Regulated Price Plan Pilot – Final Report

Submitted to the Ontario Energy Board

Alectra Utilities with its partner BEworks

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About Alectra

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

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About BEworks

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

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

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Executive Summary

In 2016, the Ontario Energy Board (OEB), through its Regulated Price Plan (RPP) pilots, sought to examine the impact of alternative pricing schemes and non-price interventions on conservation and demand management behaviours among utility customers. Alectra Utilities (Alectra), and its partners tested the impact of three separate Time-of-Use pricing schemes (Dynamic, Overnight, and Enhanced) with two non-price interventions ("Nudge Reports" and programmable smart thermostat Technology) to achieve the OEB's RPP pilot objectives. Collectively, the three pricing pilots were communicated and marketed to customers under the name Advantage Power Pricing (APP) and will be referred to as such throughout this report. It should be noted that a version of the Dynamic pricing pilot had been run previously by Alectra and that customers participating in this legacy program were encouraged to remain in Dynamic pricing as part of the current pilot. In this report, we use the terms 'Dynamic' and 'Legacy Dynamic' to differentiate between Dynamic pricing pilot customers who signed up as part of this most recent instantiation of the RPP pilot and those that were retained from previous iterations of Dynamic pricing. This report covers the reporting period May 01, 2018 – April 30, 2019 inclusive. Next, we outline the prices and associated time periods for each of the three pricing pilots.

Enhanced pricing

Customers participating in the Enhanced pricing pilot experienced a larger On- to Off-Peak price differential (4:1) relative to standard TOU pricing (2:1) as well as a larger Mid- to Off-Peak price differential (3:1) relative to standard TOU pricing (1.5:1). The exact prices and associated price periods are shown in Table 1.

Table 1: Enhanced Pricing kWh Prices

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

Dynamic pricing

Customers participating in the Dynamic pricing pilot experienced variable On-Peak prices depending on anticipated demand. Demand forecasts by the IESO were used by Alectra to set the variable On-Peak price (Low, Medium, or High) for each day. This was done in such a manner as to abide by the proportion of variable On-Peak periods called as Low, Medium, or High that was prescribed by the OEB. These customers also experienced Critical Peak Periods (CPP; 6 Summer and 6 Winter, lasting 4 hours each) with an especially high price. In addition, there was no Mid-Peak period. These CPP events were also called by the OEB based on IESO demand forecasts and customers were notified of an impending CPP event by Alectra via SMS test or email at 4pm on the day preceding an event. The prices and associated time periods are shown in Table 2. This information applies to both the Dynamic Pricing Pilot and the Legacy Dynamic Pricing Pilot.

Table 2: Dynamic Pricing kWh Prices

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

Overnight pricing

Customers taking part in the Overnight pricing pilot experienced an especially low overnight Off-Peak price. This pricing pilot is designed to appeal to customers working irregular shifts or who are electric vehicle owners (or prospective electric vehicle owners). The prices and associated time periods are shown in Table 3.

Table 3: Overnight Pricing kWh Prices

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

Standard (Status quo) Time-of-Use (TOU) Pricing

Customers assigned to control conditions for each of the three pricing pilots described above experienced standard (or 'status quo') TOU prices. The standard TOU prices and associated time periods are shown in Table 4.

Table 4: Standard TOU Pricing kWh Prices

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

Program Results

Sample Size

Sample sizes as a function of pricing pilot and condition are shown in Tables 5 through 8 **Error! Reference source not found.**below.

Table 5: Enhanced Pricing Pilot Sample Sizes

	Summer			Winter	
	Starting N	Total Exclusions[1]	Final N	Total Exclusions	Final N
Enhanced Pricing	3500	504	2996	241	2733
Enhanced Pricing + Nudge Report	3500	536	2964	263	2723
Std. TOU Control	3500	261	3239	222	3042
Std. TOU Control + Nudge Report	3500	263	3237	197	3015
Total	14000	1564	12436	923	11513

[1] Total Exclusions: This is simply the sum of Opt-Outs + Move-Outs + Missing Data + Outliers. Full descriptions of each of these exclusion criteria are provided in Section 4. Advantage Power Pricing Impact Analysis Methodology.

Table 6: Overnight Pricing Pilot Sample Sizes

	Summer			Winter	
	Starting N	Total Exclusions[2]	Final N	Total Exclusions	Final N
Overnight Pricing	366	26	340	99	241
Overnight Pricing, 6-Month Group[3]	74	--	--	13	61
Std. TOU Control	366	5	361	2	359
Std. TOU Control, 6-Month Group	74	--	--	3	71
Total			701		732

Table 7: Dynamic Pricing Pilot Sample Sizes

	Summer			Winter	
	Starting N	Total Exclusions[2]	Final N	Total Exclusions	Final N
Dynamic Pricing, No Nudge Report	3500	47	338	103	235
Dynamic Pricing + Nudge Report	3500	40	345	110	235
Std. TOU Pricing, No Nudge Report	3500	21	364	22	342
Std. TOU Pricing + Nudge Report	3500	23	362	21	341
Total	14000	131	1409	256	1153

[2] Total Exclusions: This is simply the sum of Opt-Outs + Move-Outs + Missing Data + Outliers. Full descriptions of each of these exclusion criteria are provided in Section 4. Advantage Power Pricing Impact Analysis Methodology.
[3] The '6-month group represents a group of customers who enrolled in Overnight pricing but did not have sufficient historical consumption data to allow for their inclusion in the Summer impact analysis; they were included in the Winter analysis.

Table 8: Number of Participants for Legacy Dynamic Pilot

	Summer			Winter		
	Starting N	Total Exclusions[4]	Final N	Starting N	Total Exclusions	Final N
Registration Bin 1						
Legacy Dynamic	778	114	664	839	111	728
Std TOU Control	778	114	664	839	111	728
Registration Bin 2						
Legacy Dynamic	650	147	503	639	141	498
Std TOU Control	650	147	503	639	141	498

Summary of Analytical Approach

As a result of seasonal variations and year-over-year fluctuations in weather patterns, there was substantially higher overall electricity consumption in the 12-month pilot period relative to the preceding 12 months. For this reason, we employed a difference-in-difference (DID) approach for impact analyses, when appropriate. The DID compares the year-to-year difference in consumption between treatment and control groups. For example, if from the pre-treatment to the treatment period, a given control group consumed 0.05 kWh more electricity, but the corresponding treatment group consumed only 0.01 kWh more electricity, we can then report that the treatment lead to a 0.04 kWh reduction in consumption relative to the control group. We present DID impact analysis results as mean hourly kW differences from control. We subsequently derive and report percentage change equivalents from the results of the kW impact estimates. In all regression tables, mean hourly kW impact estimates represent the *additional* change in mean hourly kW consumption between periods for participants receiving an experimental Treatment, compared to the change in kW experienced by participants in the appropriate Control group. We extrapolate percent change in mean hourly kW consumption owing to a pilot Treatment variable by dividing the mean hourly kW impact coefficient by the relevant Treatment group's counterfactual consumption, which we derived by subtracting the impact coefficient from the Treatment group's observed mean hourly consumption in the relevant TOU price period in the pilot Treatment period. Thus, percent impact estimates represent the percentage by which the observed consumption in the Treatment

[4] Total Exclusions: This is simply the sum of Opt-Outs + Move-Outs + Missing Data + Outliers. Full descriptions of each of these exclusion criteria are provided in Section 4. Advantage Power Pricing Impact Analysis Methodology.

group differs from their counterfactual consumption had they not been Treated. As these values were calculated from the kW impacts, we did not conduct statistical significance testing directly on the percentage values. Statistical significance of impacts is only reported for the mean hourly kW effects from the linear regression models.

There are two instances in which mean hourly kW impact estimates were not derived and statistically analyzed using a difference-in-difference (DID) approach: (1) the Legacy Dynamic Pilot; and (2) the Technology Analyses pertaining to the incremental impacts owing to curtailment-enabled smart thermostats. Firstly, the Legacy Dynamic pricing program began in 2014, meaning that the employment of a DID approach to impact estimation is problematic. Mainly, in order to compare consumption in the current pilot period (May 01, 2018 – April 30, 2019) to a pre-treatment historical baseline period, a historical data set that is (in many cases) over four years old would have to be used. Despite the fact that this would be a very 'noisy' and arguably inappropriate historical data set with which to employ a DID approach, historical data sets for Legacy Dynamic Matched Control customers was not made available to the evaluator during the implementation and evaluation stages of this pilot. This is further complicated by the fact that Legacy Dynamic pricing customers enrolled into Dynamic pricing at 3 different historical time periods, meaning that different historical baseline periods would have to be used for different groups of customers within the Legacy Dynamic customer group (this is discussed further below). It is for these reasons that we compare Legacy Dynamic pricing customer consumption with Standard TOU Control pricing customers during each year on record separately, without using the DID approach. Caution should be used when making qualitative or quantitative comparisons between Dynamic and Legacy Dynamic impacts. Legacy Dynamic participants have been exposed to the Dynamic pricing structure for (in some cases) up to four years, whereas newly enrolled Dynamic participants have only been exposed to Dynamic pricing for a little over one year (including the pre-treatment price protected period). Even with this in mind, any comparisons made between these two groups of customers would not provide an accurate picture of the effect of exposure duration to Dynamic pricing on electricity consumption behaviour. This is because Legacy Dynamic participants enjoyed full price protection for the entirety of the Legacy program. Thus, because of differences in the analytical approach, differential exposure durations to Dynamic pricing, and differences in the length of exposure to price protection, any comparisons between the Legacy and newly enrolled Dynamic customer groups inappropriate.

Secondly, in each pilot, the smart thermostat "Technology" analysis compares households with registered smart thermostats to those without registered devices *during the 2018-2019 Treatment period only*. Exact timing of smart thermostat installation for each household is unknown, therefore Technology was analyzed comparing kWh consumption of households with and without registered smart thermostat during the Treatment period only, and we did not employ a difference-in-difference approach. Registered smart thermostats were capable of receiving some form of automatic load curtailment during certain peak TOU periods during the pilot[5]. Analyzing Technology during the Treatment period only avoids any noise introduced by potential smart thermostat usage during the pre-Treatment pricing period. Put differently, we assume that there

[5] The exception to this concerns the Honeywell and Ecobee thermostats, which only allowed for load curtailment in the Dynamic and Legacy Dynamic pilots. Energate and Nest thermostats allowed for load curtailment in all pilot pricing groups (Enhanced, Dynamic, Legacy Dynamic, and Overnight).

are likely consumption reduction benefits conferred by (1) owning and using a smart thermostat, and (2) registering that thermostat for automatic load curtailment. If we were to employ a DID approach to Technology impact estimates, some Technology customers would be compared to a pre-treatment period in which they used a smart thermostat that was not load-curtailment enabled, some would be compared to a pre-Treatment period in which they did not possess a smart thermostat at all, and still some would be compared to a pre-Treatment period in which they owned a smart thermostat for some, but not all of the pre-treatment period. We therefore opted to simply compare those with registered smart thermostats to those without registered smart thermostats during the Treatment period only.

Under Time-of-Use pricing in Ontario, the calendar year is divided into two 6-month periods referred to as Summer months (May 01 to October 31 inclusive) and Winter months (November 01 to April 30 inclusive). The times of day (during weekdays) that are designated as On-Peak and Off-Peak hours vary depending on whether they fall within Summer or Winter months. As such, we report impact estimates related to TOU price periods separately for Summer and Winter months throughout this report.

Impact of Pricing Structures

The interim impacts resulting from both the price and non-price interventions (covering the Summer months of May to October 2018 inclusive) as well as the final impacts (covering the Winter months of November 2018 to April 2019 inclusive) are summarized in

Table 9 below. We present only the impact estimates for the highest and lowest priced TOU periods across pilots, however detailed TOU period impact estimates are provided in Section 5. Impacts are represented as the difference in year-over-year mean hourly kW consumption between a Treatment and Control group for a given pricing structure and TOU period. We observe substantial decreases in average hourly electricity consumption during On-Peak hours for the Overnight and Dynamic pricing groups (0.100 kWh and 0.260 kWh respectively) in the Summer period and substantial decreases in consumption during High On-Peak hours for the Dynamic group in the Winter period (0.122 kWh). In addition, there was a substantial increase in consumption during Overnight Super Off-Peak hours (0.345 kWh in the Summer period and 0.511 kWh in the Winter period) and no change in consumption during Dynamic Off-Peak hours. In contrast, the Enhanced pricing pilot showed no significant effects of Enhanced pricing relative to customers on status quo Time-of-Use (TOU) pricing.

Table 9: Main effects of price plans (comparing treatment group versus control group)

APP Price Plan	Main Effect of Price (Relative to Control in Mean Hourly kW)							
	Summer Period				Winter Period			
Enhanced	On-Peak		Off-Peak		On-Peak		Off-Peak	
	KW	%[6]	KW	%	KW	%	KW	%
	-0.001	-0.173	0.006	0.599	0.005	0.533	0.011	1.189
Overnight	On-Peak		Super Off-Peak		On-Peak		Super Off-Peak	
	KW	%	KW	%	KW	%	KW	%
	-0.1* **	-9.641	**0.345*** **	45.038	0.012	1.463	**0.511*** **	73.344
Dynamic	High On-Peak		Off-Peak		High On-Peak		Off-Peak	
	KW	%	KW	%	KW	%	KW	%
	-0.26* **	-12.968	0.000	0	**-0.122*** **	-10.558	0.001	0.114
Legacy Dynamic Registration Bin 1	**-0.144 ** **	-7.496	**0.108 *** **	11.878	-0.005	-0.465	**0.057 *** **	6.898
Legacy Dynamic Registration Bin 2	-0.065	-3.59	**0.072 * **	7.959	-0.005	-0.354	0.091	8.447

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

The Legacy Dynamic pilot was divided into two different sub-groups, based on different dates of registration. These two subgroups of participants were analyzed separately, based of different periods of pilot enrollment: Registration Bin 1 (registration date on or before May 01, 2015) and Registration Bin 2 (registration date between October 01, 2015 and May 04, 2016). Registration Bin 1 consumed significantly less electricity than their Standard TOU Matched Control group during the Summer Period (0.144 kWh), while neither Bin differed from Control with respect to Winter High On-Peak consumption. Both bins also offset their reduction during High On-Peak hours with increases during all Summer and Winter Off-Peak periods.

Impact estimates owing to the three pricing pilots indicate significant On-Peak electricity consumption savings for both the Overnight and Dynamic pricing pilots. The failure to observe significant consumption reductions owing to the Enhanced pricing pilot may be due to one or more of the following reasons: (1) the Overnight and Dynamic pilots required a voluntary sign-up process which may have self-selected a group of participants more highly motivated to conserve electricity relative to the Enhanced pricing pilot in which customers were randomly chosen to be assigned to the pricing Treatment group, and (2) the price differential between On and Off-Peak TOU periods in the Enhanced pricing pilot is substantially smaller than in to the Dynamic and Overnight pilots, and so there may have been insufficient economic incentive for Enhanced pricing participants to alter their consumption behaviour.

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[6] % impacts are calculated as kW impact / (PostTOUUsage - kW impact), where PostTOUUsage is the average consumption between the Enhanced Pricing + No Nudge Report and Enhanced Pricing + Nudge Report groups in 2018 from table 36.

Non-Price Interventions

In addition to the pricing interventions, half of the participants in each of the pricing Treatment and Control groups for the Enhanced and Dynamic pricing pilots, and half of the participants in the Legacy Dynamic pricing Treatment group, were randomly assigned to receive a non-price intervention called a "Nudge Report" (there was a lower than expected sign-up rate for the Overnight pricing plan which precluded the addition of a second experimental factor in order to preserve statistical power. In addition, participant premise ID information for Legacy Dynamic Matched Control customers was not made available in time for these customers to receive Nudge Reports). This non-price intervention took the form of a monthly report and is referred to as a 'Nudge Report' because it contains information drawn from the field of behavioural economics intended to nudge conservation behaviours among recipients. Specifically, the Nudge Report encourages recipients to 'pledge' to reduce their on-peak electricity consumption, displays personalized tips for achieving this goal, and provides personal benchmarking feedback so that recipients can track their On-Peak consumption behaviour month-to-month. The Nudge Reports resulted in decreased On-Peak consumption relative to customers who did not receive Nudge Reports in both the Enhanced and Dynamic pilots, however the effects observed within the Dynamic pilot were observed to only be 'trends' but were not statistically significant (Table 10). Impacts are represented as the difference in year-over-year mean hourly kW consumption between a Treatment and Control group for a given pricing structure and TOU period.

Table 10: Effects of Nudge Report on Mean Hourly kW Consumption (comparing Nudge Report recipients versus non-recipients)

APP Price Plan		Main Effect of Nudge Report (Relative to non-recipients in Mean Hourly kW)						
		Summer Period			Winter Period			Year-Round Impact
		On-Peak	Off-Peak	Total Summer	On-Peak	Mid-Peak	Total Winter	
Enhanced	kW	**-0.013***	-0.001	-0.003	**-0.008***	**-0.014***	-0.006	-0.004
	%	-1.113	-0.099	-0.286	-0.832	-1.604	-0.639	-0.401
		High On-Peak	Off-Peak	Total Summer	High On-Peak	Off-Peak	Total Winter	Year-Round Impact
Dynamic	kW	-0.015	0.007	0.005	0.024	0.011	0.01	0.007
	%	-0.792	0.709	0.478	2.206	1.246	1.094	1.226
Legacy Dynamic	kW	-0.005	-0.029	-0.024	-0.005	0.005	-0.004	--
	%	-0.279	-2.865	-1.772	-0.404	0.494	-0.352	--

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

In addition to measuring the effect of Nudge Reports as a non-price intervention, the impacts of smart thermostat Technology in driving conservation and load-shifting behaviours among pilot participants was also of interest. Households were designated as "Technology" households if they registered an eligible device to receive automatic load curtailment during Mid-Peak, On-Peak, and Critical Peak TOU periods (depending on which pricing pilot they were participating in[7]). Exact timing of smart thermostat installation for each household remains unknown (i.e., some households had a pre-existing smart thermostat that they simply registered at the commencement of the pilot), therefore Technology was analyzed comparing the mean hourly kW consumption of households with and without registered smart thermostats during the Treatment period only, without employing a difference-in-difference approach. None of the Standard TOU Control participants registered Technology in either the Overnight or Legacy Dynamic pilots, so those analyses include pricing Treatment participants only.

Overall, we found differences in mean hourly electricity consumption between Technology and No Technology groups in the Enhanced, Dynamic, and Legacy Dynamic pilots for both On, and Off-Peak TOU periods (Table 11). Interestingly, smart thermostats were actually associated with higher electricity consumption in the Overnight pilot; although we speculate that the primary means by which Overnight participants responded to the Overnight pricing signals was via the timing of Electric Vehicle charging, not smart thermostat usage. When also considering the Off-Peak Overnight results, we hypothesize that some customers shifted their EV charging behaviour so as to capitalize on the especially low Super Off-Peak Overnight prices and it is likely that individuals who purchase EVs are also more likely to acquire and register smart thermostats. In this way, the observed difference in consumption between Technology and No Technology groups within the Overnight pilot, may simply reflect (to some extent) an effect of higher EV ownership in the Technology group relative to the No Technology group.

Table 11: Effects of smart thermostat Technology on Mean Hourly kW Consumption

APP Price Plan		Main Effect of Technology (Relative to No Technology Customers, in Mean Hourly kW)					
		Summer Period			Winter Period		
		On-Peak	Off-Peak	Total Summer	On-Peak	Off-Peak	Total Winter
Enhanced	kW	**-0.144****	-0.071^	**-0.109****	**-0.128****	**-0.094***	**-0.115***
	%	-12.457	-7.03	-10.088	-13.495	-9.979	-12.555
		On-Peak	Super Off-Peak	Total Summer	On-Peak	Super Off-Peak	Total Winter
Overnight	kW	0.134^	**0.273***	**0.205***	0.129	0.273	0.205
	%	14.729	25.953	20.223	16.091	31.297	20.854
		High On-Peak	Off-Peak	Total Summer	High On-Peak	Off-Peak	Total Winter
Dynamic	kW	-0.062	-0.015	-0.031	**-0.145***	**-0.110****	**-0.114***
	%	-3.541	-1.527	-2.347	-13.704	-12.241	-11.531
		High On-Peak	Off-Peak	**Total Summer**	High On-Peak	Off-Peak	**Total Winter**

[7] The exception to this concerns the Honeywell and Ecobee thermostats, which only allowed for load curtailment in the Dynamic and Legacy Dynamic pilots. Energate and Nest thermostats allowed for load curtailment in all pilot pricing groups (Enhanced, Dynamic, Legacy Dynamic, and Overnight).

Legacy Dynamic	kW	**-0.127***	0.052	-0.061	**-0.281*****	**-0.171*****	**-0.208*****
	%	-6.887	5.383	-4.379	-20.078	-15.283	-16.363

**** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ^$p < 0.1$*

Bill Savings

The impact of the three pricing pilots on Treatment customers' electricity bills are shown in

Table 12 and

Table 13. The average monthly APP bills for each price plan were calculated and compared to the average monthly TOU bills (what participants would have paid if they showed the exact same consumption patterns but were billed as per standard TOU prices).
Table 14 and

Table 15 show the impact on the commodity portion of the bill; since the alternate prices are only represented in this portion of the bill, it is more reflective of the impact that APP prices had on electricity costs[8]. The analysis shows that Overnight participants obtained savings on their monthly bills, Enhanced participants experienced small costs in Summer and savings in Winter, and Dynamic participants experienced small savings in the Summer period and moderate savings in the Winter period, with Legacy customers seeing larger savings than "new" Dynamic customers. Figures showing the distribution of the total savings per pricing pilot are shown in Appendix D.

Table 12: Monthly Bill Savings (Summer 2018)

APP Price Plan	May	June	July	August	September	October	Average Monthly Savings
Enhanced	$0.19	-$0.39	-$0.16	-$1.39	-$0.20	$0.21	-$0.29
Dynamic	$11.93	$4.99	-$17.80	-$12.64	$2.37	$12.81	$0.28
Legacy Dynamic	$11.73	$5.22	-$16.45	-$11.01	$2.99	$12.34	$0.81
Overnight	$5.23	$5.92	$5.91	$5.07	$5.95	$5.80	$5.64
Bill Savings are Denoted as Positive							

[8] The monthly bill savings (or costs) associated with APP pricing relative to status quo TOU pricing should not be interpreted as an economic metric of behaviour change, per se. Differences between what program participants were charged under APP pricing relative to what they would have been charged under status quo TOU pricing could be due to price changes, behaviour changes, or both.

