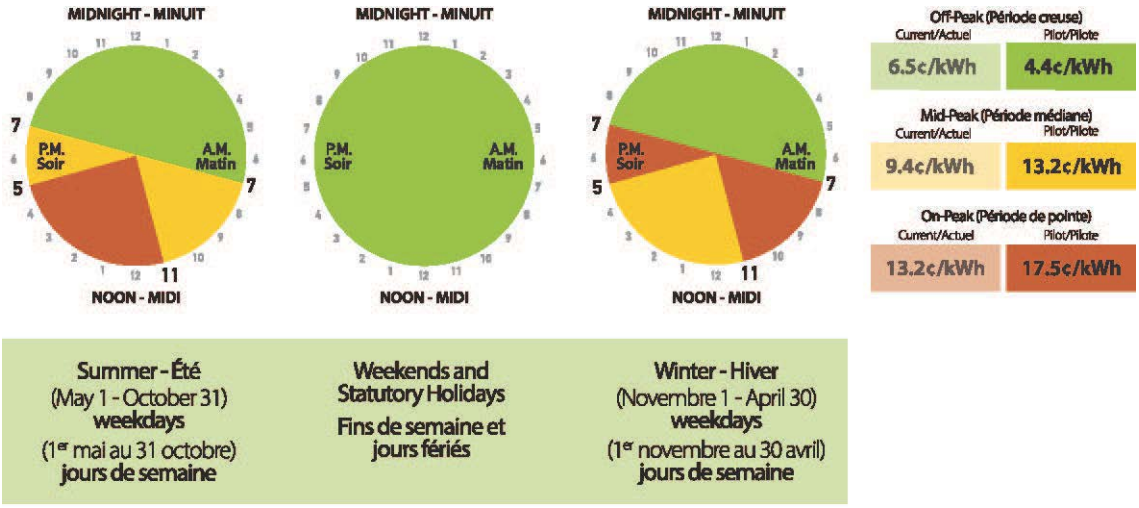
D.2 Enrollment Confirmation Email – ESQ Price – Rate & Enabling Technology Treatment

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,