Table 13: Monthly Bill Savings (Winter 2018-2019)

APP Price Plan	November	December	January	February	March	April	Average Monthly Savings
Enhanced	-$0.08	$0.09	$1.52	$0.19	$0.53	$0.42	$0.44
Dynamic	$13.98	$10.14	-$0.79	-$14.42	-$3.19	$10.54	$2.71
Legacy Dynamic	$14.54	$10.43	-$1.31	-$16.16	-$3.84	$11.01	$2.45
Overnight	$6.46	$6.68	$6.71	$7.65	$7.24	$6.64	$6.90
Bill Savings are Denoted as Positive							

Table 14: Bill Savings as Percentage of Total Commodity Bill (Summer 2018)

APP Price Plan	May (%)	June (%)	July (%)	August (%)	September (%)	October (%)	Average Monthly Savings (%)
Enhanced	0.45	-0.64	-0.21	-1.81	-0.27	0.45	-0.34
Dynamic	25.83	7.98	-23.14	-16.76	3.31	25.97	3.87
Legacy Dynamic	25.07	8.48	-21.44	-14.58	4.16	25.55	4.54
Overnight	11.07	9.39	7.45	6.62	8.08	11.53	9.02
Bill Savings are Denoted as Positive							

Table 15: Bill Savings as Percentage of Total Commodity Bill (Winter 2018-2019)

APP Price Plan	November (%)	December (%)	January (%)	February (%)	March (%)	April (%)	Average Monthly Savings (%)
Enhanced	0.08	0.23	2.54	0.40	1.05	1.07	0.90
Dynamic	26.70	16.93	-2.04	-23.93	-6.24	20.97	5.40
Legacy Dynamic	26.68	16.93	-3.46	-24.86	-7.21	20.83	4.82
Overnight	8.29	7.54	8.18	8.04	8.63	8.91	8.27
Bill Savings are Denoted as Positive							

Conclusions

In summary, we examined residential electricity consumption behaviour in three alternative TOU pricing structures (Dynamic and Legacy Dynamic were analyzed separately but received the same pricing structure) in combination with two non-price manipulations (Nudge Reports and curtailment-enabled smart thermostat Technology). In the Summer period, both Dynamic Pricing (including the Legacy group) and Overnight Pricing yielded reductions in On-Peak consumption. There were no observed effects of Enhanced Pricing on energy consumption. Furthermore, Nudge Reports yielded reductions in On-Peak consumption in the Enhanced group and had minimal effects in all other customer groups.

There are two potential causes for why On-Peak consumption savings were observed in the Dynamic and Overnight pricing pilots but not in the Enhanced pilot. The first possibility is that the Enhanced plan did not offer a large enough price differential between On-Peak and Off-Peak prices to motivate customers to change their behaviour. The Enhanced pilot offered customers moderately lower Off-Peak prices (6.5¢/kWh to 4.4¢/kWh) and moderately higher On-Peak prices (13.2¢/kWh to 17.6¢/kWh) compared with standard TOU prices. In contrast, the Overnight pilot offered a considerable discount on the Overnight Super Off-Peak price (only 2¢/kWh), with higher On-peak prices of 18.3¢/kWh. Dynamic pricing incorporated a considerably higher High-On-Peak price of 39.7¢/kWh and 49.8¢/kWh during Critical Peak Periods.

A second possibility is the opt-in vs. opt-out nature of the pilots tested in the current program. Both Dynamic and Overnight plans required customers to volunteer and opt-in to the pilot pricing initiatives. This is in contrast to the Enhanced Pricing pilot in which customers were selected at random to participate. This point is particularly salient with respect to future scaling of Dynamic and Overnight pricing schemes in the Province of Ontario as the findings of the present pilot can only be generalized to a broader population who is offered these programs on a voluntary opt-in basis.

There was no evidence that Enhanced pricing (as structured in the current program) is an effective means to reduce consumption during either On-Peak hours or to reduce overall consumption. There is strong evidence however, that Dynamic and Overnight pricing schemes are effective in reducing consumption during On-Peak hours in the Summer period and that Dynamic pricing is effective in reducing consumption during On-Peak hours during the Winter period.

Contents

1. Introduction

In an effort to achieve the conservation and demand management (CDM) objectives in the province of Ontario, the Ontario Energy Board has been seeking to examine the impact of alternative electricity pricing schemes under the Regulated Price Plan (RPP) as well as the impact of non-price interventions (such as communications and technology) on electricity consumption behaviour among residential customers. Alectra Utilities participated in the RPP Pilot Program to test the impact of three separate Time-of-Use (TOU) pricing schemes and two non-price interventions on conservation, load-shifting, and peak period consumption reduction behaviours amongst a sub-set of its customers.

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

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

1. *Implementing price pilots: The OEB stated that it would work with LDCs to undertake several pricing (and non-price) pilots. The pilots will run for at least one calendar year to assess whether there is persistence in the impact of the intervention.*

2. *Empowering Consumers: Enhancing energy literacy and non-price tools: The OEB stated that it intends to launch non-price pilot initiatives, such as piloting automated load control technology and behavioural interventions.*[9]

The first prioritized opportunity area outlined by the OEB acknowledges that perhaps the price differential between On-Peak and Off-Peak TOU periods is currently insufficient to function as meaningful financial disincentive to the consumption of electricity during peak hours. It is therefore hypothesized that more severe financial disincentives for On-Peak consumption might result in On-Peak conservation and/or load-shifting behaviours among consumers. The second prioritized opportunity area outlined by the OEB acknowledges that perhaps financial levers are not the only (and perhaps not the most effective) method of promoting behaviour change. This perspective (grounded in the field of behavioural economics) holds that individuals do not

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

always respond to pricing signals in the way that traditional economic theory would predict. This occurs because we are subject to myriad cognitive biases such as temporal discounting. In the context of electricity consumption, this means we are prone to value our comfort in the present moment (resulting in over-use of electricity consuming appliances such as air conditioners) and to discount the future costs associated with that behaviour. It is therefore hypothesized that non-price behavioural interventions that mitigate the effects of these cognitive biases may represent a complementary approach to financial disincentives in promoting conservation and/or load shifting behaviours.

In the sections that follow, we first outline the details of each of the pricing pilots (referred to as APP Price Plans) and non-price interventions that were tested experimentally as part of the current RPP pilot project. We then present a detailed impact analysis, separately for each of the three pricing pilots. Finally, we present the findings from customer-facing surveys distributed throughout the 12 months of the pilot program that aimed to measure TOU comprehension and motivations to conserve among pilot participants. This report covers the reporting period May 01, 2018 – April 30, 2019 inclusive.

2. APP Price Plans

Alectra Utilities and the Ontario Energy Board identified three priority pricing schemes to be piloted amongst the Alectra Utilities customer base (specifically a sub-set of those residing within the legacy PowerStream service territory). These pricing pilots were communicated and marketed to customers under the name Advantage Power Pricing (APP) and chosen with the following considerations in mind:

1. *Feasibility of implementation: Pricing pilots were prioritized in which the necessary implementation infrastructure (due to legacy pricing pilots) was already at least partially in place.*

2. *Access to pilot participants: The nature and number of pricing pilots was constrained by the necessary sample sizes required to achieve statistically valid results, coupled with the available participant pool (i.e., the number of customers residing within the legacy PowerStream service territory not participating in other pilot programs or potentially conflicting initiatives).*

3. *Compatibility with other RPP pilot programs: As part of the re-examination of the RPP, several LDCs in the province have undertaken pricing pilot initiatives. Specific pricing pilots chosen in the present initiative should complement existing RPP pricing pilots by yielding novel insights.*

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

2.1 Enhanced Pricing

Customers participating in the Enhanced pricing pilot experienced a larger On- to Off-Peak price differential (4:1) relative to standard TOU pricing (2:1) as well as a larger Mid- to Off-Peak price differential (3:1) relative to standard TOU pricing (1.5:1). The exact kWh prices and associated price periods are shown in Table 16.

Table 16: Enhanced Pricing kWh Prices

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

2.2 Dynamic Pricing

Customers participating in the Dynamic pricing pilot experienced variable On-Peak prices depending on anticipated demand determined by the IESO. This pricing pilot is designed to appeal to customers who are typically home in the afternoon. Participating customers were informed of the variable On-Peak price each day at 4pm (at which point they are informed of what the price will be the following day). Customers were informed of the variable peak price each day either by logging into their APP online portal or subscribing to receive SMS text and/or email alerts from Alectra at 4pm each day. These customers also experienced Critical Peak Periods (6 Summer and 6 Winter, lasting 4 hours each) with an especially high price. In addition, there was no Mid-Peak period. Customers were informed of a CPP event in the same manner as they were informed about variable On-Peak prices. The prices and associated price periods are shown in Table 17.

Table 17: Dynamic Pricing kWh Prices

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

2.3 Overnight Pricing

Customers taking part in the Overnight pricing pilot experienced an especially low overnight Off-Peak price. This pricing pilot is designed to appeal to customers working irregular shifts or who are electric vehicle owners (or prospective electric vehicle owners). Indeed, customer-facing surveys indicate that about 43% of respondents in the Overnight pricing Treatment group self-report electric vehicle ownership, suggesting that this pricing plan was successful in attracting this customer segment. The prices and associated time periods are shown in

Table 18.

Table 18: Overnight Pricing kWh Prices

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

2.4 Standard Time-of-Use Pricing

Customers assigned to control conditions for each of the three pricing pilots described above experienced standard (or 'status quo') TOU prices. The standard TOU prices and associated time periods are shown in Table 19.

Table 19: Standard TOU Pricing kWh Prices

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

Electricity costs associated with pilot participation were communicated to pricing pilot participants via Shadow Bills. Shadow Bills are a monthly electricity consumption report that communicates to pilot participants how much electricity they have consumed in the prior billing period and how the associated costs of that electricity compare with that of standard TOU pricing (i.e., what customers would have been charged if they had the exact same consumption pattern in the billing period, but were billed according to status quo TOU prices). The primary function of this Shadow Bill was to communicate bill cost savings or increases as a result of pricing pilot participation. It was hypothesized that (1) positive feedback (i.e., bill cost savings) would encourage participants to further augment their consumption patterns to realize additional savings and remain in the program. It was hypothesized that (2) negative feedback (i.e., bill cost increases) would encourage participants to begin to augment their consumption behaviours in order to realize bill cost savings. The Shadow Bill was mailed in paper form to pilot participants each billing period as a separate piece of communication to the actual monthly Alectra Utilities bill. An example Shadow Bill is shown in Appendix B. All customers in Dynamic (including Legacy), Enhanced, and Overnight pricing pilots received Shadow Bills.

3. Non-Price Interventions

In order to address the second key objective of the RPP pilot program as outlined by the OEB (i.e., *Empowering Consumers: Enhancing energy literacy and non-price tools*[10]) Alectra, in collaboration with BEworks, Util-Assist, and Bidgley, created communications that were distributed to customers on a monthly basis. These reports served to provide behavioural 'nudges' to customers to drive conservation and load-shifting behaviours (Nudge Reports). In addition, Alectra, in collaboration with Nest, Ecobee, and Energate, offered smart thermostats to pricing pilot participants to help them better realize consumption savings. It was hypothesized that pricing pilot participants with programmable smart thermostats (which allowed for automatic load curtailment) would exhibit greater consumption reductions than pricing pilot participants without such devices. We describe the rationale and logistics of each of the two non-price interventions (Nudge Reports and Technology) below.

3.1.1 *Nudge Reports*

Exactly half of customers in both the pricing Treatment and Control groups within the Enhanced and Dynamic pricing pilots were randomly selected to receive Nudge Reports[11]. These are one-page reports that accompany the Shadow Bills each month for Enhanced and Dynamic pricing Treatment customers and are sent as a stand-alone report each month for Enhanced and Dynamic Control customers (i.e., those on standard TOU pricing who do not receive Shadow Bills). Nudge Reports employ behavioural economic approaches to drive load shifting and conservation behaviours. Specifically, four different behavioural approaches – a commitment device, feedback and benchmarking, personalized recommendations, and salient reminders – were featured in the Nudge Reports. We describe each of these tactics in turn, including the behavioural approach and relevant supporting research.

Commitment device: The initial cycles of Nudge Reports included a monetary offer whereby customers were asked to take a pledge to reduce their electricity usage during On-Peak times of day. A monetary incentive ($5 rebate) was offered to consumers when they sent an SMS message indicating their intent to sign the pledge (e.g., "YES") to a short code.

Commitment devices such as pledges can be an effective strategy for changing behaviour where intention does not match action. According to cognitive dissonance theory[12], people have the tendency to keep attitudes and beliefs in line with their externalized behaviours. Consequently, when people perceive that they have freely chosen to commit to a behaviour, this becomes internalized within their self-concept, making it more likely that people will follow through on behaviours consistent with the initial (comparatively trivial) act of commitment. An example of this phenomenon is known as the *foot-in-the-door* technique whereby asking individuals to agree

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[10] https://www.oeb.ca/sites/default/files/uploads/RPP_Roadmap_Report_of_the_Board_20151116.pdf

[11] No customers in the Overnight pricing pilot received Nudge Reports due to a lower than expected enrolment rate for that pilot. As a result, we were not able to introduce an additional experimental factor while maintaining sufficient experimental power to detect the interactive effects of both price *and* Nudge Reports on consumption behaviour.

[12] Festinger, L. (1957). A Theory of Cognitive Dissonance, Evanston, ILL, Row, Peterson.

to a small request makes it more likely for them to later comply with a larger request[13]. In the present context, it was hypothesized that pledges would act as initial small requests that aimed to regulate subsequent conservation behaviours.

There is support in the scientific literature for using commitment devices to nudge individuals towards environmentally friendly behaviours including energy conservation[14,15,16]. In one study, researchers found that when hotel guests made a specific commitment at check-in and received a lapel pin as a reminder of their pledge, they were 25% more likely to reuse their towels[17]. A study on household recycling found that a commitment intervention where participants were asked to sign a pledge card and then received a sticker to remind them of their commitment resulted in a significant increase in the frequency of recycling during the pledge period, relative to a control group[18].

Additional research indicates that providing people with a financial incentive to commit to a prosocial cause can increase compliance with that cause[19]. Using a monetary reward in the present pilot was hypothesized to increase the likelihood that consumers would agree to the conservation pledge (although we did not test this experimentally since all customers who received Nudge Reports were offered the pledge with a monetary incentive). The pledge campaign ran for 3 months (bills mailed from June to August 2018). There were a total of 331 participants (101 Dynamic, 68 Enhanced, 11 Overnight[20] and 151 Control) who responded to the pledge and were therefore eligible for the $5 bill credit.

Consumption feedback and benchmarks: Using Bidgely's load disaggregation data, appliance level usage feedback information was provided to customers receiving monthly Nudge Reports. A meta-analytic review of 21 unique papers on the impact of feedback on electricity consumption supports the idea that individualized feedback leads consumers to better understand and control their usage[21]. The findings revealed an average of 5% to 12% reduction in electricity consumption as a result of different feedback mechanisms. Particularly, the meta-analysis examined the variable impact of feedback mechanisms and found that the most effective

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[13] Freedman, Jonathan L., and Scott C. Fraser. "Compliance without pressure: the foot-in-the-door technique." Journal of personality and social psychology 4, no. 2 (1966): 195.
[14] Katzev, R. D., & Johnson, T. R. (1984). Comparing the Effects of Monetary Incentives and Foot-in-the-Door Strategies in Promoting Residential Electricity Conservation. Journal of Applied Social Psychology, 14(1), 12-27.
[15] Pallak, M. S., & Cummings, W. (1976). Commitment and voluntary energy conservation. Personality and Social Psychology Bulletin, 2(1), 27-30.
[16] Werner, C. M., Turner, J., Shipman, K., Twitchell, F. S., Dickson, B. R., Bruschke, G. V., & Wolfgang, B. (1995). Commitment, behavior, and attitude change: An analysis of voluntary recycling. Journal of Environmental Psychology, 15(3), 197-208.
[17] Baca-Motes, K., Brown, A., Gneezy, A., Keenan, E. A., & Nelson, L. D. (2012). Commitment and behavior change: Evidence from the field. Journal of Consumer Research, 39(5), 1070-1084.
[18] Burn, S. M., & Oskamp, S. (1986). Increasing community recycling with persuasive communication and public commitment. Journal of Applied Social Psychology, 16(1), 29-41.
[19] Katzev, R. D., & Pardini, A. U. (1987). The comparative effectiveness of reward and commitment approaches in motivating community recycling. Journal of Environmental Systems, 17(2).
[20] These pledges are due to "spillover". Although Overnight group participants did not receive Nudge Reports, it is possible that customers from other groups showed the pledge promotion to Overnight customers.
[21] Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? Energy efficiency, 1(1), 79-104.

feedback is delivered frequently and consistently over a long period of time, includes specific appliance level information, and is presented in a clear and appealing way.

In addition, Nudge Reports included a historical benchmark visual comparing consumers' On-Peak usage in the billing cycle to their calibrated average historical On-Peak usage. The visual included a feedback message informing consumers of whether their On-Peak consumption deviated negatively or positively relative to a moving average. Research suggests that consumers typically respond well to goal-specific feedback resulting in reductions in electricity usage. For example, in a field study of residential energy use, families that were asked to set a goal to reduce their electricity consumption and were provided with frequent feedback on their progress achieved an average of 13%-15.1% in electricity savings[22]. In prior BEworks research conducted on behalf of the Ontario Energy Board, participants were more likely to understand and indicate intent to conserve electricity after receiving negative comparisons to past usage behaviour paired with a visual of a red, wide house (meant to appear as though it were 'bloated' with energy) relative to other types of feedback[23]. Together, feedback and benchmarking provide information attributable to specific actions, allowing consumers to make comparisons to standards of behaviour and exert effort towards the most effective courses of action[24].

Personalized recommendations: Nudge Reports include personalized energy saving recommendations using Bidgely's personalization algorithm. These recommendations accompanied usage feedback information to provide customers with actionable tips on how to become more energy efficient. Prior research reveals that highly personally relevant and specific information can be effective in reducing household energy consumption. In one study, home energy audits that provide tailored energy savings options to households reduced electricity consumption by 21% compared to a control group[25]. In addition to personalized information, research shows that when people have a detailed plan for when and how they intend to reach a goal, they are more likely to attain it[26]. Psychologists refer to these actionable plans as *implementation intentions*. Theories supporting the use of implementation intentions postulate that when anticipated situations are linked with a goal-directed response, people are less likely to be deterred by obstacles impeding the completion of a task[27]. By providing customers with specific load-shifting actions that are relevant to them, it was hypothesized that customers would be more likely to follow through with these recommended conservation actions.

Salient reminders: Potential behavioural barriers to load shifting include failing to pay attention to and/or simply forgetting the pricing schedule when consuming electricity on a daily basis. To address these barriers, consumers received visual memory aids to act as reminders to shift consumption behaviour in accord with their pricing schedule. These took the form of a visually

[22] McCalley, L.T. & Midden, J.H. Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation. Journal of Economic Psychology, 23, 589–603

[23] BEworks, 2014

[24] Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. Psychological bulletin, 119(2), 254.

[25] Winett, R. A., Love, S. Q., & Kidd, C. (1982). The effectiveness of an energy specialist and extension agents in promoting summer energy conservation by home visits. Journal of Environmental Systems, 12(1).

[26] Gollwitzer, P.M. & Brandstätter, V (1997). Implementation intentions and effective goal pursuit. Journal of Personality and social Psychology. 73, 186.

[27] Gollwitzer, P. M. Implementation intentions: strong effects of simple plans. American Psychologist. 54, 7, 493.

salient, color-coded Time-of-Use pricing schedule that consumers had the opportunity to cut out then place in a prominent area of their home, such as on their fridge or in the laundry room. This visually salient linear timeline also clearly illustrated TOU period costs and showed how much more On-Peak and Mid-Peak periods cost relative to Off-Peak periods.

3.1.2 *Thermostat Technology*

In addition to measuring the effect of Nudge Reports as a non-price intervention, it was also of interest to measure the impacts of smart thermostat Technology in driving conservation and load-shifting behaviours among pilot participants. As smart thermostats can be programmed and adjusted dynamically with weather effects and changes in price, it was hypothesized that pilot participants with such devices would exhibit greater responsiveness to pilot pricing schemes relative to those without such devices. Crucially, all Technology impact estimations are restricted to customers who registered their thermostats through Alectra to receive automatic load curtailment, which reduced heating/cooling load during higher-priced TOU periods across the four TOU pricing structures within the pilot[28] (i.e., status quo TOU, Enhanced TOU, Dynamic TOU, Overnight TOU). For all three pricing pilots, customers with eligible devices were required to opt-in to load curtailment, which was accomplished by simply registering their device. In our analysis of smart thermostat Technology as a non-price manipulation for all three pilots, we designate customers with registered smart thermostats as ‘Technology’ customers. This means that the impacts of smart thermostats on consumption behaviour derive from both owning such a device *and* receiving some form of automatic load curtailment. As can be seen in Table 20, the availability and nature of load curtailment varied by thermostat type and pricing pilot:

Table 20: Thermostat Curtailment Periods

	Curtailment Period			
Thermostat Type	Enhanced (On, Mid-Peak)	Dynamic (On-Peak)	Dynamic (Critical Peak)	Overnight (On, Mid-Peak)
Energate	Based on customer-selected ‘comfort’ setting	Based on customer-selected ‘comfort’ setting	Based on customer-selected ‘comfort’ setting	Based on customer-selected ‘comfort’ setting
Honeywell	N/A	Based on operating time	Based on operating time	N/A
Ecobee	N/A	Based on operating time	Based on operating time	N/A
Nest	Custom[29]	N/A	Based on Rush Hour Rewards[30]	Custom

[28] The exception to this concerns the Honeywell and Ecobee thermostats, which only allowed for load curtailment in the Dynamic and Legacy Dynamic pilots. Energate and Nest thermostats allowed for load curtailment in all pilot pricing groups (Enhanced, Dynamic, Legacy Dynamic, and Overnight).
[29] At the time of installation, customers could dictate the amount of curtailment during On/Mid-Peak TOU periods
[30] https://support.google.com/googlenest/answer/9244031?co=GENIE.Platform%3DAndroid&hl=en

Energate Foundation Thermostat Load Curtailment Functionality by Pricing Pilot: For Energate Foundation thermostats, the amount of load curtailment at any given time was determined by: (1) the price of electricity, with higher priced TOU periods being subjected to higher curtailment, and (2) the thermostat comfort settings chosen by the homeowner, which ranged from 'Max Comfort' (no curtailment whatsoever) to 'Max Savings' (the highest possible curtailment). The mapping of TOU period to potential curtailment (in °C) for each of the three pricing pilots are shown in Tables 21-23 below. Also shown in Table 24 is the mapping of smart thermostat Comfort Settings to Savings Percentages.

Table 21: Enhanced Pilot - Mapping of TOU Period to Max Savings

TOU Period	Max Savings (°C)
Off-Peak	0
Mid-Peak	1
On-Peak	2

Table 22: Dynamic Pilot - Mapping of TOU Period to Max Savings

TOU Period	Max Savings (°C)
Off-Peak	0
Low On-Peak	1
Medium On-Peak	2
High On-Peak	3
Critical Peak	4

Table 23: Overnight Pilot - Mapping of TOU Period to Max Savings

TOU Period	Max Savings (°C)
Super Off-Peak	0
Off-Peak	0
Mid-Peak	1
On-Peak	2

Table 24: Curtailment Enabled Energate Thermostats - Mapping of Savings Percentage to Comfort Setting

Savings Percentage (%)	Comfort Setting
0	Max Comfort
25	Comfort
50	Balanced
75	Savings
100	Max Savings

Given the above information, this means that an Enhanced pricing customer with a curtailment-enabled registered smart thermostat who selected the 'Balanced' comfort setting, would have seen On-Peak curtailment of 1 degree Celsius (50% of the Max Savings for that TOU period). The relationship between Savings Percentage and Comfort Setting is thermostat-specific and so is constant across the three pricing pilots reported here. Ecobee thermostats were also eligible for load curtailment, but only for Critical Peak Price events associated with the Dynamic pricing pilot. Because these thermostats do not have the same functionality or comfort settings as the Energate devices, CPP event load curtailment for Ecobee, Nest, or Honeywell thermostat owners (who registered these devices and opted into curtailment) took the form of a 4 °C curtailment during CPP event hours.

Honeywell and Ecobee Thermostat Load Curtailment Functionality by Pricing Pilot: Unlike Energate curtailment functionality, curtailment settings for Honeywell and Ecobee owners was based on Air Conditioning run-time, not degree settings. The mapping of run-time curtailment to peak period within Dynamic and Legacy dynamic pricing is shown in Table 25.

Table 25: Honeywell and Ecobee Thermostats – Mapping of Pricing Period to Run-Time

Pricing Period	Maximum Air Conditioner Run Time
Off-Peak	N/A
Low On-Peak	30 minutes/hour
Medium On-Peak	24 minutes/hour
High On-Peak	18 minutes/hour
Critical Peak	12 minutes/hour

4. Advantage Power Pricing Impact Analysis Methodology

4.1 General Approach

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

The first step in the sampling procedure was to isolate the sample frame from which participants would be drawn for participation in the pilot. In doing so, there were several considerations/constraints. First, only households within the PowerStream legacy service territory were considered eligible. Second, eligible participants must not have been participating in any other pilot programs with conservation and/or demand management objectives (e.g., Home Energy Report pilots). Specifically, households receiving Home Energy Reports (or designated as part of the control group for Alectra's Home Energy Report program) were not included in the sample frame. The remaining households were then recruited or assigned to pricing pilot Treatment and Control groups. The specifics of the assignment of households to the various pricing pilots are described below, separately for each of the three pricing pilots.
For each of the pricing pilots, we estimated a required sample size of approximately 300 participants per condition in order to detect a small effect size (f = 0.1) at 90% power. For calculations and assumptions related to the power analysis, see Appendix E.

In the sections that follow, we describe the sampling procedure and present participant numbers as a function of experimental condition for each of the three pricing pilots. The presentation of sample size numbers is intended to provide transparency on the different criteria under which participants who originally opted-in, or were automatically enrolled into the pilot, were excluded from the data set used to estimate impacts. The columns in the sample size tables should be read as follows:

Starting N: The number of participants in each experimental condition (Price Treatment, Control; Nudge Report Treatment, Control) at the beginning of the relevant reporting period (Summer or Winter treatment period months).

Opt-Outs: The number of participants who communicated to Alectra that they wished to discontinue participation in the pilot at any point during the relevant reporting period.

Move-Outs: The number of participants who moved at any point during the relevant reporting period, precluding their continued participation in the pilot (even if they moved to a new dwelling within the Alectra service territory, potential differences in baseline electricity consumption owing to dwelling characteristics meant that they were excluded).

Missing Data: The number of participants for whom sufficient hourly Smart Meter data was not available to allow for consumption impact estimation in the relevant reporting period.

Outliers: The number of participants for whom their average hourly kW consumption was deemed to be excessively high or low (i.e. <0.05kW/h or >15kW/h), indicating that they may not be a representative household with respect to electricity consumption within the Alectra service territory.

Total Exclusions: This is simply the sum of Opt-Outs + Move-Outs + Missing Data + Outliers.

Final N: This is simply the Starting N – Total Exclusions. Final N represents the number of households that contributed electricity consumption data to the impact analyses for the relevant reporting period.

4.1.1 *Enhanced Pricing Sampling Procedure*

Since the Enhanced pricing pilot observed the exact same Time-of-Use schedule as Standard TOU, the only material change from the experience of the customer was the price charged during Off-, Mid-, and On-Peak periods. For this reason, the Enhanced plan was run as an opt-out randomized controlled trial (RCT). In addition to the Enhanced pricing Treatment, communications in the form of Nudge Reports were randomly distributed to half of Enhanced pricing Treatment and half of Enhanced pricing Control customers. This results in a total of four distinct customer groups in the Enhanced pilot. Given that the rate of opt-outs could not be known in advance, a relatively large sample size was required in order to account for opt-outs and move-outs over the 12-month duration of the pilot. To that end, 14,000 residential customers were randomly selected from the sample frame and then randomly assigned to each of the four groups. The distribution of program participants to each of the four groups is shown in Table 26. Summary statistics and analyses comparing Enhanced Treatment and Control participants along key pre-pilot consumption metrics can be found in Appendix A.

Table 26: Final Number of Participants for Enhanced Pilot

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[31]	Outliers	Total Exclusions	Final N
Enhanced Pricing	3500	233	235	6	30	504	2996
Enhanced Pricing + Nudge Report	3500	245	247	11	33	536	2964
Std. TOU Control	3500	3	197	11	50	261	3239
Std. TOU Control + Nudge Report	3500	31	191	6	35	263	3237
Total	14000	512	870	34	148	1564	12436
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Enhanced Pricing	2996	62	194	2	5	241	2733
Enhanced Pricing + Nudge Report	2964	42	192	1	6	263	2723
Std. TOU Control	3239	9	178	1	9	222	3042
Std. TOU Control + Nudge Report	3237	51	160	2	9	197	3015
Total	12436	164	724	6	29	923	11513

4.1.2 *Dynamic Pricing Sampling Procedure*

Since the Time-of-Use pricing periods under the Dynamic plan did not align with Standard TOU pricing periods, customers participating in the Dynamic plan experienced significant material changes to their TOU schedules. In addition, the inclusion of Critical Peak Pricing events and Variable Peak Pricing required that participating residential customers be notified on a daily basis of whether there would be Low-, Medium-, High-, or Critical-Peak periods. For these reasons, the Dynamic plan was run on an opt-in basis, requiring that eligible residential customers sign-up for (opt-in to) Dynamic pricing. As such, the Dynamic plan was run as a Matched Controlled Trial, meaning that once enrollment into the pricing Treatment group was

[31] See Section 4.2.4 Issues or Concerns for further explanation

completed, a Control group was created from the remaining sample frame that matched pricing Treatment participants on historical consumption behaviours. Additional detail on the matching algorithm and the consumption metrics used to derive the matched control group can be found in Appendix A. Once the Treatment and Matched Control groups for the Dynamic plan were established, half were randomly assigned to receive Nudge Reports. The distribution of participants to each of the four Dynamic Pricing Pilot groups is shown in Table 27.

Table 27: Final Number of Participants for Dynamic Pilot

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[32]	Outliers	Total Exclusions	Final N
Dynamic Pricing, No Nudge Report	385	34	9	0	4	47	338
Dynamic Pricing + Nudge Report	385	29	6	0	5	40	345
Std. TOU Pricing, No Nudge Report	385	0	14	1	6	21	364
Std. TOU Pricing + Nudge Report	385	1	17	0	5	23	362
Total	1540	64	46	1	20	131	1409
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Dynamic Pricing, No Nudge Report	338	25	8	70	0	103	235
Dynamic Pricing + Nudge Report	345	38	4	67	1	110	235
Std. TOU Pricing, No Nudge Report	364	0	20	0	2	22	342
Std. TOU Pricing + Nudge Report	362	4	14	0	3	21	341
Total	1409	67	46	137	6	256	1153

[32] See Section 4.2.4 Issues or Concerns for further explanation.

4.1.3 *Legacy Dynamic Pricing Sampling Procedure*

Alectra began offering a version of Dynamic pricing to its customers in 2015, and over the course of three separate registration periods, had been continuing to offer Dynamic pricing to a subset of its residential customer base. This means that at the commencement of the most recent instantiation of the RPP pilot program, there existed approximately 1,500 households already enrolled in Dynamic pricing. In an attempt to gather data on the longevity of previously observed behavioural response to Dynamic pricing, Alectra and the OEB sought to retain this 'Legacy' Dynamic customer group. There exist three key differences between the Legacy and 'new' Dynamic customer bases that necessitate that we treat these groups independently, both in terms of the sampling procedure and subsequent analysis.

- The Legacy Dynamic households had been subjected to Dynamic pricing for (in some cases) up to 3 years at the commencement of the reporting period of the current evaluation

- Until the start of the current pilot reporting period, Legacy Dynamic pricing was offered with full price protection, representing an important qualitative difference between the previous and current instantiations of Dynamic pricing

- The Legacy Dynamic pricing pilot was created as an opt-in pricing pilot with a matched Control group; however, separate matched Control groups were created for Summer and Winter impact analyses (whereas the present evaluator has created a single matched Control group for all impact analysis pertaining to the "new" Dynamic households)

Legacy Dynamic households were not required to re-enroll into the current pilot program, but instead were informed via email and/or direct mail that Dynamic pricing was being extended until April 2019, with the removal of price protection beginning in May 2018. As with the new Dynamic customers, half of Legacy Dynamic households were then randomly assigned to receive Nudge Reports for the duration of the pilot. Unlike the New Dynamic matched Control customers however, Nudge Reports were not distributed to Legacy Dynamic matched Control customers. Procurement of household premise IDs for Legacy Dynamic Control customers (which were not known by Alectra since they were identified by an independent evaluator several years prior) was not completed in a timely enough manner to begin distributing Nudge Reports to those customers at the commencement of the pilot.

4.1.4 *Overnight Pricing Sampling Procedure*

Since the Time-of-Use pricing periods under the Overnight plan did not align with Standard TOU pricing periods, customers participating in the Overnight plan experienced significant material changes to their TOU schedules. For this reason, the Overnight pricing pilot was run on an opt-in basis, requiring that eligible residential customers sign-up for (opt-in to) Overnight pricing. As such, like the Dynamic pricing pilot, the Overnight pilot was run as a Matched Controlled Trial, meaning that a Control group was created from the sample frame that matches the pricing Treatment participants on historical consumption behaviours. Due to recruitment challenges associated with the Overnight pilot, recruitment was extended to a broader population of residential customers who did not reside in the service territory long enough to provide historical baseline data for the Summer impact analysis, but for whom there was sufficient data to provide a historical baseline for the Winter impact analysis. These additional participants were only included in the Winter impact analysis in the latter 6 months of the pilot and are therefore referred to as the '6-Month Group'. Additional detail on the matching algorithm and the consumption metrics used to derive the matched Control group can be found in Appendix A. The distribution of participants to each of the Overnight pricing pilot groups is shown in Table 28.

Table 28: Final Number of Participants in the Overnight Pilot

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[33]	Outliers	Total Exclusions	Final N
Overnight Pricing	366	18	7	0	1	26	340
Std. TOU Control	366	0	0	1	4	5	361
Total	732	18	7	1	5	31	701
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Overnight Pricing	340	20	2	76	1	99	241
Overnight Pricing, 6-Month Group	74	3	1	3	6	13	61
Std. TOU Control	361	1	0	0	1	2	359
Std. TOU Control, 6-Month Group	74	0	0	0	3	3	71
Total	849	24	3	79	11	117	732

4.2 Treatment of Hourly Consumption Data

4.2.1 *Description of the Data*

The impact analyses that follow used quantitative data to perform inferential statistical analyses to test the effects of pricing Treatments and non-price interventions on household energy consumption. The consumption impacts were derived from hourly Smart Meter readings for each household over the course of at least two years (12 months of pre-pilot data and 12 months of pilot data) measured in kilowatt hours (kWh) and was delivered to the evaluator (BEworks Inc.)

[33] See Section 4.2.4 Issues or Concerns for further explanation.

from Savage Data Systems, Alectra's Operational Data Store. For estimated consumption impacts, hourly means are reported in kilowatts (kW).

4.2.2 *Preprocessing Activities*

The data cleaning process to convert raw hourly data to the data used for the statistical analysis involved converting the hourly data into means tables based on the appropriate timeframe. In total, there were 4 means tables created for each of the three pilots for a total of 12 means tables. The means tables consisted of:

- Time-of-Use Period Impacts: Hourly means in kW for each defined peak period, for each month, for each household
- Average Conservation Impacts: Hourly means in kW for each month, for each household

Preprocessing also involved removing households based upon several exclusionary criteria. Households were excluded if they moved during the pilot, or if they actively opted-out of the program. Households were also excluded if they exhibited many consecutive missing hourly measurements. Households exhibiting missing data generally did so for several months or longer, thus a minimum threshold of one month of missing data was set for exclusion. Lastly, households were excluded if their hourly consumption measurements were outliers relative to other households. The operational definition of an outlier is any household that recorded hourly consumption greater than 15 kWh or less than 0.05 kWh. Households that qualified for any exclusionary criteria were indexed and subsequently removed prior to statistical analyses.

4.2.3 *Estimated Elasticities*

The purpose of the Estimated Price Elasticity analysis is to measure the percent change in consumption relative to a percent change in price. Both own-price (daily) elasticity and inter-period substitution elasticity are computed:

- Own Price Elasticity: Daily means in kW for each household
- Inter-Period Substitution Elasticity: Hourly means in kW for each Peak period, for each month, for each household

4.2.4 *Issues or Concerns*

There were issues concerning the completeness of the *Technology* data. Data was available from Alectra on households who had purchased a smart thermostat through their thermostat incentive program offerings, but this does not cover households who purchased a smart thermostat outside of Alectra. Households were asked about the presence of a smart thermostat in the baseline, interim, and end-of-pilot surveys. However, smart thermostats not registered with Alectra were not eligible for load curtailment. This means that all analyses related to the incremental impacts owing to smart thermostats will be restricted only to customers with registered devices that are capable of some form of load curtailment.

There was a disproportionate incidence of 'missing data' for two of the pricing Treatment groups in the current pilot: (1) Dynamic Treatment (only 'new' Dynamic Treatment customers, not Legacy Dynamic Treatment customers) and (2) Overnight Treatment customers. Upon investigation, there was not enough historical baseline data for a number of customers in both of these groups. As a result of the fact that historical data for at least one year prior to the unprotected period of the current pilot is required in order to employ our difference-in-difference methodology, customers with insufficient historical baseline data were excluded from analysis. The missing data in question was simply delivered to the evaluator by Alectra's operational data store as 'NA' values for the requested baseline period and so the evaluator cannot shed any further light on why customers were allowed to participate in the pilot without the requisite historical consumption data. We speculate however, that customers opted into the pilot, not through direct solicitation by Alectra (since only customers within the eligible sample frame were subject to direct marketing) but instead through referral by neighbors, friends, or family members. Further investigation by Alectra Utilities would be required to unequivocally determine how these customers opted into the pricing Treatment plans offered under APP. The evaluator can confirm however, that given the observed effect sizes owing to Dynamic and Overnight pricing plans, this loss in sample size due to missing data (approximately 9.7% and 9.3% for the Winter Dynamic and Overnight impact estimations respectively) had no material effect on statistical power for all conducted analyses.

4.3 Dependent Variables

In this section, we present definitions and impact estimation model specifications for each of three dependent variable categories:

- Time-of-Use Period Impacts (including Critical Peak for Dynamic group only)
- Average Conservation Impacts
- Estimated Price Elasticities

The dependent variables upon which statistical significance testing were performed are presented in results summary tables as mean hourly kW impacts.

4.3.1 *Time-of-Use Period Impacts*

The purpose of the Time-of-Use period impact analysis is to measure the change in energy consumption for a Treatment group relative to a Control group during specific Time-of-Use periods as a function of pricing Treatment and/or non-price intervention.

We define Time-of-Use period impacts as: The year-over-year difference in the average hourly consumption, attributable to the pilot program intervention, calculated separately for each TOU period. The only exception to this is the Legacy Dynamic Pilot impact estimations. The primary reason for this is that no appropriate historical baseline period existed for all Legacy Dynamic participants. Consequently, Legacy Dynamic impacts were derived by simply comparing Treatment and Control customer consumption within the 12-month pilot period.

The timing and nature of each TOU period depended on the specific pricing pilot that a given customer was placed in (Enhanced) or opted in to (Dynamic, Overnight). The days and hours associated with each TOU period as a function of pricing pilot is shown in Table 29.

Table 29: TOU Periods by Pilot

TOU Period	Summer May 1 – October 31	Winter November 1 – April 30	Pilot Group
On-Peak	11am – 5pm	7am – 11am and 5pm – 7pm	Enhanced and Overnight
Mid-Peak	7am – 11am and 5pm - 7pm	11am – 5pm	Enhanced and Overnight
Off-Peak	7pm – 7am	7pm – 7am	Enhanced and Overnight
Overnight Off-Peak	12am – 6am	12am – 6am	Overnight
High, Medium, Low Peak	3pm-9pm	3pm-9pm	Dynamic
Off-Peak (Dynamic)	12am-3pm and 9pm – 12am and Weekends and Holidays	12am-3pm and 9pm – 12am and Weekends and Holidays	Dynamic
Critical Peak Period	Top six system peak days, each event lasting four hours. Start time of events determined by peak demand hour of event day	Top six system peak days, each event lasting four hours. Start time of events determined by peak demand hour of event day	Dynamic
System-Coincident Peak Impact	1pm-7pm (June, July, August) Weekdays and is based on the OPA's analysis of peak hourly load	6pm – 8pm (December, January, and February) Weekdays, and is based on the IESO's analysis of peak hourly load	Enhanced, Dynamic, and Overnight

With the exception of Legacy Dynamic impact estimations (and Technology analyses outlined in Section 4.3.3), a difference-in-difference approach was used to measure the effect of TOU period on household energy consumption for all TOU period impact estimations. Employing a difference-in-difference (DID) approach was relatively easy for TOU period impact estimations for the Enhanced and Overnight pilots since the days/hours that correspond to the TOU time periods within these pilots do not vary and can be compared to the same time periods in the historical (pre-pilot) time period for each participant. Put differently, the days and hours that define the Summer 'On-Peak' TOU period (for example) are the exact same during the pilot treatment period and the pre-pilot historical baseline period. This is not the case for Dynamic pricing, in which the On-Peak TOU period is variable and determined in an ad hoc manner during the pilot Treatment period. Thus, in order to employ a DID approach for TOU period impact estimations for the Dynamic pilot, there is an additional step required in order to determine the appropriate historical baseline consumption period. This additional step deals with the fact that Dynamic pricing customers were not exposed to Dynamic On-Peak TOU periods under status quo TOU pricing in the historical baseline period. We solve for this issue here by capitalizing on the fact that there was a Legacy Dynamic pricing program in effect for a separate group of Alectra customers during the historical baseline period. As a result, we are able to compute historical baseline consumption for Dynamic customers separately for High, Medium, and Low On-Peak days based on whether the weekdays contained within the historical baseline period were called as High, Medium, or Low On-peak days for the Legacy Dynamic pricing customers at that time.

Estimated TOU period impacts are averages and were calculated separately for the Summer (May – October) and Winter (November – April) periods. Estimated impacts were calculated based on mean hourly kW consumption using linear regression models (Equations 4.1 and 4.2), with estimations of the impact as a corresponding percentage change derived from the mean hourly kW impact (discussed further below). Consumption impacts deriving from pricing manipulation, communication (i.e., Nudge Report) manipulation, and the interaction of the price and communication manipulation are estimated, as relevant.

Overnight TOU period impacts were assessed in a single factor model, while the Enhanced and Dynamic pilots assessed the impact of TOU period pricing and the Nudge Report in the same model (Equation 4.1). The Nudge Reports that were distributed to randomly selected households within the Enhanced and Dynamic pricing pilots contained monthly consumption feedback and personalized conservation tips to recipients. The consumption feedback was delivered as a visual depiction of On-Peak electricity consumption that benchmarked households to their On-Peak consumption at the same time in the previous year. For this reason, we hypothesized that even though personalized conservation tips were not TOU period specific, the On-Peak specificity of the consumption feedback may result in Nudge Reports imparting a differential effect on On-Peak consumption. We might expect therefore, that when pricing signals are sufficient to drive motivations to reduce On-Peak consumption (as was the intention of Enhanced and Dynamic pricing) that Nudge Reports would convey particularly useful consumption feedback information for participants. For this reason, we may expect that the effect of Nudge Reports interacts with the effect of pricing condition *only* for higher-priced TOU periods.

Because we hypothesized a potential interaction between price Treatment and Nudge Report, we calculated models with the inclusion of an interaction term Equation 4.1. We outlined an a priori analytical procedure in (a) the case that the interaction would be significant, in which case we report all lower order factor results from the interaction model (Equation 4.1), and (b) the case that the interaction would be non-significant, in which case we re-calculate the models including only the main effects and no interaction term (Equation 4.2), and we report main effects from this model. This is a reasonable approach because the coefficients of the predictors represent difference values depending on whether the model includes or does not include an interaction term. In regression, adding interaction terms changes the coefficients of the lower order predictors from main effects to *conditional effects*[34]. Main effects describe the impact of one predictor across all levels of the other, while a conditional effect means that the effect of one

[34] Stevens, J. (1996). *Applied Multivariate Statistics for the Social Sciences* (3rd ed.). Lawrence Erlbaum Associates.

predictor is conditional on the value of the other. In our models, this means that the coefficient associated with the conditional effect of Price Treatment ($\beta_1\ Price_P$) describes the impact of Price Treatment only for the No Nudge Report households (i.e. $Price_P|Communication_C$=0). This makes intuitive sense when you consider that a significant interaction indicates that $Price_P$ varies depending on $Communication_C$; therefore, it would not also be appropriate to interpret a main effect of $Price_P$ that would be consistent across all levels of $Communication_C$. Following the same rationale in the case of a non-significant $Price_P * Communication_C$ interaction, interpretation of the conditional effect of the lower order effects as the full story of the impact of those factors is obviously incomplete. In this case, it is appropriate to drop the interaction term and calculate a model with only main effects, which describe the effect of one factor independent of the other factors in the model. To minimize confusion, coefficients from non-significant interactions are not reported in the results tables to clarify that reported main effects were derived from a model that did not include the interaction. To foreshadow, none of the Price by Communication interactions were significant for any TOU period analysis for any pilot. As such, all impact estimates for the effect of Price pilot and Communication derive from linear models that did not include the interaction term. All models calculated with and without interactions are included in the Appendix for reference, regardless of statistical significance.

$$(4.1)\qquad (PostTOUUsage_i - PreTOUUsage_i) = \alpha + \beta_1\ Price_P + \beta_2\ Communication_C + \beta_3\ Price_P * Communication_C + \varepsilon_i$$

$$(4.2)\qquad (PostTOUUsage_i - PreTOUUsage_i) = \alpha + \beta_1\ Price_P + \beta_2\ Communication_C + \beta_3 + \varepsilon_i$$

Where,

PostTOUUsage	=	Average hourly TOU-period kW consumed during experimental period by household *i*
PreTOUUsage	=	Average hourly TOU-period kW consumed during pre-experiment period by household *i*
Price	=	Dummy indicator denoting presence of price manipulation
Communication	=	Dummy indicator denoting presence of communication manipulation
i	=	Indicates individual household
ε	=	Indicates regression error term

It is also worth noting that the TOU period regression models do not cluster standard errors, compared to what has sometimes become common practice in certain disciplines when dealing with panel regression data. Clustering standard errors, and other corrections for possible biases in standard error estimation, are common in two econometric circumstances. The first is when the experimental design is such that there are within-condition sub-groups or clusters[35]. A common example of this is when researchers are examining the effects of a law compared to some states

[35] Cameron, A. C., & Miller, D. (2015). A Practitioner 's Guide to Cluster-Robust Inference. *The Journal of Human Resources, 50*(2), 317–372.

without the same law, usually in a difference-in-difference model. Because of the high within-state correlation in dependent variable scores, it is important to adjust the standard errors by these geographic clusters. Secondly, some researchers, such as Bertrand and colleagues[36] describe that although standard error correction in difference-in-difference studies without geographical or other a priori clusters was not common at the time of publication, it is advisable because the serial correlation of many data points in a timeseries may underestimate the true standard error. We did not make any adjustments to the standard errors in our research because our models do not fulfill either of these criteria. We did compute a difference-in-difference; however, we did not fit a regression line to a timeseries in order to model change across time, as would be cautioned by Bertrand. Our approach calculates one timepoint change from baseline to treatment for the treatment and control groups, aggregating over all measurements within the given window. In this method, each participant has one difference score, and these difference scores are compared between treatment and control groups. The potential for standard error bias becomes apparent as the number of timepoints in the model increases to levels not modelled in the present study. Finally, Abadie and his collaborators[37] have recently argued that standard error correction as a default choice in a broad range of circumstances without strong theoretical basis is overly conservative.

A different approach was used to estimate TOU period consumption impacts amongst Legacy Dynamic pricing participants. This program began in 2014, meaning that the employment of a DID approach to impact estimation is problematic. Mainly, in order to compare consumption in the current pilot period (May 01, 2018 – April 30, 2019) to a pre-treatment historical baseline period, a historical data set that is (in many cases) over four years old would have to be used. Aside from the fact that hourly consumption data dating back this far was not provided to the evaluator for both Legacy Dynamic Treatment and matched Control participants at the time of impact evaluation, the logistics of employing a DID approach is further complicated by the fact that Legacy Dynamic pricing customers enrolled into Dynamic pricing at 3 different historical time periods, meaning that different historical baseline periods would have to be used for different groups of customers within the Legacy Dynamic customer group (this is discussed further below). It is for these reasons that we compare Legacy Dynamic pricing with Standard TOU Control pricing in each year on record separately, without using the DID approach. Given this, caution should be used when making qualitative or quantitative comparisons between Dynamic and Legacy Dynamic impacts. Legacy Dynamic participants have been exposed to the Dynamic pricing structure for (in some cases) up to four years, whereas newly enrolled Dynamic participants have only been exposed to Dynamic pricing for a little over one year (including the pre-treatment price protected period). Even with this in mind, any comparisons made between these two groups of customers would not provide an accurate picture of the effect of exposure duration to Dynamic pricing on electricity consumption behaviour. This is because Legacy Dynamic participants enjoyed full price protection for the entirety of the Legacy program. Thus, because of differences in the analytical approach, differential exposure durations to Dynamic pricing, and differences in the length of exposure to price protection, make any comparisons between the Legacy and newly enrolled Dynamic customer groups inappropriate.

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[36] Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How Much Should We Trust Differences-in-Differences Estimates? Quarterly Journal of Economics, 119(1), 249–275.
[37] Abadie, A., Athey, S., Imbens, G., & Wooldridge, J. (2017). When Should You Adjust Standard Errors for Clustering? *National Bureau of Economic Research, Working Paper No. 24003.*

Because of the inherited legacy nature of the Legacy Dynamic group, none of the Standard TOU Control participants received Nudge Reports. Therefore, main effect of price was examined between Treatment and Control participants (Eq. 4.3), and separate linear analyses examined the main effect of Nudge Report in the treatment group only (Eq. 4.4). Full results of all models are reported in Appendix I.

$$(4.3) \qquad PostTOUUsage_i = \alpha + \beta_1 \, Price_P + \varepsilon_i$$

$$(4.4) \qquad PostTOUUsage_i = \alpha + \beta_1 \, Communication_C + \varepsilon_i$$

Where,

PostTOUUsage	=	Average hourly TOU-period kW consumed during experimental period by household *i*
Price	=	Dummy indicator denoting presence of price manipulation
Communication	=	Dummy indicator denoting presence of communication manipulation
i	=	Indicates individual household
ε	=	Indicates non-clustered regression error term

Estimated impacts are averages and are calculated separately for the Summer 2018 (May – October) and Winter 2018-19 (November – April) periods.

4.3.2 *Average Conservation Impacts*

The purpose of the average conservation impact analysis is to measure the change in energy consumption for a Treatment group compared to a Control group during the Summer period, Winter period, and the entire duration of the pilot as a function of pricing Treatment and/or non-price intervention.

We define average conservation impact as: The year-over-year difference in the average hourly consumption per month, calculated in the Summer, Winter, and 12-month pilot period. Average conservation impacts are collapsed across TOU periods.

The analytical approach mirrored that of the TOU period impact estimation for each pilot. Impacts for Summer, Winter and total pilot duration (12-months) are estimated based on mean kW consumption differences for pricing Treatment, communication Treatment (i.e., Nudge Reports), and the interaction between price and communication Treatments, as relevant for each pilot. The linear regression models for the Enhanced, Overnight and Dynamic pilot used to estimate average conservation impacts with and without interaction terms are represented algebraically in Equations (4.5 and 4.6) and Legacy Dynamic linear models are represented in Equations 4.7 and 4.8.

(4.5) $$\left(PostAvgHourlyUsage_i - PreAvgHourlyUsage_{i,}\right) = \alpha + \beta_1 \, Price_P + \beta_2 \, Communication_C + \beta_3 \, Price_P * Communication_C + \varepsilon_i$$

(4.6) $$\left(PostAvgHourlyUsage_i - PreAvgHourlyUsage_{i,}\right) = \alpha + \beta_1 \, Price_P + \beta_2 \, Communication_C + \varepsilon_i$$

(4.7) $$PostAvgHourlyUsage_i = \alpha + \beta_1 \, Price_P + \varepsilon_i$$

(4.8) $$PostAvgHourlyUsage_i = \alpha + \beta_1 \, Communication_C + \varepsilon_i$$

Where,

PostAvgHourlyUsage	=	Average kWs consumed per hour in each month for household *i*, averaged over all experimental period months
PreAvgHourlyUsage	=	Average kWs consumed per hour in each month for household *i*, averaged over all pre-experimental period months
Price	=	Dummy indicator denoting presence of price manipulation
Communication	=	Dummy indicator denoting presence of communication manipulation
i	=	Indicates individual household
ε	=	Indicates regression error term

4.3.3 *smart thermostat Technology*

Separate analyses are performed to assess the impacts of smart thermostat Technology within each of the pricing pilots. Our estimation of consumption impacts owing to smart thermostats is completed using verified thermostat registration data obtained from Alectra. However, exact timing of smart thermostat installation for each household remains unknown; therefore, technology impacts are analyzed with linear models (Equation 4.9) comparing mean hourly kW consumption of households with and without registered smart thermostats during the Treatment period only, and we did not employ a difference-in-difference approach.

Since we do not have data regarding thermostat acquisition dates for many of the customers classified as belonging to the ‘Technology’ groups in this pilot, it means that ‘Technology’ customers (those who registered a device as part of the pilot) fall into three distinct categories during the relevant historical baseline period:

1. Households who did not possess a smart thermostat at any point during the baseline (pre-pilot) period but acquired one for the start of the pilot period

2. Households who acquired a smart thermostat at some point during the baseline period, meaning they could benefit from programmable settings for some but not all of the baseline period used for differencing

3. Households who possessed a smart thermostat for the entirety of the baseline period, and simply registered that device at the commencement of the pilot

Given the heterogeneity of smart thermostat ownership status for the Technology group in the historical baseline period, we wanted to avoid introducing this 'noise' into the analysis via a difference-in-difference methodology. Put another way, if we employed a DID approach, then for some individuals, the observed treatment effect would be that of thermostat ownership AND registration, for others it would represent the effect of thermostat ownership AND registration for some but not all time periods, and yet for others, the DID method would deliver an effect solely of thermostat registration. By simply comparing customers with registered devices during the pilot period to customers without registered devices it ensures that at least our Treatment group consumption derives entirely from both thermostat ownership AND registration. The linear model used to estimate technology impacts is shown algebraically in equation (4.9).

(4.9) $$PostTOUUsage_i = \alpha + \beta_1 \, Technology_T + \varepsilon_i$$

PostAvgHourlyUsage	=	Average hourly kW consumed during experimental period by household *i*
Technology	=	Dummy indicator denoting presence of smart thermostat Technology
i	=	Indicates individual household
ε	=	Indicates regression error term

4.3.4 ***Estimated Price Elasticity***

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

We define own-price (daily) elasticity as: The percent change in hourly electricity consumption relative to the percent change in hourly electricity price.

We define inter-period substitution elasticity as: The percent change in the ratio of on-peak to Off-Peak electricity consumption relative to the percent change in the ratio of On-Peak to Off-Peak electricity price.

The regression models for the estimated price elasticity analysis are represented algebraically in Equation (4.10) for own-price (Daily) elasticity and Equation (4.11) for inter-period substitution elasticity.

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

$$(4.11) \quad ln\left(\frac{Q_{on-peak,d}}{Q_{off-peak,d}}\right) = \alpha + \sigma\ ln\left(\frac{P_{on-peak,d}}{P_{off-peak,d}}\right) + \delta_1\ (CDH_{on-peak,d} - CDH_{off-peak,d}) + \delta_2\ (HDH_{on-peak,d} - HDH_{off-peak,d}) + \sum_{i=1}^{N} \theta_i D_i + \varepsilon_{i,d}$$

Where,

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

4.3.5 *Estimated Percentage Impacts*

For analyses in which a difference-in-difference methodology was employed, mean hourly kW Treatment estimates represent the difference in year-over-year kW consumption in each TOU period for participants receiving a price/non-price Treatment, relative to participants in the appropriate Control group. We extrapolate percent impact from these mean hourly kW consumption estimates by dividing the impact coefficient by the relevant Treatment group's counterfactual consumption, which we derived by subtracting the impact coefficient from the Treatment group's observed consumption in the unprotected pilot period. From equation (4.1):

$$\%\ impact = \frac{\widehat{\beta_1}}{(PostTOUUsage_i - \widehat{\beta_1})}$$

As such, $percent\ impact$ estimates represent the percentage in the pilot period by which the observed consumption in the Treatment group differs from their counterfactual consumption had they not been exposed to the Treatment.

4.3.6 *Summer vs. Winter Impacts Analysis*

Beginning in October 2017, households who were automatically enrolled into the Enhanced pricing plan were informed of their participation in Advantage Power Pricing and eligible households from the remaining sample frame were contacted via direct marketing efforts to voluntarily sign up for either the Dynamic or Overnight pricing plan (again, marketed as Advantage Power Pricing). All advantage Power Pricing participants were then placed into a full price protection period meaning that bill savings accrued as a result of participation in the APP program (relative to what charges for consumption would have been under standard TOU pricing) were credited to their subsequent electricity invoices, but any additional costs owing to APP participation were not charged. This protected period lasted until March 31, 2018.

Due to the difference-in-difference methodology employed to estimate consumption impacts, pre-Treatment baseline consumption data is required for each household. For example, a household's On-Peak consumption during May 2018 is compared to their consumption in May 2017, when they were not in the pilot. Since the price protection period ran from October 2017 to March 2018, this time period could not be used as a pre-Treatment baseline period for the Winter impact analysis (which covers November 2018 to April 2019). In order to circumvent this issue, we obtained consumption data from the year previous to the protected period for all participants (November 2016 – April 2017). In short, this means that the pre-Treatment historical baseline data used for the DID impact estimation for the Summer period is one year prior to the pilot, whereas for the Winter impact estimation, the pre-Treatment historical baseline data is 2 years prior to the pilot.

Winter impact analyses derive from a comparison of consumption data from the Unprotected-Treatment Period (Nov 2018 – April 2019) to the Pre-Treatment Period (Nov 2016 – April 2017). However, we do not present data from the Protected-Treatment Period (Nov 2017 – April 2018) as we do not have any a priori hypotheses regarding the effects of the pricing pilots on price-protected consumption and due to the fact that the duration of the protected period is variable across customers in the Dynamic and Overnight pilots depending on their enrolment date.

Table 30: Time periods associated with Winter impact estimation

Winter Season Analysis		
Pre-Treatment Period	Protected-Treatment Period	Unprotected-Treatment Period
November 2016 – April 2017	November 2017 – April 2018	November 2018 – April 2019

5. Results

5.1 Bill Savings

Here we present customers' bill savings/costs owing to APP participation. Shown in Table 31 and

Table 32, are the average monthly APP bills for each price plan which were calculated and compared to what customers would have paid if they exhibited the same consumption behaviour observed in the current pilot, but had been billed as per status quo TOU prices instead of the APP prices they were subjected to in the pilot. This method of calculating bill savings is how Alectra determines whether or not a given customer is saving money as a result of pilot participation (which would appear as a bill credit on the next billing cycle) or is paying more (which is reflected as the billable amount on their current billing cycle invoice)[38]. Average monthly bill savings indicate that Overnight participants obtained savings on their monthly bills, Enhanced participants experienced small costs in Summer and savings in Winter, and Dynamic participants experienced small savings in the Summer period and moderate savings in the Winter period, with Legacy Dynamic customers seeing larger savings than customers who had joined the program since September 2017 ("new" Dynamic customers). Figures showing the distribution of the total bill savings amounts per pricing pilot are shown in Appendix D.

Table 31: Monthly Bill Savings (Summer 2018)

APP Price Plan	May	June	July	August	September	October	Average Monthly Savings
Enhanced	$0.19	-$0.39	-$0.16	-$1.39	-$0.20	$0.21	-$0.29
Dynamic	$11.93	$4.99	-$17.80	-$12.64	$2.37	$12.81	$0.28
Legacy Dynamic	$11.73	$5.22	-$16.45	-$11.01	$2.99	$12.34	$0.81
Overnight	$5.23	$5.92	$5.91	$5.07	$5.95	$5.80	$5.64
Bill Savings are Denoted as Positive							

[38] The monthly bill savings (or costs) associated with APP pricing relative to status quo TOU pricing should not be interpreted as an economic metric of behaviour change, per se. Differences between what program participants were charged under APP pricing relative to what they would have been charged under status quo TOU pricing could be due to price changes, behaviour changes, or both.

Table 32: Monthly Bill Savings (Winter 2018-2019)

APP Price Plan	November	December	January	February	March	April	Average Monthly Savings
Enhanced	-$0.08	$0.09	$1.52	$0.19	$0.53	$0.42	$0.44
Dynamic	$13.98	$10.14	-$0.79	-$14.42	-$3.19	$10.54	$2.71
Legacy Dynamic	$14.54	$10.43	-$1.31	-$16.16	-$3.84	$11.01	$2.45
Overnight	$6.46	$6.68	$6.71	$7.65	$7.24	$6.64	$6.90
Bill Savings are Denoted as Positive							

Table 33: Bill Savings as Percentage of Total Commodity Bill (Summer 2018)

APP Price Plan	May (%)	June (%)	July (%)	August (%)	September (%)	October (%)	Average Monthly Savings (%)
Enhanced	0.45	-0.64	-0.21	-1.81	-0.27	0.45	-0.34
Dynamic	25.83	7.98	-23.14	-16.76	3.31	25.97	3.87
Legacy Dynamic	25.07	8.48	-21.44	-14.58	4.16	25.55	4.54
Overnight	11.07	9.39	7.45	6.62	8.08	11.53	9.02
Bill Savings are Denoted as Positive							

Table 34: Bill Savings as Percentage of Total Commodity Bill (Winter 2018-2019)

APP Price Plan	November (%)	December (%)	January (%)	February (%)	March (%)	April (%)	Average Monthly Savings (%)
Enhanced	0.08	0.23	2.54	0.40	1.05	1.07	0.90
New Dynamic	26.70	16.93	-2.04	-23.93	-6.24	20.97	5.40
Legacy Dynamic	26.68	16.93	-3.46	-24.86	-7.21	20.83	4.82
Overnight	8.29	7.54	8.18	8.04	8.63	8.91	8.27

Bill Savings are Denoted as Positive

5.2 Enhanced Pricing Pilot

5.2.1 *Sample Size and Summary Statistics*

The number of participants selected for the Enhanced pricing pilot is shown in

Table 35. Enhanced pricing began with 14,000 participants evenly distributed between the Treatment and Control groups. As of October 30, 2018 (the end of the reporting period for the interim impact analysis) the number of participants was 12,436, which then dropped to 11,513 by the end of the reporting period for the final impact analysis on April 30, 2019. Participant drop off occurred due to either households moving out of the service territory, opting out of the program, missing data[39], or the household consumption was deemed to be an extreme outlier[40]. Summary statistics for On-Peak, Off-Peak, and Total consumption for the Winter and Summer periods are provided in

[39] See Section 4.2.4 Issues or Concerns for further explanation.

[40] An outlier was defined as any household who consumed more than 15kWh, less than 0.05kWh, or had missing data during any hour in the analysis period

Table 36 and

Table 37. Summary statistics are presented as the mean hourly kW consumption (and associated standard deviation (SD)) for a given group (Treatment, Control) for a given pilot for a given time-point (i.e., baseline year, Treatment year).

Table 35: Number of Enhanced Pilot Participants

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[41]	Outliers	Total Exclusions	Final N
Enhanced Pricing, No Nudge Report	3500	233	235	6	30	504	2996
Enhanced Pricing + Nudge Report	3500	245	247	11	33	536	2964
Std. TOU Control, No Nudge Report	3500	3	197	11	50	261	3239
Std. TOU Control + Nudge Report	3500	31	191	6	35	263	3237
Total	14000	512	870	34	148	1564	12436
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Enhanced Pricing	2996	62	194	2	5	241	2733
Enhanced Pricing + Nudge Report	2964	42	192	1	6	263	2723
Std. TOU Control	3239	9	178	1	9	222	3042
Std. TOU Control + Nudge Report	3237	51	160	2	9	197	3015
Total	12436	164	724	6	29	923	11513

[41] See Section 4.2.4 Issues or Concerns for further explanation

Table 36: Summary of Consumption in mean hourly kW per Condition for Enhanced Pilot (Summer Period May – October 2018)

Summer Period		Std. TOU Pricing, No Nudge Report	Enhanced Pricing, No Nudge Report	Std. TOU Pricing + Nudge Reports	Enhanced Pricing + Nudge Reports
On-Peak 2017	Mean	0.984	0.972	0.985	0.997
	SD	0.874	0.866	0.852	0.911
On-Peak 2018	Mean	1.164	1.147	1.151	1.159
	SD	0.976	0.964	0.961	1.009
Mid-Peak 2017	Mean	0.934	0.931	0.940	0.948
	SD	0.766	0.755	0.747	0.785
Mid-Peak 2018	Mean	1.077	1.070	1.078	1.084
	SD	0.842	0.836	0.838	0.864
Off-Peak 2017	Mean	0.875	0.871	0.876	0.879
	SD	0.681	0.704	0.668	0.704
Off-Peak 2018	Mean	1.006	1.008	1.012	1.009
	SD	0.743	0.778	0.761	0.776
Total 2017	Mean	0.931	0.925	0.934	0.941
	SD	0.779	0.779	0.761	0.806
Total 2018	Mean	1.082	1.075	1.080	1.084
	SD	0.862	0.865	0.859	0.891

Table 37: Summary of Consumption in mean hourly kW per Condition for Enhanced Pilot (Winter Period November 2018 – April 2019)

Winter Period		Standard TOU Pricing, No Nudge Report	Enhanced Pricing, No Nudge Report	Standard TOU Pricing + Nudge Reports	Enhanced Pricing + Nudge Reports
On-Peak Pre '16-17	Mean	0.879	0.870	0.897	0.893
	SD	0.676	0.717	0.745	0.704
On-Peak Protected '17-18	Mean	0.930	0.931	0.952	0.947
	SD	0.697	0.787	0.806	0.755
On-Peak Post '18-19	Mean	0.945	0.938	0.960	0.948
	SD	0.727	0.773	0.795	0.764
Mid-Peak Pre '16-17	Mean	0.783	0.772	0.802	0.793
	SD	0.660	0.689	0.709	0.674
Mid-Peak Protected '17-18	Mean	0.834	0.829	0.852	0.842
	SD	0.676	0.760	0.763	0.721
Mid-Peak Post '18-19	Mean	0.859	0.847	0.868	0.850
	SD	0.715	0.748	0.757	0.728
Off-Peak Pre '16-17	Mean	0.862	0.862	0.885	0.869
	SD	0.635	0.699	0.727	0.662
Off-Peak Protected ‘17-18	Mean	0.923	0.936	0.952	0.932
	SD	0.663	0.778	0.793	0.726
Off-Peak Post '18-19	Mean	0.931	0.940	0.962	0.933
	SD	0.693	0.766	0.798	0.746
Total Pre '16-17	Mean	0.841	0.835	0.861	0.852
	SD	0.659	0.703	0.728	0.682
Total Protected '17	Mean	0.896	0.898	0.919	0.907
	SD	0.680	0.777	0.789	0.736
Total Post '18	Mean	0.912	0.908	0.930	0.910
	SD	0.713	0.764	0.785	0.747

5.2.2 *Time-of-Use Period Impacts and Seasonal Impacts with Elasticities*

Impact estimates owing to Enhanced pricing and Nudge Reports for Summer and Winter TOU periods are displayed in Table 38 and Table 39**.**

We observed no significant effect of Enhanced pricing on On-Peak, Mid-Peak or Off-Peak consumption during the Summer or Winter periods. With respect to the Nudge Reports, we observed an effect of -0.013 mean hourly kW (1.1%) during On-Peak hours and no effect during Mid-Peak hours in the Summer months. In the Winter months, we observed a -0.008 mean hourly kW (0.8%) effect during On-Peak hours and a -0.014 mean hourly kW (1.6%) effect during Mid-Peak hours. There was no effect of the Nudge Reports on consumption during Off-Peak hours or system-coincident peak hours in either the Summer or the Winter months.

Table 38: Enhanced Pricing Pilot TOU Peak Mean Hourly kW Impact Analysis Results – Summer Period

Summer	Enhanced Pricing[42] (Main Effect)		Nudge Report (Main Effect)	
	kW	%	kW	%
On-Peak	-0.001	-0.173	**-0.013***	-1.113
Mid-Peak	-0.001	-0.093	-0.005	-0.46
Off-Peak	0.006	0.599	-0.001	-0.099
System-Coincident Peak	-0.008	-0.526	-0.009	-0.589

**** p < 0.001; ** p < 0.01; * p < 0.05*

Table 39: Enhanced Pricing Pilot TOU Period Mean Hourly kW Impact Analysis Results – Winter Period

Winter	Enhanced Pricing (Main Effect)		Nudge Report (Main Effect)	
	kW	%	kW	%
On-Peak	0.005	0.533	**-0.008***	-0.832
Mid-Peak	0.004	0.474	**-0.014***	-1.604
Off-Peak	0.011	1.189	-0.003	-0.316
System-Coincident Peak	-0.001	-0.1	-0.015	-1.09

**** p < 0.001; ** p < 0.01; * p < 0.05*

With respect to overall seasonal consumption (regardless of TOU period; shown in

Table 40), we found no significant effects on *total* consumption during the Summer or Winter periods.

[42] % impacts are calculated as kW impact / (PostTOUUsage - kW impact), where PostTOUUsage is the average consumption between the Enhanced Pricing + No Nudge Report and Enhanced Pricing + Nudge Report groups in 2018 from table 36.

Table 40: Enhanced Pilot Seasonal Average Mean Hourly kW Conservation Impact Analysis Results

	Enhanced Pricing (Main Effect)		Nudge Report (Main Effect)	
	kW	%	kW	%
Summer Impact	0.004	0.384	-0.003	-0.286
Winter Impact	0.009	0.972	-0.006	-0.639
Year-Round Impact	0.007	0.709	-0.004	-0.401

**** p < 0.001; ** p < 0.01; p < 0.05*

Daily and Inter-Period Substitution Elasticities are reported in Table 41. Daily elasticity of demand was estimated at -0.133. The daily elasticity of demand was negative and between -1 and 0 (i.e., the absolute value is less than 1), indicating that for a percent change in price there was an inconsequential change in percent consumption. Inter-Period Substitution Elasticity was estimated at -0.019 again indicating that for a percent change in price there was an inconsequential change in percent consumption. These elasticities were calculated over the summation of the Winter and Summer period.

Table 41: Enhanced Pilot Daily and Substitution Elasticities of Demand

	Elasticity Estimate
Daily Elasticity	**-0.133***
Substitution Elasticity On/Overnight Off-Peak	**-0.019***

**** p < 0.001; ** p < 0.01; *p < 0.05*

5.2.3 *Technology Impacts*

The analytical approach for assessing the impact of smart thermostat ownership on electricity consumption is described in detail in Section 4.3.3. In summary, households were designated as "Technology" if they registered an eligible smart thermostat for automatic load curtailment at the commencement of the pilot. It should be noted that meaningful comparisons between those with and without Technology is solely dependent on (1) the incidence rate of Technology ownership within the sample populations, and (2) the availability of data on which customers have such Technology. Objectively verifiable data on smart thermostat ownership exists only for customers who purchased their devices through Alectra. The evaluator did attempt to acquire self-report data on privately acquired smart thermostats from all participants (both Treatment and Control) via survey instruments. However, besides the fact that self-report data is somewhat unreliable, the response rate to these surveys was very low. For the above reasons, our estimation of consumption impacts owing to smart thermostats could only be completed using verified thermostat possession/registration data obtained from Alectra. Recall that registered devices were equipped with some form of load curtailment during peak pricing events across all three pilots and so the estimated impacts of smart thermostats (i.e., "Technology") reported here are a measure of the (likely) additive effects of both owning a smart thermostat *and* receiving automatic load curtailment signals[43].

The reader should be reminded that our calculation of impacts owing to smart thermostat ownership differs from our calculation of impacts owing to pricing Treatment or communications Treatment. Exact timing of smart thermostat installation for each household remains unknown, therefore Technology was analyzed comparing consumption of households with and without registered smart thermostats during the Treatment period only, and we did not employ a difference-in-difference approach. Analyzing Technology only during the Treatment period avoids any noise introduced by potential smart thermostat usage during the pre-Treatment pricing period.

Frequency of smart thermostat registration is presented in Table 42, and mean hourly kW consumption summary statistics are presented in
Table 43 (Summer) and Table 44 (Winter). Due to the small cell sizes, we collapsed across Nudge Report for all analyses.

Table 42: Number of Enhanced Pilot participants with registered smart thermostats

	Energate	Ecobee	Nest	Honeywell
Summer Period				
Enhanced Pricing + Nudge Report	73	12	14	0
Enhanced Pricing, No Nudge Report	46	11	10	0
Std. TOU Pricing + Nudge Report	98	20	6	0
Std. TOU Pricing, No Nudge Report	47	11	3	0
Winter Period				
Enhanced Pricing + Nudge Report	69	11	12	0
Enhanced Pricing, No Nudge Report	42	10	10	0
Std. TOU Pricing + Nudge Report	93	19	5	0

[43] The exception to this concerns the Honeywell and Ecobee thermostats, which were not able to receive load curtailment signals for the Enhanced pilot. Thus, despite the fact that there were no registered Honeywell devices, and only a small number of registered Ecobee devices within the Enhanced pilot, the impacts owing to 'Technology' likely slightly under-estimate the impact of load curtailment.

Std. TOU Pricing, No Nudge Report	47	10	3	0

Table 43: Enhanced Pricing Technology (smart thermostats) Mean Hourly kW Consumption Summary Statistics – Summer

Summer (kWh)			Enhanced Pricing	Standard TOU Pricing	Total
On-Peak 2018	Technology	Mean	0.948	1.076	1.016
		SD	0.674	0.894	0.800
	No Technology	Mean	1.155	1.164	1.159
		SD	0.969	0.996	0.983
Mid-Peak 2018	Technology	Mean	0.910	1.017	0.966
		SD	0.573	0.786	0.695
	No Technology	Mean	1.079	1.082	1.080
		SD	0.843	0.855	0.850
Off-Peak 2018	Technology	Mean	0.920	0.958	0.940
		SD	0.547	0.696	0.630
	No Technology	Mean	1.013	1.009	1.011
		SD	0.775	0.762	0.768
Total 2018	Technology	Mean	0.926	1.017	0.974
		SD	0.601	0.797	0.713
	No Technology	Mean	1.082	1.085	1.084
		SD	0.868	0.878	0.873

Table 44: Enhanced Pricing Technology (smart thermostats) Mean Hourly kW Consumption Summary Statistics – Winter

Winter (kWh)			Enhanced Pricing	Standard TOU Pricing	Total
On-Peak 2018-19	Technology	Mean	0.779	0.862	0.823
		SD	0.441	0.617	0.544
	No Technology	Mean	0.954	0.949	0.951
		SD	0.791	0.749	0.769
Mid-Peak 2018-19	Technology	Mean	0.697	0.773	0.737
		SD	0.475	0.569	0.528
	No Technology	Mean	0.862	0.857	0.859
		SD	0.759	0.725	0.742
Off-Peak 2018-19	Technology	Mean	0.832	0.864	0.849
		SD	0.495	0.644	0.580
	No Technology	Mean	0.954	0.934	0.944
		SD	0.789	0.722	0.754
Total 2018-19	Technology	Mean	0.769	0.833	0.803
		SD	0.474	0.612	0.553

	No Technology	Mean	0.923	0.913	0.918
		SD	0.781	0.733	0.756

For the Enhanced pricing pilot, results of the Technology impact analysis for the Summer and Winter months are shown in Table 45 and Table 46**.** During the Summer period, we observed statistically significant effects of Technology during On-, Mid-, and Off-Peak periods, contributing to an overall effect of -0.109 kW per hour (-10.1%). Similarly, during the Winter period, we observed statistically significant effects during On-, Mid-, and Off-Peak periods, contributing to a total overall effect of -0.115 kW per hour (-12.6%), attributable to smart thermostat possession. There were no significant interactions between Technology and Price Group.

Table 45: Enhanced Pricing Technology Mean Hourly kW Impacts (Summer)

Summer 2018 (kWh)	Technology (Main Effect)		Price Group (Main Effect)	
	kW	%	kW	%
On-Peak Effects	**-0.144****	-12.457	-0.013	-1.221
Mid-Peak Effects	**-0.114****	-10.58	-0.007	-0.699
Off-Peak Effects	-0.071^	-7.03	0.003	0.311
Total Effects	**-0.109****	-10.088	-0.005	-0.496

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

Table 46: Enhanced Pricing Technology Mean Hourly kW Impacts (Winter)

Winter 2018-19 (kWh)	Technology (Main Effect)		Price Group (Main Effect)	
	kW	%	kW	%
On-Peak Effects	**-0.128****	-13.495	0.002	0.231
Mid-Peak Effects	**-0.122****	-14.236	0.003	0.386
Off-Peak Effects	**-0.094***	-9.979	0019	2.174
Total Effects	**-0.115***	-12.555	0.008	0.955

**** p < 0.001; ** p < 0.01; * p < 0.05*

5.2.4 ***Pledges***

Finally, we examined consumption between households who pledged to reduce On-Peak electricity consumption by responding via SMS text to the pledge displayed on the Nudge Reports versus households who received the Nudge Report but did not respond to the pledge.

Households who responded to the pledge were offered a $5 bill rebate. The number of participants who responded to the pledge in the Enhanced pricing pilot are shown in Table 47. Due to the large difference in sample sizes between participants who did and did not sign the pledge, a Welch's independent samples *t*-test was used to compare average On-Peak electricity consumption between households who received the Nudge Report and responded to the pledge versus those who received the Nudge Report but did not respond to the pledge. Summer results are reported in

Table 48 and Winter results are reported in

Table 49.

Overall, both Summer and Winter impacts (displayed in

Table 48 and

Table 49**)** show that households who responded to the pledge had lower consumption relative to households who did not respond to the pledge across all TOU periods. This effect does appear to be stronger in the Standard TOU Control group than the Enhanced Price group; however, follow-up analysis revealed the interaction was non-significant. As the pledge was not experimentally manipulated and served as an embedded feature of the Nudge Report, we cannot make a causal inference that the pledge created energy savings or if it is the case that households who were already more motivated to save were also more likely to respond to the pledge.

Table 47: Pledge Numbers

	Std. TOU Control, Pledge Not Signed	Std. TOU Control, Pledge Signed	Enhanced Pricing, Pledge Not Signed	Enhanced Pricing, Pledge Signed
Summer 2018	3,092	145	2,910	54
Winter 2019	2,876	139	2,671	52

Table 48: Pledge Analysis - Summer

Average Year-Year Summer Consumption Change (Mean Hourly kW)				
	Control Group	No Pledge	Signed Pledge	Welch's T-Test
On-Peak Consumption				
Base Line (Status Quo TOU, No Nudge Report)	0.180	-	-	
Status Quo TOU, Nudge Report	-	0.166	0.084	***t(168.25)=-3.67, p<0.001***
Enhanced Pricing, Nudge Report	-	0.169	0.056	***t(54.98)=-2.27, p=0.027***
Mid-Peak Consumption				
Base Line (Status Quo TOU, No Nudge Report)	0.144	-	-	
Status Quo TOU, Nudge Report	-	0.138	0.078	***t(171.58)=-3.2, p=0.002***
Enhanced Pricing, Nudge Report	-	0.139	0.088	*t(55.69)=-1.37, p=0.177*
Off-Peak Consumption				
Base Line (Status Quo TOU, No Nudge Report)	0.130	-	-	
Status Quo TOU, Nudge Report	-	0.132	0.091	***t(169.73)=-2.29, p=0.024***
Enhanced Pricing, Nudge Report	-	0.136	0.161	*t(55.03)=0.65, p=0.518*
Total Consumption				
Base Line (Status Quo TOU, No Nudge Report)	0.142	-	-	
Status Quo TOU, Nudge Report	-	0.139	0.088	***t(170.57)=-2.9, p=0.004***
Enhanced Pricing, Nudge Report	-	0.142	0.131	*t(55.34)=-0.32, p=0.754*

Table 49: Pledge Analysis - Winter

Average Winter Year-Year Consumption Change (Mean Hourly kW)				
	Control Group	No Pledge	Signed Pledge	Welch's T-Test
On-Peak Consumption				
Baseline (Status Quo TOU, No Nudge Report)	0.066	-	-	-
Status Quo TOU, Nudge Report	-	0.058	0.007	***t(178.82)=-2.84, p=0.005***
Enhanced Pricing and Nudge Report	-	0.064	0.037	*t(55.08)=-0.66, p=0.509*
Mid-Peak Consumption				
Baseline (Status Quo TOU, No Nudge Report)	0.077	-	-	-
Status Quo TOU, Nudge Report	-	0.059	0.006	**t(176.47)=-3, p=0.003**
Enhanced Pricing and Nudge Report	-	0.068	0.014	*t(54.82)=-1.35, p=0.182*
Off-Peak Consumption				
Baseline (Status Quo TOU, No Nudge Report)	0.069	-	-	-
Status Quo TOU, Nudge Report	-	0.065	0.03	*t(186.55)=-1.95, p=0.052^*
Enhanced Pricing and Nudge Report	-	0.076	0.14	*t(53.15)=1.14, p=0.26*
Total Consumption				
Baseline (Status Quo TOU, No Nudge Report)	0.070	-	-	-
Status Quo TOU, Nudge Report	-	0.063	0.022	***t(187.19)=-2.47, p=0.014***
Enhanced Pricing and Nudge Report	-	0.072	0.1	*t(53.83)=0.6, p=0.553*

5.2.5 *Overall Summary for the Enhanced Pilot*

Impact analyses for the Enhanced pricing pilot across both Summer and Winter reporting periods yield clear results. Despite almost doubling the On-to-Off Peak price differential relative to Standard Time-of-Use pricing, Enhanced pricing as structured in the current RPP pilot program failed to realize On-Peak consumption reductions or overall conservation impacts. Standard economic theory would predict that an increase in price would lead to a decrease in consumption and vice-versa. It seems, therefore, that the increase in On-Peak price relative to Standard Time-of-Use pricing did not provide enough of a financial incentive for program participants to alter their daily consumption behaviours in order to realize bill savings.

Given that the Enhanced pricing pilot was run as an opt-out RCT, one may hypothesize that the lack of behavioural response may be at least partly due to a lack of awareness of participation in the program (perhaps due to the fact that Enhanced pricing participants did not have to actively sign-up for the program). This however seems unlikely for two reasons: (1) participants were sent several rounds of communications regarding their selection for Enhanced pricing throughout the duration of the pilot, (2) participants were exposed to a salient material change in their monthly consumption-related communications in the form of Shadow Bills.

Recall that half of the participants in the Enhanced pricing pilot (both the pricing Treatment and Control groups) received monthly communications in the form of Nudge Reports. These Nudge Reports contained feedback on customers' On-Peak consumption in the previous billing period (with personal benchmarking) coupled with personalized tips on electricity consumption reduction (calculated from load disaggregation data provided by Bidgley). Impact analyses reveal that customers who received these Nudge Reports exhibited lower On-Peak consumption by approximately 1.1% and 0.8% relative to customers who did not receive these reports (in both the Summer and Winter reporting periods respectively).

Technology impacts were also examined as an additional means of assessing the effectiveness of non-price interventions on conservation and demand management behaviours in the present program. We observed that customers in the Enhanced pricing group who participated in Alectra's smart thermostat incentive program (meaning they registered an eligible device to receive automatic load curtailment signals during higher priced TOU periods[44]) exhibited lower electricity consumption relative to Enhanced pricing customers who did not register smart thermostats.

In summary, impact analyses of the 12 months of hourly kW consumption data for customers assigned to the Enhanced pricing pilot reveal that Enhanced pricing as currently structured is an ineffective means of driving load-shifting and/or conservation behaviours among the piloted customer base. In contrast, non-price interventions in the form of personalized feedback reports (informed by behavioural economics) as well as programmable smart thermostat technologies are able to drive reliable electricity consumption reductions during On-Peak hours in both Summer and Winter months.

[44] The only caveat to this is that there were a small number of participants within the Enhanced pilot that registered Ecobee devices, which were not equipped with load curtailment functionality for this pilot.

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

The Enhanced pricing pilot was run as a Randomized Control Trial (RCT), meaning that households were randomly assigned to either the pricing Treatment or Control group. Households assigned to the pricing Treatment group were informed that they had been selected for participation in a pricing pilot program call Advantage Power Pricing which would begin charging them differential TOU prices relative to status quo TOU. These households were informed that they could opt-out of the pilot at any time and return to status quo TOU pricing. Households randomly assigned to the Control group (i.e., those on Standard TOU pricing) were not aware they were part of the pilot and thus there was nothing for them to opt-out of. This scenario introduces a source of selection bias in the data over time. Mainly, participating households will self-select out of the Treatment group, but not the Control group and it is likely the case that individuals who opt out of Enhanced pricing may be especially high consumers of On-Peak electricity which would create differences in baseline consumption behaviour between Treatment and Control groups, a situation that the use of an RCT is explicitly intended to avoid.

In order to account for the asymmetric selection bias introduced into the experimental design, we conducted an Intent-to-Treat analysis (ITT). In this analysis we leave all the households who opted-out of Enhanced pricing *in* the data set. This means that for the estimation of Summer impacts, we retain all households who opted out within the first 6 months of the pilot. Similarly, for the estimation of Winter impacts, we retain all Enhanced pricing households who opted out of the pilot between months 7 and 12. From there, we derive a new set of impact estimates and divide the coefficients by the percentage of the households remaining in the sample. We then compare these scaled coefficients to the original analyses (in which opt-outs were excluded). Based on the number of opt-outs, we scaled the summer coefficients by 0.962 (96.2% retention, 3.8% opt-out) and the winter coefficients by 0.948 (94.8% retention, 5.2% opt-out). Summary Statistics of mean hourly kW consumption for each Treatment group and time period are shown in

Table 50 (Summer) and

Table 52 (Winter) and consumption impact estimates are shown in

Table 51 (Summer) and

Table 53 (Winter).

Table 50: Enhanced Pilot Mean Hourly kW Consumption Summary Statistics with Opt-Outs Included (Summer)

Summer Period (Mean Hourly kW)		Std TOU Pricing, No Nudge Report	Enhanced Pricing, No Nudge Report	Std TOU Pricing + Nudge Reports	Enhanced Pricing + Nudge Reports
On-Peak 2017	Mean	0.984	0.986	0.996	0.996
	SD	0.874	0.890	0.910	0.861
On-Peak 2018	Mean	1.164	1.159	1.158	1.163
	SD	0.976	0.985	1.008	0.972
Mid-Peak 2017	Mean	0.934	0.941	0.947	0.947
	SD	0.767	0.774	0.784	0.754
Mid-Peak 2018	Mean	1.078	1.078	1.082	1.084
	SD	0.842	0.853	0.863	0.845
Off-Peak 2017	Mean	0.876	0.874	0.878	0.879
	SD	0.682	0.704	0.703	0.671
Off-Peak 2018	Mean	1.006	1.009	1.008	1.015
	SD	0.743	0.776	0.775	0.765
Total 2017	Mean	0.931	0.934	0.940	0.941
	SD	0.779	0.794	0.805	0.767
Total 2018	Mean	1.082	1.082	1.082	1.087
	SD	0.862	0.878	0.889	0.867

Table 51: ITT Analysis Results (Summer, Mean Hourly kW)

Summer Period (Mean Hourly kW)	Enhanced Pricing (Main Effect)		Nudge Report (Main Effect)	
	Original Estimate	ITT Coef. Adjusted	Original Estimate	ITT Coef. Adjusted
On-Peak Effects	-0.001	-0.001	**-0.013***	**-0.012***
Mid-Peak Effects	-0.001	-0.002	-0.005	-0.004
Off-Peak Effects	0.006	0.005	-0.001	0
System-Coincident Peak Effects	-0.008	-0.008	-0.009	-0.009
Total Effects	0.004	0.001	-0.003	-0.005

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$; ^$p < 0.1$

Table 52: Enhanced Pilot Mean Hourly kW Consumption Summary Statistics with Opt-Outs Included (Winter)

Winter Period (Mean Hourly kW)		Std TOU Pricing, No Nudge Report	Enhanced Pricing, No Nudge Report	Std TOU Pricing + Nudge Reports	Enhanced Pricing + Nudge Reports
On-Peak 2016-2017	Mean	0.879	0.888	0.892	0.907
	SD	0.676	0.740	0.703	0.752
On-Peak 2018-2019	Mean	0.945	0.952	0.947	0.971
	SD	0.727	0.787	0.761	0.811
Mid-Peak 2016-2017	Mean	0.782	0.793	0.793	0.814
	SD	0.660	0.727	0.674	0.721
Mid-Peak 2018-2019	Mean	0.859	0.863	0.850	0.883
	SD	0.714	0.769	0.728	0.779
Off-Peak 2016-2017	Mean	0.862	0.871	0.868	0.890
	SD	0.634	0.703	0.659	0.729
Off-Peak 2018-2019	Mean	0.931	0.945	0.931	0.968
	SD	0.692	0.764	0.743	0.808
Total 2016-2017	Mean	0.841	0.851	0.851	0.870
	SD	0.658	0.725	0.680	0.735
Total 2018-2019	Mean	0.912	0.920	0.909	0.941
	SD	0.712	0.775	0.745	0.800

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$; ^$p < 0.1$

Table 53: ITT Analysis Results (Winter, Mean Hourly kW)

Winter (Mean Hourly kW)	Enhanced Pricing (Main Effect)		Nudge Report (Main Effect)	
	Original Estimate	ITT Coef. Adjusted	Original Estimate	ITT Coef. Adjusted
On-Peak Effects	0.005	0.003	**-0.008***	-0.006
Mid-Peak Effects	0.004	0.002	**-0.014***	-0.011^
Off-Peak Effects	0.011	0.01	-0.003	-0.001
System-Coincident Peak Effects	-0.001	-0.003	-0.015	-0.009
Total Effects	0.009	0.005	-0.006	-0.006

Based on these data we observe a very similar pattern of results when estimating for consumption of households who opted-out of the price treatment. The exception to this is the mean hourly kW savings attributable to Nudge Reports in the Winter period, which are no longer significant when adjusting for opt-outs; On-Peak reductions owing to Nudge Reports in the Summer period remain significant.

5.3 Overnight Pricing Pilot

5.3.1 *Sample Size and Summary Statistics*

Recall that the Overnight pilot was designed to appeal primarily to customers who work irregular shifts or own electric vehicles (EVs). Survey data from customers indicates that approximately 43% of Overnight pricing Treatment customers own an EV, suggesting that the Overnight pricing plan was successful in attracting this particular customer segment. The numbers of participants in the Overnight Pilot for the Summer and Winter periods are displayed in Table 54. Participant drop off was due to either households moving out of the service territory, households opting out of the pilot, missing data[45], or the household consumption was deemed to be an

[45] See Section 4.2.4 Issues or Concerns for further explanation.

outlier[46]. The Overnight Pilot began with 849 participants; however, at the time eligibility was determined 148 participants did not have the full 12 months of historical data (required for the difference-in-difference regression modelling), but all had 6 months of historical data. These 148 participants were missing historical baseline data for the Summer period and were therefore excluded from the Summer impact analyses. Summary statistics for the Overnight pilot are shown in Tables 55 to 57. Summary statistics are presented as the mean hourly kW consumption (and associated standard deviation (SD)) for a given group (Treatment, Control) for a given pilot for a given time-point (i.e., baseline year, Treatment year).

Table 54: Number of Overnight Pilot Participants

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[47]	Outliers	Total Exclusions	Final N
Overnight Pricing	366	18	7	0	1	26	340
Std. TOU Control	366	0	0	1	4	5	361
Total	732	18	7	1	5	31	701
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Overnight Pricing	340	20	2	76	1	99	241
Overnight Pricing, 6-Month Group	74	3	1	3	6	13	61
Std. TOU Control	361	1	0	0	1	2	359
Std. TOU Control, 6-Month Group	74	0	0	0	3	3	71
Total	849	24	3	79	11	117	732

[46] An outlier was defined as any household who consumed more than 15kWh, less than 0.05kWh, or had missing data during any hour in the analysis period
[47] See Section 4.2.4 Issues or Concerns for further explanation.

Table 55: Summary of Consumption in Mean kW per hour per TOU Period as a Function of Condition for Overnight Pilot Customers (Summer)

Summer Period (Mean Hourly kW)		Std. TOU Control	Overnight Pricing
On-Peak 2017	Mean	0.861	0.836
	SD	0.684	0.675
On-Peak 2018	Mean	1.063	0.938
	SD	0.840	0.703
Mid-Peak 2017	Mean	0.863	0.854
	SD	0.601	0.634
Mid-Peak 2018	Mean	1.021	0.930
	SD	0.722	0.643
Off-Peak 2017	Mean	1.004	1.059
	SD	0.840	0.748
Off-Peak 2018	Mean	1.139	1.252
	SD	0.843	0.790
Overnight-Off-Peak 2017	Mean	0.661	0.705
	SD	0.811	0.703
Overnight-Off-Peak 2018	Mean	0.722	1.112
	SD	0.735	1.075
Total 2017	Mean	0.847	0.863
	SD	0.750	0.703
Total 2018	Mean	0.986	1.058
	SD	0.803	0.830

Table 56: Summary of Consumption in Mean kW per Hour per TOU Period as a Function of Condition for Overnight Pilot Customers (Winter) – Participants with data for all time periods

Complete data participants, excluding 6-month only participants (Final N=600)			
	Mean Hourly kW	Std. TOU Control	Overnight Pricing
On-Peak 2016-2017	Mean	0.806	0.762
	SD	0.550	0.529
On-Peak 2018-2019	Mean	0.882	0.819
	SD	0.662	0.607
Mid-Peak 2016-2017	Mean	0.687	0.635
	SD	0.514	0.475
Mid-Peak 2018-2019	Mean	0.777	0.700
	SD	0.648	0.542
Off-Peak 2016-2017	Mean	0.957	0.934
	SD	0.742	0.620
Off-Peak 2018-2019	Mean	0.988	1.082
	SD	0.778	0.727
Overnight-Off-Peak 2016-2017	Mean	0.715	0.675
	SD	0.809	0.609
Overnight-Off-Peak 2018-2019	Mean	0.732	1.220
	SD	0.786	1.326
Total Consumption 2016-2017	Mean	0.791	0.751
	SD	0.674	0.573
Total Consumption 2018-2019	Mean	0.845	0.955
	SD	0.728	0.883

Table 57: Summary of Consumption in Mean kW per Hour per TOU Period as a Function of Condition for Overnight Pilot Customers (Winter 2018-2019) – All participants, including those with only Winter treatment period data (Overnight 6-month group)

All participants, including 6-month only participants (Final N = 732)			
	Mean Hourly kW	Std. TOU Control	Overnight Pricing
On-Peak 2016-2017	Mean	0.793	0.738
	SD	0.531	0.517
On-Peak 2018-2019	Mean	0.883	0.841
	SD	0.668	0.651
Mid-Peak 2016-2017	Mean	0.679	0.619
	SD	0.497	0.467
Mid-Peak 2018-2019	Mean	0.774	0.719
	SD	0.644	0.575
Off-Peak 2016-2017	Mean	0.934	0.894
	SD	0.707	0.602
Off-Peak 2018-2019	Mean	0.985	1.098
	SD	0.773	0.763
Overnight-Off-Peak 2016-2017	Mean	0.696	0.654
	SD	0.773	0.620
Overnight-Off-Peak 2018-2019	Mean	0.738	1.208
	SD	0.813	1.334
Total Consumption 2016-2017	Mean	0.775	0.726
	SD	0.646	0.565
Total Consumption 2018-2019	Mean	0.845	0.966
	SD	0.734	0.904

5.3.2 *Time-of-Use Period Impacts and Seasonal Results with Elasticities*

Mean hourly kW impacts conditional on Time-of-Use period are displayed in Table 58 for the Summer period and

Table 59 for the Winter period.

With respect to the Super-Off-Peak and Off-Peak periods, we observed significantly higher Off-Peak consumption relative to the Standard Time-of-Use Control group for both the Summer and Winter periods. During the Summer period we observed effects of -0.1 kW (9.6%) and -0.082 (8.1%) during the On-Peak and Mid-Peak periods, while also seeing effects of +0.345 kW (45.0%) and +0.058 kW (4.9%) in the Super-Off-Peak and Off-Peak periods, respectively. Within the Winter period we observed even larger effects during Off-Peak and Super-Off-Peak of +0.117 kW (12.1%) and +0.52 kW (76.0%), compared to minimal year-over-year changes in consumption in the Standard TOU Control group. The sizeable increases in Super-Off Peak and Off-Peak consumption for Overnight pricing Treatment customers relative to their Matched Controls is perhaps unsurprising. Recall that the Overnight pricing plan was designed to appeal to customers who work irregular shifts or own Electric Vehicles (EVs). EV charging at-home results in substantial electricity consumption and it is likely that customers with at-home chargers simply plug their cars in when they return home from work (likely during On-Peak times of day). Indeed, customer-facing survey data show that approximately 43% of Overnight pilot survey respondents indicated owning an EV during the pilot period. We therefore hypothesize that much of the Off and Super Off-Peak consumption observed for the Overnight pricing Treatment group derives from some proportion of customers shifting their charging behaviour to capitalize on the especially low overnight electricity price. Further investigation with this customer group would be required in order to validate this hypothesis.

Table 58: Overnight Pricing TOU Period Mean Hourly kW Impacts - Summer

	Price Group Regression Coefficients	
	Mean Hourly kW	%
On-Peak	**-0.1*** **	-9.641
Mid-Peak	**-0.082*** **	-8.111
Off-Peak	**0.058***	4.854
Overnight Off-Peak	**0.345*** **	45.038
System-Coincident Peak	**-0.108*** **	-7.673

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 59: Overnight Pricing TOU Period mean Hourly kW Impacts – Winter

	6-month Participants Excluded		All Participants Included	
	Mean Hourly kW	%	Mean Hourly kW	%
On-Peak Effects	-0.019	-2.223	0.012	1.463
Mid-Peak Effects	-0.024	-3.322	0.005	0.656
Off-Peak Effects	**0.117*** **	12.133	**0.153*** **	16.202
Overnight Off-Peak Effects	**0.52*** **	76.04	**0.511*** **	73.344
System-Coincident Peak	**0.091** **	9.799	**0.144*** **	16.669

*** $p < 0.001$; ** $p < 0.01$; $p < 0.05$

Average conservation impact results for the Overnight Pilot are presented in Table 60. Overall, consumption during the Summer period was 0.056 kW (5.3%) higher and 0.165 kW (19.6%) higher during the Winter period for Overnight Treatment customers relative to Control, averaging to about 14.8% higher overall 12-month consumption.

Table 60: Overnight Pricing Seasonal Average Conservation Impact Analysis Results

	6-Month Participants Excluded		All Participants Included	
	Mean Hourly kW	%	Mean Hourly kW	%
Summer Impact	**0.056***	5.261	--	--
Winter Impact	**0.14*** **	16.376	**0.165*** **	19.572
Year-Round Impact	**0.099*** **	12.358	**0.118*** **	14.806

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$

Daily and Substitution Elasticities are reported in

Table 61. Daily elasticity of demand was estimated at -0.29. The daily elasticity of demand was negative and less than 1, indicating an inelastic daily demand curve. The substitution Elasticity was estimated at -0.23. This indicates an approximate 0.23% decrease in the ratio of On/Super Off-Peak consumption relative to a 1% increase in the On/Super Off-Peak price.

Table 61: Overnight Pilot Daily and Substitution Elasticities of Demand

	Elasticity Estimate
Daily Elasticity	**-0.291*** **
Substitution Elasticity On/Overnight Off-Peak	**-0.230*** **

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$

5.3.3 *Technology Impact Analysis*

The analytical approach for assessing the impact of smart thermostat ownership on energy consumption is described in detail in Section 4.3.3. In summary, households were designated as "*Technology*" if they registered an eligible smart thermostat for load curtailment at the commencement of the pilot. Energate and Nest thermostats were capable of receiving load curtailment signals in the Overnight pilot, however we also include those with registered Ecobee thermostats in the 'Technology' group since the number of participants with a registered smart thermostat of any type was relatively low in the Overnight pilot. It should be noted that meaningful comparisons between those with and without Technology is solely dependent on (1) the incidence rate of Technology ownership within the sample populations, and (2) the availability of data on which customers have such Technology. Objectively verifiable data on smart thermostat ownership exists only for customers who registered their devices with Alectra. Therefore, our estimation of consumption impacts owing to smart thermostats could only be completed using this verified data. Recall that Energate and Nest devices were equipped with some form of load curtailment during peak pricing and so the estimated impacts of smart thermostats (i.e., "Technology") reported here are a measure of the (likely) additive effects of both owning a smart thermostat *and* receiving automatic load curtailment signals.

The number of participants with registered smart thermostats are presented in Table 62. Technology impacts were analyzed only within the Overnight Treatment group because there were no Overnight Standard TOU Control participants with smart thermostats.

Table 62: Number of Overnight Pilot Participants with Registered smart thermostats

	Energate	Ecobee	Nest	Honeywell
Summer Reporting Period				
Overnight Pricing	20	21	31	0
Standard TOU Control	0	0	0	0
Winter Reporting Period				
Overnight Pricing	18	11	17	0
Standard TOU Control	0	0	0	0

Summary statistics for Technology compared to No-Technology households within the Overnight pilot Treatment group are displayed in Table 63. The results of the Technology impact analysis for the Summer and Winter periods are shown in Table 63 and

Table 64. Overall, we observed higher consumption during the Summer Overnight Off-Peak, Off-Peak, and Mid-Peak TOU periods, for households who owned a smart thermostat relative to households who did not report smart thermostat ownership. No significant effects of thermostat ownership were observed during the Winter period.

Table 63: Overnight Pricing Technology (smart thermostats) Mean Hourly kW Consumption Summary Statistics – Summer

Summer 2018		Mean Hourly kW	SD
On-Peak 2018	Technology	1.044	0.724
	No Technology	0.910	0.695
Mid-Peak 2018	Technology	1.054	0.684
	No Technology	0.896	0.628
Off-Peak 2018	Technology	1.453	0.862
	No Technology	1.198	0.761
Overnight Off-Peak 2018	Technology	1.327	1.146
	No Technology	1.054	1.048
Total 2018	Technology	1.220	0.890
	No Technology	1.014	0.808

Table 64: Overnight Pricing Technology (smart thermostats) Mean Hourly kW Consumption Summary Statistics – Winter

Winter 2018-19		Mean Hourly kW	SD
On-Peak 2018	Technology	0.931	1.247
	No Technology	0.903	0.709
Mid-Peak 2018	Technology	0.809	1.161
	No Technology	0.774	0.611
Off-Peak 2018	Technology	1.130	1.313
	No Technology	1.054	0.787
Overnight Off-Peak 2018	Technology	1.110	1.713
	No Technology	0.943	1.135
Total 2018	Technology	0.995	1.369
	No Technology	0.918	0.840

Table 65: Overnight Pricing Technology Summer Impact Analysis Results (Mean Hourly kW)

Summer 2018	Technology	
	Mean Hourly kW	%
On-Peak Effects	0.134^	14.729
Mid-Peak Effects	**0.158***	17.662
Off-Peak Effects	**0.256****	21.304
Overnight Off-Peak Effects	**0.273***	25.953
Total Effects	**0.205***	20.223

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$; ^$p < .10$

Table 66: Overnight Pricing Technology Winter Impact Analysis Results (Mean Hourly kW)

Winter 2018	Technology	
	Mean Hourly kW	%
On-Peak Effects	0.129	16.091
Mid-Peak Effects	0.158	15.236
Off-Peak Effects	0.256	19.725
Overnight Off-Peak Effects	0.273	31.297
Total Effects	0.205	20.854

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$

5.3.4 *Overall Summary*

The impact analyses for the Overnight pricing pilot yield very clear findings. The higher On-Peak price did result in lower On-Peak consumption for Overnight pricing Treatment customers relative to matched Control customers, but only for the Summer reporting period. The most striking finding from the Overnight pilot is the large increase in consumption during the Off-Peak and Super Off-Peak periods (between approximately 0.117 kW per hour and 0.52 kW per hour, respectively) relative to Standard Time-of-Use matched Control customers in the Winter reporting period. The net result of these impacts is an increase in overall electricity consumption owing to the Overnight pricing plan.

Due to lower than expected enrolment rates into the Overnight pricing pilot, non-price communications in the form of Nudge Reports were not distributed to any of the pricing Treatment or Control customers in order to secure sufficient statistical power for the primary impact analysis of the pricing intervention. Non-price interventions in the form of smart thermostat Technology was however assessed for the Overnight pilot. Interestingly, smart thermostats were actually associated with higher electricity consumption in the Overnight pilot; although we speculate that the primary means by which Overnight participants responded to the Overnight pricing signals was via the timing of Electric Vehicle charging, not smart thermostat usage. We hypothesize that some customers shifted their EV charging behaviour so as to capitalize on the especially low Super Off-Peak Overnight prices and it is likely that individuals who purchase EVs are also more likely to acquire and register smart thermostats. In this way, the observed difference in consumption between Technology and No Technology groups within the Overnight pilot, may simply reflect (to some extent) an effect of higher EV ownership in the Technology group relative to the No Technology group.

In summary, the effects of Overnight pricing do not drive conservation, but do demonstrate customer response to price signals, resulting in higher consumption of electricity that is available at low-cost due to system surplus conditions. The extremely low overnight price (2 cents/kWh) incentivized especially high consumption during Off-Peak and Super Off-Peak hours without a commensurate decrease in On-Peak consumption. This pattern was mildly exacerbated by the use of programmable smart thermostats.

5.4 Dynamic Pricing Pilot

5.4.1 *Sample Size and Summary Statistics*

The number of participants for the Dynamic Pricing pilot is displayed in

Table 67. The Dynamic pilot began with 1,540 participants evenly distributed between the four Treatment and Control groups. Households who were part of the Legacy Dynamic pricing pilot (that is, PowerStream legacy customers who were participating in Dynamic pricing prior to the commencement of the current Regulated Price Plan pilot) were not included in these analyses. As the Legacy group has been part of Dynamic pricing for over one year prior to the start of the this most recent pilot program, we cannot compare their consumption behaviour to the same Control group as the new participants; therefore, Legacy Dynamic customers are analyzed separately in the following section. At the end of pilot (April 30, 2019) the number of Treatment participants was 1,153. Participant drop off was due to either households moving out of the service territory, households opting out of the program, missing data[48] or the household consumption was deemed to be an outlier[49]. Summary statistics for the Dynamic pilot are shown in Table 68 and Table 69. Summary statistics are presented as the mean hourly kW consumption (and associated standard deviation (SD)) for a given group (Treatment, Control) for a given pilot for a given time-point (i.e., baseline year, Treatment year).

[48] See Section 4.2.4 Issues or Concerns for further explanation.

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

Table 67: Number of Participants - Dynamic Pilot

Summer Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data[50]	Outliers	Total Exclusions	Final N
Dynamic Pricing, No Nudge Report	385	34	9	0	4	47	338
Dynamic Pricing + Nudge Report	385	29	6	0	5	40	345
Std. TOU Pricing, No Nudge Report	385	0	14	1	6	21	364
Std. TOU Pricing + Nudge Report	385	1	17	0	5	23	362
Total	1540	64	46	1	20	131	1409
Winter Reporting Period							
	Starting N	Opt-Outs	Move-Outs	Missing Data	Outliers	Total Exclusions	Final N
Dynamic Pricing, No Nudge Report	338	25	8	70	0	103	235
Dynamic Pricing + Nudge Report	345	38	4	67	1	110	235
Std. TOU Pricing, No Nudge Report	364	0	20	0	2	22	342
Std. TOU Pricing + Nudge Report	362	4	14	0	3	21	341
Total	1409	67	46	137	6	256	1153

[50] See Section 4.2.4 Issues or Concerns for further explanation.

Table 68: Summary of Consumption in Mean Hourly kW per Condition for Dynamic Pilot (Summer Period)

Summer Period (Mean Hourly kW)		Std. TOU Pricing, No Nudge Report	New Dynamic Pricing, No Nudge Report	Std. TOU Pricing + Nudge Report	New Dynamic Pricing + Nudge Report
High-Peak 2017	Mean	1.185	1.225	1.252	1.175
	SD	0.855	0.974	1.012	0.736
High-Peak 2018	Mean	1.974	1.802	2.072	1.688
	SD	1.204	1.276	1.319	0.994
Medium-Peak 2017	Mean	1.243	1.276	1.301	1.212
	SD	0.817	0.972	0.986	0.702
Medium-Peak 2018	Mean	1.647	1.509	1.718	1.427
	SD	1.011	1.100	1.175	0.852
Low-Peak 2017	Mean	1.102	1.145	1.154	1.078
	SD	0.710	0.870	0.866	0.607
Low-Peak 2018	Mean	1.088	1.053	1.131	0.995
	SD	0.722	0.803	0.860	0.607
Off-Peak 2017	Mean	0.851	0.902	0.892	0.850
	SD	0.545	0.706	0.725	0.475
Off-Peak 2018	Mean	0.966	1.021	1.017	0.971
	SD	0.608	0.726	0.781	0.588
Total 2017	Mean	1.084	1.126	1.137	1.068
	SD	0.750	0.892	0.911	0.648
Total 2018	Mean	1.397	1.331	1.462	1.256
	SD	0.994	1.042	1.131	0.828

Table 69: Summary of Consumption in Mean Hourly kW per Condition for Dynamic Pilot (Winter Period)

Winter Period (Mean Hourly kW)		Std. TOU Pricing, No Nudge Report	New Dynamic Pricing, No Nudge Report	Std. TOU Pricing + Nudge Report	New Dynamic Pricing + Nudge Report
High-Peak 16-17	Mean	1.194	1.170	1.181	1.104
	SD	0.754	0.829	0.799	0.599
High-Peak 18-19	Mean	1.198	1.059	1.216	1.008
	SD	0.733	0.703	0.905	0.523
Medium-Peak 16-17	Mean	1.121	1.085	1.126	1.030
	SD	0.667	0.727	0.760	0.521
Medium-Peak 18-19	Mean	1.154	1.041	1.175	0.985
	SD	0.698	0.699	0.831	0.515
Low-Peak 16-17	Mean	1.047	1.028	1.082	0.986
	SD	0.615	0.723	0.732	0.527
Low-Peak 18-19	Mean	1.096	1.019	1.125	0.949
	SD	0.663	0.696	0.771	0.492
Off-Peak 16-17	Mean	0.864	0.838	0.854	0.800
	SD	0.531	0.604	0.583	0.416
Off-Peak 18-19	Mean	0.918	0.896	0.922	0.865
	SD	0.566	0.578	0.670	0.454
Total 16-17	Mean	1.040	1.014	1.046	0.966
	SD	0.646	0.725	0.725	0.524
Total 18-19	Mean	1.076	0.996	1.094	0.944
	SD	0.666	0.669	0.790	0.496

5.4.2 *Time-of-Use Period Impacts and Seasonal Results with Elasticities*

There was a slight deviation from the prescribed breakdown of Low-, Medium-, and High-On-Peak days. The way Alectra determined the price per day was based on the IESO's overall demand forecast – which is highly correlated to the weather forecast – which is variable and hard to predict. Alectra set a threshold on the demand forecast that will determine if a day is Low, Medium or High. Alectra adjusted the threshold to ensure that the correct number of day-types occurred in each season, while trying to be mindful of creating a consistent experience for customers. This means that, for example, if Alectra anticipated a very hot day late in the Summer season, they would have planned to call a 'High' On-Peak price, but if it turned out to be a fairly mild day in reality, Alectra would instead have called a 'Low' or 'Medium' On-Peak price in order to maintain consistency (from a customer's point of view) between actual experienced weather fluctuation and variable peak prices. For this reason, the realized percentages of Low, Medium, and High On-Peak days may differ slightly from what was prescribed by the OEB.

In Table 70 and Table 71 we report the number of High, Medium, and Low On-Peak days along with the number of CPP days during the pilot period.

Table 70: Dynamic On-Peak and CPP Days (Summer 2018)

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

Days are counted beginning May 1, 2018

Table 71: Dynamic On-Peak and CPP Days (Winter 2018-2019)

Dynamic On-Peak	Number of Days	% of Total	Prescribed by OEB
High	27	22%	20%
Medium	34	27%	30%
Low	63	51%	50%
CPP	6	n/a	n/a

Days are counted beginning November 1, 2018

Because of the difference-in-difference methodology employed to estimate consumption impacts, there is an additional step required in order to determine the appropriate historical baseline consumption period for the estimation of On-Peak TOU period impacts for Dynamic pricing customers. During the pilot period, customers participating in Dynamic pricing experience either a High, Medium, or Low On-Peak price on any given day according to the breakdown in Table 70 and Table 71. This slightly complicates the derivation of historical baseline consumption for each of these three variants of On-Peak pricing, since of course, these customers were not exposed to Dynamic On-Peak prices under status quo TOU pricing in the historical baseline period. We solve for this issue here by capitalizing on the fact that there was a Legacy Dynamic pricing program in effect for a separate group of Alectra customers (results of which are reported in the next section) during the historical baseline period. As a result, we are able to compute historical baseline consumption for Dynamic customers separately for High, Medium, and Low On-Peak days based on whether the weekdays contained within the historical baseline period were called as High, Medium, or Low On-peak days for the Legacy Dynamic pricing customers at that time.

Impacts for Dynamic pricing TOU periods are displayed in

Table 72 and Table 73. Overall, in both the Summer and Winter periods, we observe lower electricity consumption for Dynamic pricing Treatment customers relative to matched Controls during all (High, Medium, and Low) On-Peak periods, and no significant differences in consumption during the Off-Peak hours.

For the Summer months during On-Peak periods (High, Medium, and Low), we observed lower consumption for participants in the Dynamic pricing Treatment condition relative to their matched Control participants on standard TOU of -0.26 kW per hour (12.9%), -0.186 kW per hour (11.2%) and -0.069 kW per hour (6.3%), respectively. For the Winter months during On-Peak periods (High, Medium, and Low), we also observed lower consumption for participants in the Dynamic pricing Treatment condition relative to their matched Control participants on standard TOU of -0.122 kW per hour (10.6%),- 0.085 kW per hour (7.741%) and -0.069 kW per hour (6.6%), respectively.

In comparing Dynamic pricing pilot participants who received monthly Nudge Reports to those who did not receive Nudge Reports, we observed no significant differences in consumption for any of the peak periods in either the Summer or Winter months.

During the System-Coincident Peak hours, results differed between Summer and Winter. In the Summer period we observed -0.161 kW per hour (10.7%) lower consumption relative to Control for Dynamic pricing Treatment customers. In the Winter Period, consumption during System-Coincident Peak hours between Dynamic pricing Treatment and Control customers was not significantly different from 0. System-Coincident Peak hours during the Summer were from 1pm-7pm whereas they were from 6pm-8pm in the Winter. We postulate that individuals are more likely to be home between the hours of 6pm-8pm (vs. 1pm-7pm) resulting in a lower likelihood of conserving energy during these hours.

Table 72: Dynamic Pilot Impact Analysis Results - Summer

Summer	Dynamic Pricing (Main Effect)		Nudge Report (Main Effect)	
	Mean Hourly kW	%	Mean Hourly kW	%
High-Peak Effects	**-0.26*** **	-12.968	-0.015	-0.792
Medium-Peak Effects	**-0.186*** **	-11.245	-0.002	-0.127
Low-Peak Effects	**-0.069*** **	-6.313	0.000	0
Off-Peak Effects	0.000	0	0.007	0.709
System-Coincident Peak	**-0.161*** **	-10.651	-0.003	-0.207

**** p < 0.001; ** p < 0.01; *p < 0.05*

Table 73: Dynamic Pilot Impact Analysis Results - Winter

Winter	Dynamic Pricing (Main Effect)		Nudge Report (Main Effect)	
	Mean Hourly kW	%	Mean Hourly kW	%
High-Peak Effects	**-0.122*** **	-10.558	0.024	2.206
Medium-Peak Effects	**-0.085*** **	-7.741	0.009	0.84
Low-Peak Effects	**-0.069*** **	-6.553	-0.016	-1.519
Off-Peak Effects	0.001	0.114	0.011	1.246
System-Coincident Peak	-0.027	-2.738	0.008	0.824

**** p < 0.001; ** p < 0.01; *p < 0.05*

Seasonal Average Conservation impact estimates are shown in Table 74. Overall, we observed a marginally significant main effect of Dynamic pricing on total Summer electricity consumption with lower consumption of approximately -0.024 kW per hour (2.3%) for Dynamic pricing Treatment customers relative to Control customers, and no significant effect during the Winter months. We observed no interaction effect between Dynamic Pricing and Nudge Report. In terms of year-round impact, we observe lower consumption for those participants receiving Dynamic Pricing of approximately -0.026 kW per hour (2.1%).

Table 74: Dynamic Pilot Seasonal Average Conservation Impact Analysis Results

	Dynamic Pricing		Nudge Report	
	Mean Hourly kW	%	Mean Hourly kW	%
Summer Impact	-0.024^	-2.256	0.005	0.478
Winter Impact	-0.014	-1.528	0.01	1.094
Year-Round Impact	**-0.026*** **	-2.126	0.007	1.226

$*** p < 0.001$; $** p < 0.01$; $*p < 0.05$

In order to compute the appropriate historical baseline consumption required to employ a difference-in-difference approach to the calculation of consumption impacts owing to Critical Peak Pricing (CPP) events, we once again capitalize on the existence of the Legacy Dynamic pricing pilot that was being run with a separate group of customers during the historical baseline period. This means that consumption impacts were calculated for each specific CPP day in the present pilot by first computing the difference between consumption for a given customer during a given CPP day in the current pilot (e.g., Winter, CPP Day 1) and their consumption during the corresponding CPP day in the baseline period. The descriptive statistics for mean hourly kW consumption as a function of CPP day are shown in Tables 75 and 76. The impact estimates for Critical Peak Pricing (CPP) events are shown in

Table 77 and Table 78. We observed consistently lower electricity consumption during CPP hours for the Dynamic pricing Treatment participants relative to Control participants amounting to a 0.282 - 0.407 kW per hour on average (13.9-24.1%) decrease in the Summer months and a 0.094 - 0.319 kW per hour on average (8.1-20.3%) decrease in the Winter months. The average effect of CPP pricing across the 6 CPP events amounted to -0.354 kW per hour (17.2%) lower consumption in the Summer months and -0.168 kW per hour (12.9%) lower consumption during the Winter months for Dynamic pricing Treatment customers relative to Control customers on status-quo TOU pricing. The overall impact of Nudge Reports on consumption for CPP days was not significant. Full results for each individual day can be found in Appendix I.

Table 75: Summary of Consumption in Mean Hourly kW per Dynamic Pilot Critical Peak Day (Summer Period)

Summer 2018 CPP		Std. TOU Pricing, No Nudge Report	New Dynamic Pricing, No Nudge Report	Std. TOU Pricing + Nudge Report	New Dynamic Pricing + Nudge Report
CPP Day 1	Mean	1.977	1.696	2.077	1.582
	SD	1.441	1.600	1.568	1.254
CPP Day 2	Mean	2.500	2.181	2.556	2.014
	SD	1.664	1.636	1.62	1.346
CPP Day 3	Mean	2.113	1.819	2.075	1.676
	SD	1.473	1.503	1.58	1.242
CPP Day 4	Mean	1.562	1.309	1.804	1.26
	SD	1.277	1.246	1.571	1.044
CPP Day 5	Mean	1.914	1.612	2.068	1.562
	SD	1.461	1.391	1.588	1.326
CPP Day 6	Mean	2.208	1.906	2.346	1.777
	SD	1.523	1.65	1.663	1.295
Total	Mean	2.046	1.754	2.154	1.645
	SD	1.505	1.534	1.616	1.276

Table 76: Summary of Consumption in Mean Hourly kW per Dynamic Pilot Critical Peak Day (Winter Period)

Winter 2018-2019 CPP		Std. TOU Pricing, No Nudge Report	New Dynamic Pricing, No Nudge Report	Std. TOU Pricing + Nudge Report	New Dynamic Pricing + Nudge Report
CPP Day 1	Mean	1.488	1.269	1.583	1.23
	SD	1.125	0.949	1.359	0.91
CPP Day 2	Mean	1.454	1.265	1.497	1.193
	SD	1.096	0.983	1.255	0.776
CPP Day 3	Mean	1.289	1.062	1.333	1.064
	SD	0.966	0.833	1.177	0.741
CPP Day 4	Mean	1.228	1.103	1.322	1.039
	SD	0.956	0.866	1.062	0.704
CPP Day 5	Mean	1.33	1.108	1.347	1.135
	SD	1.222	0.872	1.129	0.786
CPP Day 6	Mean	1.201	1.097	1.245	1.04
	SD	0.894	0.955	1.14	0.746
Total	Mean	1.326	1.146	1.383	1.113
	SD	1.052	0.911	1.193	0.783

Table 77: Dynamic Pilot Critical Peak Day Impact Analysis Results (Summer)

Summer 2018 CPP	Dynamic Pricing (Main Effect)	
	Mean Hourly kW	%
CPP Day 1	**-0.375*** **	-18.62
CPP Day 2	**-0.329*** **	-13.559
CPP Day 3	**-0.282*** **	-13.895
CPP Day 4	**-0.407*** **	-24.061
CPP Day 5	**-0.361*** **	-18.532
CPP Day 6	**-0.365*** **	-16.542
Total	**-0.354*** **	-17.239

**** p < 0.001; ** p < 0.01; *p < 0.05*

Table 78: Dynamic Pilot Critical Peak Day Impact Analysis Results (Winter)

Winter 2018-2019 CPP	Dynamic Pricing (Main Effect)	
	Mean Hourly kW	%
CPP Day 1	**-0.319*** **	-20.338
CPP Day 2	**-0.113* **	-8.42
CPP Day 3	**-0.139*** **	-11.564
CPP Day 4	**-0.189*** **	-15
CPP Day 5	**-0.158*** **	-12.349
CPP Day 6	-0.094^	-8.086
Total	**-0.168*** **	-12.948

**** p < 0.001; ** p < 0.01; *p < 0.05*

Daily and Substitution Elasticities are reported in Table 79. Daily elasticity of demand was estimated at -0.151. The daily elasticity of demand was negative and less than 1, indicating an inconsequential change in percent consumption per percent increase in price. Substitution elasticity of demand was estimated at -0.054 again, indicating an inconsequential change in percent consumption per percent increase in price.

Table 79: Dynamic Pilot Daily and Substitution Elasticities of Demand

	Elasticity Estimate
Daily Elasticity	**-0.151*** **
Substitution Elasticity On/Off-Peak	**-0.054*** **

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

5.4.3 *Technology Impacts*

Technology analyses were conducted in the same manner as for the other pilots. Dynamic pricing households were designated as "Technology" if they registered an eligible smart thermostat for load curtailment at the commencement of the pilot. Again, since objectively verifiable data on smart thermostat ownership exists only for customers who registered their devices through Alectra, our estimation of consumption impacts owing to smart thermostats could only be completed using this verified data. Recall that all registered devices were equipped with some form of load curtailment during peak pricing events within Dynamic pricing and so the estimated impacts of smart thermostats (i.e., "Technology") reported here are a measure of the (likely) additive effects of both owning a smart thermostat *and* receiving automatic load curtailment signals. The number of registered thermostats as a function of group and thermostat type for the Dynamic pricing Pilot is shown in Table 80.

Table 80: Number of Dynamic Pilot participants with registered smart thermostats

Summer 2018	Energate	Ecobee	Nest	Honeywell	Unknown[51]
New Dynamic Pricing + Nudge Report	35	22	29	0	3
New Dynamic Pricing, No Nudge Report	37	9	24	0	1
Standard TOU Pricing + Nudge Report	6	2	0	0	0
Standard TOU Pricing, No Nudge Report	2	0	0	0	0
Winter 2018-2019	Energate	Ecobee	Nest	Honeywell	Unknown
New Dynamic Pricing + Nudge Report	24	14	10	0	1
New Dynamic Pricing, No Nudge Report	24	5	13	0	0
Standard TOU Pricing + Nudge Report	6	2	0	0	0
Standard TOU Pricing, No Nudge Report	2	0	0	0	0

Technology impacts were analyzed only within the Dynamic pricing Treatment group due to an insufficient number of status-quo TOU control participants with registered smart thermostats. Summaries of mean hourly kW consumption for each condition are presented in

Table 81 for the Summer period and

[51] A small number of households had duplicate smart thermostatsmart thermostat registrations for different thermostat types. These households were included a single time in all analyses comparing households with and without smart thermostats.

Table 82 for Winter, and the resulting impact estimates owing to smart thermostats for each of the Summer and Winter periods are shown in Table 83 and

Table 84. We observed no significant effect of Technology among Dynamic pricing Treatment households during the Summer months (Table 83), while significantly lower consumption owing to Technology was observed for all Dynamic pricing TOU periods during the Winter period (

Table 84; total reduction of- 0.114 kW per hour, 11.5%). Ownership of registered smart thermostats yielded additional incremental electricity consumption savings during CPP days within the Dynamic pricing Treatment households; however, these savings only reached statistical significance on Day 4 in the Summer (-0.117 kW per hour,13.3%) and Day 3 (-0.169 kW per hour, 15.2%), as well as Day 6 (-0.219 kW per hour, 19.5%) in the Winter.

Table 81: Dynamic Pricing Technology (smart thermostats) Consumption Summary Statistics – Summer

Summer 2018		Mean Hourly kW	SD
High-Peak	Technology	1.696	1.054
	No Technology	1.759	1.169
Medium-Peak	Technology	1.450	0.891
	No Technology	1.473	1.010
Low-Peak	Technology	1.007	0.660
	No Technology	1.028	0.726
Off-Peak	Technology	0.984	0.618
	No Technology	1.000	0.673
Total	Technology	1.270	0.870
	No Technology	1.300	0.961

Table 82: Dynamic Pricing Technology (smart thermostats) Consumption Summary Statistics – Winter

Winter 2018-2019		Mean Hourly kW	SD
High-Peak	Technology	0.916	0.485
	No Technology	1.062	0.645
Medium-Peak	Technology	0.926	0.503
	No Technology	1.034	0.637
Low-Peak	Technology	0.896	0.496
	No Technology	1.005	0.625
Off-Peak	Technology	0.789	0.394
	No Technology	0.903	0.544
Total	Technology	0.877	0.473
	No Technology	0.992	0.612

Table 83: Dynamic Pricing Technology Summer Impact Analysis Results (Mean Hourly kW)

Summer 2018 (Mean Hourly kW)	Technology	
	Mean Hourly kW	%
High-Peak Effects	-0.062	-3.541
Medium-Peak Effects	-0.023	-1.538
Low-Peak Effects	-0.022	-2.131
Off-Peak Effects	-0.015	-1.527
Total Effects	-0.031	-2.347

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$

Table 84: Dynamic Pricing Technology Winter Impact Analysis Results (Mean Hourly kW)

Winter 2018-19 (Mean Hourly kW)	Technology	
	Mean Hourly kW	%
High-Peak Effects	**-0.145***	-13.704
Medium-Peak Effects	**-0.110***	-10.626
Low-Peak Effects	**-0.110***	-10.894
Off-Peak Effects	**-0.110****	-12.241
Total Effects	**-0.114***	-11.531

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$

Table 85: Dynamic Pricing CPP Days Technology Impact Analysis (Summer)

Summer 2018 CPP Consumption (Mean Hourly kW)						
	Technology		No Technology		Technology Impact Analysis Results	
	Mean	SD	Mean	SD	kWh	%
CPP Day 1	1.573	1.231	1.875	1.514	-0.107	-6.379
CPP Day 2	1.966	1.42	2.367	1.605	-0.227^	-10.351
CPP Day 3	1.683	1.296	1.959	1.487	-0.109	-6.1
CPP Day 4	1.15	0.993	1.536	1.352	-**0.177***	-13.321
CPP Day 5	1.5	1.321	1.835	1.475	-0.146	-8.876
CPP Day 6	1.765	1.477	2.106	1.563	-0.118	-6.276
Total	1.606	1.322	1.946	1.523	-0.150	-8.544

*** $p < 0.001$; ** $p < 0.01$; *$p < 0.05$; ^ $p < 0.1$

Table 86: Dynamic Pricing CPP Days Technology Impact Analysis (Winter)

Winter 2018-19 Consumption (Mean Hourly kW)						
	Technology		No Technology		Technology Impact Analysis Results	
	Mean	SD	Mean	SD	kWh	%
CPP Day 1	1.190	0.853	1.441	1.159	-0.071	-5.613
CPP Day 2	1.190	0.742	1.399	1.099	-0.139	-10.43
CPP Day 3	0.939	0.630	1.236	1.000	**-0.169***	-15.216
CPP Day 4	0.976	0.733	1.212	0.947	-0.137^	-12.323
CPP Day 5	1.047	0.744	1.270	1.078	-0.133	-11.301
CPP Day 6	0.904	0.711	1.184	0.980	**-0.219***	-19.523
Total	1.027	0.745	1.286	1.048	-0.145^	-12.344

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

The qualitative differences observed for the impacts of Technology across the Summer and Winter months is perhaps surprising and merits further discussion. Upon examination of the consumption impacts attributable to Technology in the Summer and Winter months for Dynamic customers, one would expect that they are quite small, or even absent for the Winter months. This owes to the fact that the primary means by which we expect smart thermostats to confer consumption reductions is via automatic load curtailment. Since the vast majority of households are heated in the Winter by natural gas, the only electricity curtailment delivered automatically by registered smart thermostats in the Winter is the run time of the furnace fan. Given that the fan is a relatively low electricity consumer relative to Air Conditioning systems that are curtailed in the Summer, we would expect that load curtailment alone would yield larger consumption reductions in the Summer (when A/C units are curtailed) than in Winter (when only furnace fan run times are curtailed). Given that the observed Technology impacts are not in line with this expectation (i.e., we see significant incremental savings owing to smart thermostats for all Dynamic TOU periods in the Winter but not the Summer), we conclude that incremental consumption reductions owing to smart thermostats are only partially delivered via automatic load curtailment. We argue that in addition to registering smart thermostats to benefit from automatic load curtailment, individuals who simply acquire such devices voluntarily represent a sub-group of the population that is more likely to exhibit behavioural response to pricing signals. That is, there is inherent selection bias in the sample who opt-in to receive, or purchase of their own accord, a smart thermostat.

We hypothesize that smart thermostat owners may simply be more energy conscious in general than non-thermostat owners and may also avail themselves of other energy saving technologies that would increase their behavioural response to Dynamic pricing relative to non-thermostat owners. Indeed, we see evidence of this in the fact that Technology owners show statistically significant reductions in Off-Peak consumption during the Winter season relative to non-Technology owners. Given that there was no automatic load curtailment during off-peak hours, the difference in consumption between Technology and no-Technology groups must be due to some other factor. Again, this may indicate that some proportion of all observed 'Technology' effects are not being driven solely by load curtailment enablement, but rather, by intrinsic group differences between those Dynamic participants that opted in to receive and/or register a smart thermostat and those that did not.

Given the selection bias hypothesis forwarded here, we posit that there are two (likely) additive factors that drive consumption reductions among smart thermostat owners relative to non-owners: (1) smart thermostat owners use less electricity in general, by virtue of some unobserved variable (e.g., use of other energy efficient technologies, environmental consciousness, etc.), and (2) consumption reductions delivered via automatic load curtailment. If we assume that factor (1) applies equally in the Summer and Winter months and that factor (2) applies more so in the Summer months when high consumption A/C units are being curtailed, we should still be left with (at least marginally) higher observed impacts owing to smart thermostat ownership in the Summer than in the Winter. Thus, even if the selection bias hypothesis adequately accounts for at least some of the behavioural response observed for Dynamic customers in the Winter months, additional explanation is required to fully explain the similarity in observed consumption reduction observed between Summer and Winter.

Another explanation is customers are more likely to manually override load curtailment settings in the summer months. All of the automatic load-curtailment enabled smart thermostats registered with Alectra Utilities can still be manually controlled by customers during curtailment events. This means that during Variable On-Peak and Critical Peak TOU periods, Dynamic participants can override the adjustments made to temperature settings and/or run times of furnace fans and A/C units. It is therefore possible, that customers were allowing automatic load curtailment to impart its full effect on electricity consumption during variable On-Peak events in the Winter months, but were more likely to override curtailment settings during those events in the Summer months, thus diminishing the amount of the observed consumption impacts during the Summer that was delivered via curtailment. This would result in Summer and Winter peak period consumption impacts owing to smart thermostats that are comparable in magnitude, or even larger in the Winter relative to the Summer; the pattern of findings we observe here. We are careful to note however, that while we do have evidence to support the hypothesis that smart thermostat owners are a biased sample of electricity consumers relative to non-owners, our hypothesis of asymmetric overriding of curtailment settings across the Summer and Winter months is merely speculative and is an attempt to provide a plausible explanation for a counter-intuitive pattern of results in a post-hoc manner.

5.4.4 *Pledge Analysis*

Finally, we examined consumption impacts between households who responded to the On-Peak conservation pledge on the Nudge Report versus households who received the Nudge Reports but did not respond to the pledge. Recall that households had the option to respond to the pledge via SMS text message to commit to reducing their On-Peak electricity consumption. Households who chose to respond to the pledge were offered a $5 rebate. The number of participants in each of the comparison groups and the resulting impacts are shown in Table 87. Unfortunately, there were insufficient numbers of pledge participants to conduct an analysis that would drive meaningful impacts.

Table 87: Pledge Numbers

	Std. TOU Control, Pledge Not Signed	Std. TOU Control, Pledge Signed	Dynamic Pricing, Pledge Not Signed	Dynamic Pricing, Pledge Signed
Summer 2018	362	0	318	27
Winter 2019	341	0	219	16

5.4.5 *Overall Summary*

Of the three pricing pilots being assessed as part of Advantage Power Pricing, Dynamic pricing is the most complex owing to the variable On-Peak pricing periods as well as the Critical Peak Pricing events. Given that the ratio of Off-Peak price to High-On-Peak and CPP periods is quite high relative to status-quo TOU pricing, it was hypothesized that this would provide a strong incentive for Dynamic pricing customers to curtail their electricity consumption behaviour in order to realize bill savings. The observed impacts were highly consistent with this hypothesis as customers in Dynamic pricing exhibited lower electricity consumption relative to matched Control participants, with observed reductions for the On- Medium- and Low- On-Peak periods of -0.26 kW per hour (12.9%), -0.186 kW per hour (11.2%) and -0.069 kW per hour (6.3%) respectively during the Summer, and -0.122 kW per hour (10.6%), -0.085 kW per hour (7.7%) and -0.069 kW per hour (6.6%) respectively during the Winter.

Likewise, large conservation impacts were observed during CPP events, in which Dynamic pricing Treatment customers consumed on average about -0.168 kW per hour (12.9%) to -0.407 kW per hour (24.06%) less electricity during CPP event hours compared to matched Controls during those same hours. The electricity consumption reductions owing to Dynamic pricing during On-Peak and CPP periods yielded marginally significant overall lower average consumption of -0.024 kW per hour (2.3%) in the Summer; however, the lower overall consumption seen for Dynamic pricing Treatment households relative to status-quo TOU Control households in the Winter of -0.014 kW per hour (1.5%) did not reach statistical significance.

In terms of non-price communications, Dynamic pricing Treatment and Control customers who received Nudge Reports exhibited similar consumption patterns to customers who did not receive Nudge Reports during Low, Medium, and High On-Peak periods, as well as on CPP days.

Finally, Dynamic pricing Treatment customers who registered a smart thermostat through participation in Alectra’s thermostat incentive program exhibited additional incremental consumption savings relative to Dynamic pricing Treatment customers who did not posses a registered smart thermostat. Interestingly, these incremental savings were observed during all

Winter Dynamic TOU periods, but not Summer Dynamic TOU periods. Incremental consumption savings owing to smart thermostats were also observed during all CPP event hours in the Summer and Winter months.

Overall, Dynamic pricing resulted in dramatic reductions in On-Peak electricity consumption relative to Standard TOU pricing. These impacts were largest during High On-Peak days and CPP event days, indicating that strong pricing signals can act as a meaningful incentive for the curtailment of residential electricity consumption. Importantly, these savings were enhanced in some instances as a result of non-price communications in the form of Nudge Reports (for the Summer months) as well as ownership of curtailment-enabled smart thermostat Technology.

5.5 Legacy Dynamic Pricing Pilot

5.5.1 *Sample Size and Summary Statistics*

The results of the Dynamic pricing pilot estimated the effects of Dynamic pricing on newly enrolled households during the enrolment period beginning in November 2017 and ending in March 2018. These 'new' Dynamic participants were recruited via Advantage Power Pricing (APP) marketing materials as part of the Regulated Price Plan pilot project, and Dynamic pricing impacts related to these newly enrolled customers were described in detail in the previous section. However, there exist approximately 1,500 households who enrolled in Dynamic pricing between 2015-2016 as part of previous instantiations of Alectra's APP program (herein referred to as 'Legacy Dynamic' customers) and have been exposed to Dynamic pricing over a longer period of time. These Legacy Dynamic customers were encouraged to remain in Dynamic pricing as part of the most recent RPP pilot. We analyze Legacy Dynamic pricing impacts independently of new Dynamic pricing impacts for three important reasons:

1. The former (Legacy) Dynamic pricing initiative offered to customers by Alectra was run with full price protection. This means that as of their enrollment date in Dynamic pricing until the beginning of the recruitment period for the instantiation of APP described in this report, all participants were not financially penalized if their APP bill amounts were greater than what they would have been billed under status quo TOU. Because it is unknown how extended exposure to price protection affects customer responsiveness to alternative pricing schemes, we consider Legacy Dynamic customers to be a qualitatively distinct group relative to new Dynamic customers.

2. The Legacy Dynamic pricing program began in 2014, meaning that the employment of a difference-in-difference approach to impact estimation is problematic. Mainly, in order to compare consumption in the Treatment period (May 01, 2018 – April 30, 2019) to a pre-Treatment historical baseline period, a historical data set that is (in many cases) over four years old would have to be used. This is further complicated by the fact that Legacy Dynamic pricing customers enrolled into Dynamic pricing at 3 different historical time periods, meaning that different historical baseline periods would have to be used for different groups of customers within the Legacy Dynamic customer group (this is discussed further below).

3. Legacy Dynamic customers are compared to a separate matched Control group than the New Dynamic customers. Moreover, whereas the new Dynamic customers are compared to a single matched Control group, Legacy Dynamic customers were assigned separate Control groups for each of the Summer and Winter months.

The longevity of Legacy Dynamic pricing customers in the program affords us the opportunity to estimate how Dynamic Pricing affects customers over an extended period of time. Due to missing data, Winter dates from 2015-2016 and 2016-2017 were not available.

As discussed above, the procedure for measuring effects of Dynamic pricing on consumption for the Legacy households is distinct form the difference-in-difference methodology employed for the estimation of impacts in all other pilot groups in this report. Instead, the Legacy Dynamic impact estimates will simply derive from a comparison (using linear regression) of consumption between the Treatment and Control groups for each year between 2014-2018. Furthermore, as participants in the Legacy Dynamic pricing group enrolled into the pilot at different time-points, a procedure for measuring the varying durations of exposure to Dynamic pricing within the Legacy group is required. Registration dates for Legacy Dynamic customers are shown in Table 88**.**

Table 88: Breakdown of Registration Dates for Legacy Dynamic Participants

	On or Before May 1, 2015	October 1, 2015 – May 4, 2016	After June 1, 2016
Number of Registrations	978	787	55

The observed registration dates in Table 88 reveal three natural groups, or ‘waves’, of customer enrollment. 978 households enrolled on or before May 01, 2015 (the first instantiation of Dynamic pricing offered to customers by Alectra). The next major registration period was between October 01, 2015 – May 04, 2016. These 787 households would not have been exposed to Dynamic pricing in the Summer of 2015 but would have been exposed to Dynamic pricing during the Summer of 2016. The remaining 55 households signed up after June 01, 2016, meaning that 2017 would have been the earliest full summer exposure to Dynamic pricing for this group. Based on these observations, we define two distinct bins of households for which consumption impacts will be estimated: Registration Bin 1 (registration date on or before May 01, 2015) and Registration Bin 2 (registration date between October 01, 2015 and May 04, 2016). Households in Registration Bin 3 (registration after June 01, 2016) were excluded from the analysis as the sample size was too small to allow for the derivation of meaningful impacts.

The sample sizes used for impact estimation for the Legacy Dynamic pilot are displayed in

Table 89, including the breakdown of attrition rates due to either households moving out of the service territory, households opting out of the program, missing data[52], or because household consumption was deemed to be an outlier[53]. Furthermore, we observed that some households signed up for, or were erroneously assigned to, more than one pilot group (i.e. overlap with Enhanced, Dynamic, and Overnight). As a result of this, these "conflict with other pilot" households were removed from the analysis, however the number of these households was relatively small. Note that unlike in the "new" Dynamic pilot, separate matched Control groups were created for Summer and Winter months (as per Potter et al., 2016)[54]. Therefore, we conducted Control and Treatment pairwise elimination. This means that if a Treatment participant was removed, we removed their corresponding matched Control, and vice versa. In our case, this led to higher numbers of Legacy Dynamic pricing participants in the Winter analysis compared to the Summer. These participants were excluded when their Summer matched Control was removed and were added back into the Winter analysis provided that their Winter matched Control household was still within the service territory.

[52]Any household who had missing data for any hour throughout the period of analysis was removed.
[53]An outlier was defined as any household who consumed more than 15kWh per hour, less than 0.05kWh per hour during any hour in the analysis period
[54] Potter, Candice., Jain, Ankit., Thompson, Daniel., and Cumming, Trevor., (2016) "peaksaverPLUS Program 2015 Load Impact Evaluation" *Nexant, Inc.*

Table 89: Number of Participants for Legacy Dynamic Pilot

Bin 1 (registration date on or before May 1, 2015)									
	Initial N	Opt-Outs	Move-Outs	Conflict with Other Pilots	Missing Data	Outliers	Removal of Matched Exclusions	Total Exclusions	Final N
Summer Period									
Legacy Dynamic	778	3	34	5	15	4	53	114	664
Std TOU Control	778	4	0	30	13	9	58	114	664
Winter Period									
Legacy Dynamic	839	2	36	7	18	6	42	111	728
Std TOU Control	839	7	2	26	6	5	65	111	728
Bin 2 (registration date between October 1, 2015 and May 4, 2016)									
	Initial N	Opt-Outs	Move-Outs	Conflict with Other Pilots	Missing Data	Outliers	Removal of Matched Exclusions	Total Exclusions	Final N
Summer Period									
Legacy Dynamic	650	41	34	6	9	16	41	147	503
Std TOU Control	650	2	2	21	9	19	94	147	503
Winter Period									
Legacy Dynamic	639	36	37	8	13	8	39	141	498
Std TOU Control	639	1	1	29	10	9	91	141	498

Next, we present a summary of average hourly kW consumption for the Legacy Dynamic pilot from 2014 through 2018 shown separately for the two registration bins for Summer (Table 90) and Winter (Table 91). Despite the fact that we do not employ a difference-in-difference approach to impact estimation for Legacy Dynamic customers, we present summary statistics for consumption in the year(s) prior to program participation (the 'baseline' year) for customers in both registration bins. Note that for Registration Bin 1, the Summer baseline year was 2014 and the Winter baseline year was 2014-2015, whereas for Registration Bin 2, the Summer baseline years were 2014 and 2015 and the Winter baseline year was 2014-2015.

Table 90: Legacy Dynamic Pilot Summary Statistics of Mean Hourly Consumption (kW) (Summer Period)

Summer Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
High-Peak 2014	Mean	1.217	1.316	1.257	1.178	1.254	1.190
	SD	0.700	0.822	0.726	0.775	0.822	0.805
High-Peak 2015	Mean	1.860	1.538	1.489	1.750	1.844	1.820
	SD	0.939	0.914	0.858	1.012	1.096	1.055
High-Peak 2016	Mean	2.032	1.702	1.671	1.887	1.747	1.729
	SD	1.056	1.005	1.002	1.065	1.112	1.134
High-Peak 2017	Mean	1.535	1.232	1.285	1.463	1.426	1.340
	SD	0.845	0.795	0.829	0.874	0.997	0.928
High-Peak 2018	Mean	1.921	1.759	1.795	1.811	1.775	1.718
	SD	1.044	1.036	1.077	1.050	1.235	1.090
Medium-Peak 2014	Mean	1.273	1.376	1.316	1.223	1.295	1.237
	SD	0.725	0.846	0.750	0.795	0.855	0.832
Medium-Peak 2015	Mean	1.327	1.247	1.193	1.264	1.384	1.328
	SD	0.828	0.820	0.754	0.881	0.961	0.922
Medium-Peak 2016	Mean	1.553	1.431	1.389	1.452	1.407	1.403
	SD	0.907	0.909	0.869	0.926	0.965	0.985
Medium-Peak 2017	Mean	1.134	1.013	1.038	1.113	1.146	1.061
	SD	0.707	0.671	0.661	0.749	0.821	0.786
Medium-Peak 2018	Mean	1.570	1.489	1.502	1.488	1.488	1.410
	SD	0.894	0.892	0.889	0.910	1.046	0.909

Summer Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
Low-Peak 2014	Mean	1.190	1.283	1.225	1.159	1.235	1.161
	SD	0.675	0.790	0.700	0.752	0.803	0.779
Low-Peak 2015	Mean	1.030	1.038	1.008	1.002	1.116	1.045
	SD	0.631	0.659	0.630	0.691	0.769	0.754
Low-Peak 2016	Mean	1.017	1.046	0.992	0.974	1.021	0.992
	SD	0.639	0.702	0.630	0.656	0.720	0.731
Low-Peak 2017	Mean	0.916	0.881	0.881	0.909	0.963	0.898
	SD	0.540	0.573	0.534	0.585	0.644	0.662
Low-Peak 2018	Mean	0.996	1.028	1.021	0.970	1.044	0.982
	SD	0.613	0.638	0.617	0.647	0.733	0.680
Off-Peak 2014	Mean	0.852	0.902	0.876	0.853	0.903	0.840
	SD	0.480	0.569	0.511	0.577	0.596	0.591
Off-Peak 2015	Mean	0.875	0.961	0.953	0.872	0.949	0.887
	SD	0.500	0.569	0.574	0.590	0.610	0.608
Off-Peak 2016	Mean	0.941	1.053	1.035	0.912	1.021	0.963
	SD	0.542	0.653	0.601	0.593	0.656	0.639
Off-Peak 2017	Mean	0.796	0.914	0.925	0.799	0.905	0.848
	SD	0.465	0.609	0.536	0.520	0.600	0.610
Off-Peak 2018	Mean	0.909	1.022	1.013	0.905	1.005	0.952
	SD	0.527	0.626	0.582	0.590	0.662	0.620
Total Consumption 2014	Mean	1.116	1.200	1.150	1.088	1.156	1.091
	SD	0.664	0.777	0.691	0.737	0.782	0.765
Total Consumption 2015	Mean	1.325	1.178	1.142	1.263	1.356	1.305
	SD	0.937	0.834	0.792	0.957	1.011	1.011
Total Consumption 2016	Mean	1.502	1.361	1.319	1.410	1.364	1.341
	SD	1.032	0.954	0.913	1.015	1.006	1.030
Total Consumption 2017	Mean	1.145	1.040	1.060	1.115	1.141	1.066
	SD	0.786	0.729	0.721	0.799	0.856	0.824

Summer Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
Total Consumption 2018	Mean	1.412	1.361	1.373	1.355	1.378	1.307
	SD	0.939	0.909	0.922	0.945	1.036	0.935

Table 91: Legacy Dynamic Pilot Summary Statistics of Mean Hourly Consumption (kW) (Winter Period)

Winter Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
High-Peak 2014-2015	Mean	1.224	1.211	1.182	1.6	1.7	1.62
	SD	0.623	0.626	0.555	1.35	1.45	1.268
High-Peak 2015-2016	Mean	1.027	1.063	1.021	1.27	1.24	1.208
	SD	0.501	0.559	0.528	0.96	0.88	0.831
High-Peak 2016-2017	Mean	0.995	0.992	0.979	1.24	1.2	1.2
	SD	0.482	0.551	0.496	1.02	0.92	0.908
High-Peak 2017-2018	Mean	1.068	1.087	1.079	1.4	1.4	1.347
	SD	0.571	0.706	0.613	1.32	1.2	1.135
High-Peak 2018-2019	Mean	1.076	1.07	1.071	1.41	1.43	1.389
	SD	0.559	0.586	0.598	1.34	1.26	1.21
Medium-Peak 2014-2015	Mean	1.216	1.23	1.188	1.55	1.61	1.544
	SD	0.615	0.626	0.555	1.23	1.32	1.167
Medium-Peak 2015-2016	Mean	--	--	--	--	--	--
	SD	--	--	--	--	--	--
Medium-Peak 2016-2017	Mean	--	--	--	--	--	--
	SD	--	--	--	--	--	--
Medium-Peak 2017-2018	Mean	1.023	1.062	1.051	1.29	1.3	1.275
	SD	0.504	0.601	0.555	1.12	0.99	0.966
Medium-Peak 2018-2019	Mean	1.032	1.05	1.049	1.27	1.3	1.274
	SD	0.54	0.583	0.584	1.11	1.03	1.056

Winter Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
Low-Peak 2014-2015	Mean	1.112	1.14	1.091	1.35	1.41	1.349
	SD	0.559	0.591	0.522	0.98	1.03	0.934
Low-Peak 2015-2016	Mean	--	--	--	--	--	--
	SD	--	--	--	--	--	--
Low-Peak 2016-2017	Mean	--	--	--	--	--	--
	SD	--	--	--	--	--	--
Low-Peak 2017-2018	Mean	0.956	1.008	1.005	1.15	1.16	1.144
	SD	0.485	0.577	0.564	0.92	0.81	0.813
Low-Peak 2018-2019	Mean	0.997	1.022	1.023	1.18	1.21	1.181
	SD	0.52	0.57	0.551	0.95	0.89	0.886
Off-Peak 2014-2015	Mean	0.923	0.933	0.904	1.24	1.28	1.233
	SD	0.489	0.481	0.44	1.14	1.19	1.095
Off-Peak 2015-2016	Mean	0.807	0.891	0.857	1.06	1.09	1.059
	SD	0.404	0.48	0.427	0.9	0.86	0.858
Off-Peak 2016-2017	Mean	0.788	0.873	0.85	1.03	1.09	1.073
	SD	0.392	0.506	0.403	0.94	0.92	0.933
Off-Peak 2017-2018	Mean	0.812	0.896	0.89	1.08	1.17	1.137
	SD	0.408	0.539	0.453	1.06	1	1.037
Off-Peak 2018-2019	Mean	0.826	0.883	0.883	1.08	1.17	1.164
	SD	0.432	0.511	0.462	1.05	1.03	1.069
Total 2014-2015	Mean	1.065	1.073	1.038	1.38	1.44	1.37
	SD	0.585	0.597	0.549	1.2	1.28	1.13
Total 2015-2016	Mean	0.932	0.974	0.939	1.2	1.19	1.154
	SD	0.488	0.549	0.509	1.01	0.94	0.913
Total 2016-2017	Mean	0.916	0.948	0.93	1.17	1.16	1.164
	SD	0.48	0.562	0.479	1.04	0.94	0.953
Total 2017-2018	Mean	0.965	1.011	1.004	1.24	1.27	1.228
	SD	0.507	0.613	0.56	1.14	1.03	1.012

Winter Period (Mean Hourly kW)		Registration Bin 1			Registration Bin 2		
		Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report	Std TOU Control, No Nudge Report	Dynamic Pricing, No Nudge Report	Dynamic Pricing + Nudge Report
Total 2018-2019	Mean	0.999	1.019	1.02	1.26	1.3	1.269
	SD	0.545	0.584	0.579	1.16	1.1	1.091

5.5.2 *Time-of-Use Period Impacts and Seasonal Results with Elasticities*

Impact estimates for On-Peak (High, Medium, Low), Off-Peak, CPP Days, and System-Coincident Peak TOU periods are displayed in Table 92 (Summer) and

Table 94 (Winter), while percentage calculations of those effects are presented in

Table 93 and

Table 95. In order to derive impacts for High, Medium, and Low On-Peak hours during the baseline (pre-pilot) years, we used the following approach: For Registration Bin 1, we used temperature data for Summer and Winter weekdays in the baseline year to rank order the days and then assigned the warmest 20% to 'High On-Peak', the next warmest 30% to 'Medium On-Peak' and the next warmest 50% to 'Low On-Peak' for Summer months (for Winter months, the days were ranked in reverse from coldest to warmest). For Registration Bin 2, we capitalized on the pre-existing assignment of On-Peak days to Low, Medium, and High for the Legacy Dynamic participants in registration Bin 1 where possible, and where this was not possible, we again relied on temperature data to infer whether a given day would have likely been assigned to Low, Medium, or High On-Peak.

Legacy Dynamic pricing Treatment households consumed less Summer High On-Peak electricity than status-quo TOU Control pricing households during all Treatment years (Bin 1 - 2015-2018; Bin 2 - 2016-2018). For Registration Bin 1, households in the Treatment group consumed on average -0.35kW, -0.35kW, -0.28kW, and -0.14kW less electricity per hour on average (relative to Control) during High On-Peak hours in 2015, 2016, 2017, and 2018 respectively. For Registration Bin 2, the effect was -0.15kW, -0.08kW, and -0.07kW in 2016, 2017, and 2018 respectively. We also observed a significant difference during the Summer baseline periods between Legacy Dynamic pricing Control and Treatment groups. In both Registration Bins, High On-Peak consumption was higher among Treatment households in the baseline year before the program began. This would suggest that the impact estimates could be underestimating the true Treatment impact. No differences between pricing groups were observed for any of the High On-Peak Winter TOU periods across the years examined here.

With respect to the Summer Medium On-Peak hours in Registration Bin 1, the effects were similar to those observed during the High On-Peak hours. Treatment households had higher electricity consumption at baseline than the control group, followed by lower consumption for the Legacy Dynamic Treatment customers relative to control in all Treatment years (-0.075 to 0.143 kW per hour). We did not observe significant differences in consumption between Legacy Dynamic pricing Treatment and Control households during the Treatment years for Summer Medium On-Peak TOU periods. Similar to the High On-Peak results, we observed minimal significant differences between Treatment and Control households during the Winter Medium On-Peak periods for either Registration Bin (i.e. only +0.034 kW per hour in Bin 1 during 2017-2018).

With respect to Low On-Peak electricity consumption both registration bins had higher consumption than status quo TOU control household during the Summer baseline year. Differences between Treatment and Control customers during Summer and Winter Treatment periods ranged between -0.035 kW per hour and +0.076 kW per hour, with higher consumption observed more often than lower consumption for Legacy Dynamic Treatment households relative to Control households, and most years showing no significant differences between pricing groups.

Legacy Dynamic pricing Treatment households exhibited higher mean hourly kW consumption (ranging between +0.037 to +0.123 kW per hour) during most Off-Peak Summer and Winter periods relative to status-quo TOU Control households.

Table 92: Legacy Dynamic Pricing TOU Peak Impact Analysis Results (Summer, Mean Hourly kW)

Summer Period (Mean Hourly kW)	Baseline	Bin 1 Dynamic Pricing / Bin 2 Baseline	Dynamic Pricing Main Effect (Mean Hourly kW)		
	2014	2015	2016	2017	2018
High-Peak - Bin 1	0.070^	**-0.347*** **	**-0.345*** **	**-0.276*** **	**-0.144** **
High-Peak - Bin 2	0.042	0.081	**-0.149* **	-0.082	-0.065
Medium-Peak - Bin 1	0.073^	**-0.107** **	**-0.143** **	**-0.109** **	-0.075^
Medium-Peak – Bin 2	0.042	0.091^	-0.048	-0.012	-0.041
Low-Peak - Bin 1	0.064	-0.007	0.002	-0.035	0.028
Low-Peak - Bin 2	0.037	0.076^	0.032	0.020	0.041
Off-Peak - Bin 1	0.037	**0.082** **	**0.103*** **	**0.123*** **	**0.108*** **
Off-Peak - Bin 2	0.017	0.044	**0.078* **	**0.076* **	**0.072* **
CPP - Bin 1	--	**-0.756*** **	**-0.721*** **	**-0.421*** **	**-0.241*** **
CPP - Bin 2	--	0.029	**-0.37*** **	**-0.159** **	**-0.152* **
System-Coincident-Peak - Bin 1	0.009	**-0.162*** **	**-0.256*** **	-0.064^	**-0.087* **
System-Coincident-Peak – Bin 2	0.011	0.035	**-0.118* **	-0.037	-0.060

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ^ $p < .10$

Table 93: Legacy Dynamic Pricing TOU Peak Impact Analysis Results (Summer, % Change in Mean Hourly kW)

Summer Period (%)	Baseline	Bin 1 Dynamic Pricing / Bin 2 Baseline	Dynamic Pricing Main Effect (Mean Hourly % kWh)		
	2014	2015	2016	2017	2018
High-Peak - Bin 1	5.752	-18.653	-16.98	-17.986	-7.496
High-Peak - Bin 2	3.564	4.627	-7.897	-5.607	-3.59
Medium-Peak - Bin 1	5.732	-8.061	-9.206	-9.609	-4.776
Medium-Peak – Bin 2	3.435	7.202	-3.305	-1.078	-2.755
Low-Peak - Bin 1	5.379	-0.679	0.197	-3.821	2.81
Low-Peak - Bin 2	3.192	7.583	3.286	2.2	4.225
Off-Peak - Bin 1	4.344	9.367	10.951	15.447	11.878
Off-Peak - Bin 2	1.993	5.044	8.548	9.507	7.959
CPP - Bin 1	--	-35.383	-28.749	-22.868	-11.996
CPP - Bin 2	--	1.466	-15.865	-9.195	-7.851
System-Coincident-Peak - Bin 1	4.556	-13.034	-16.98	-5.405	-6.019
System-Coincident-Peak – Bin 2	0.95	2.931	-7.897	-3.212	-4.336

Table 94: Legacy Dynamic Pricing TOU Peak Impact Analysis Results (Winter, Mean Hourly kW)

Winter Period (Mean Hourly kW)	Baseline	Bin 1 Dynamic Pricing / Bin 2 Baseline	Dynamic Pricing Main Effect (Mean Hourly kW)		
	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
High-Peak – Bin 1	-0.028	0.016	-0.01	0.015	-0.005
High-Peak – Bin 2	0.057	-0.045	-0.043	-0.026	-0.005
Medium-Peak – Bin 1	-0.007	--	--	0.034	0.018
Medium-Peak – Bin 2	0.032	--	--	-0.005	0.014
Low-Peak – Bin 1	0.004	--	--	**0.05***	0.025
Low-Peak – Bin 2	0.03	--	--	0.003	0.02
Off-Peak – Bin 1	-0.004	**0.068****	**0.074*****	**0.081*****	**0.057***
Off-Peak – Bin 2	0.016	0.012	0.048	0.07	0.091
CPP – Bin 1	--	**-0.067***	**-0.076***	0.006	-0.03
CPP – Bin 2	--	-0.095	-0.146^	-0.029	-0.021
System-Coincident-Peak – Bin 1	-0.007	0.01	-0.007	0.028	0.014
System-Coincident-Peak - Bin 2	0.033	-0.071	-0.064	-0.02	-0.004

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 95: Legacy Dynamic Pricing TOU Peak Impact Analysis Results (Winter, % Change in Mean Hourly kW)

Winter Period (%)	Baseline	Bin 1 Dynamic Pricing / Bin 2 Baseline	Dynamic Pricing Main Effect (Mean Hourly % kWh)		
	2014	2015	2016	2017	2018
High-Peak - Bin 1	-2.287	1.558	0.812	1.405	-0.465
High-Peak - Bin 2	3.554	-3.552	-4.63	-1.858	-0.354
Medium-Peak - Bin 1	-0.575	-	-	3.324	1.745
Medium-Peak – Bin 2	2.071	-	-	-0.387	1.1
Low-Peak - Bin 1	0.36	-	-	5.231	2.507
Low-Peak - Bin 2	2.225	-	-	0.261	1.702
Off-Peak - Bin 1	-0.434	8.427	9.389	9.97	6.898
Off-Peak - Bin 2	1.289	1.129	4.644	6.468	8.447
CPP - Bin 1	--	-6.227	-6.305	0.589	-2.475
CPP - Bin 2	--	-6.808	-9.165	-2.076	-1.321
System-Coincident-Peak - Bin 1	-0.487	0.812	-0.59	2.351	1.17
System-Coincident-Peak – Bin 2	1.807	-4.63	-4.259	-1.329	-0.267

Critical Peak Pricing Impacts Across Time: Critical Peak Pricing (CPP) events occurred at different frequencies across each year and season of Legacy Dynamic pricing (Table 96).

Table 96 Number of Critical Peak Events by Year

	Summer	Winter
Year 1	--	--
Year 2	5	4
Year 3	5	1
Year 4	7	3
Year 5	6	6

With respect to CPP events in the Summer months across years, the pattern was consistent across the two Registration Bins (Table 92 and

Table 94). We observed lower electricity consumption (-0.152 to -0.756 kW) in mean hourly kW consumption for Legacy Dynamic Treatment customers relative to Control customers during CPP event hours all Treatment years.

CPP events were less impactful in the Winter months across the years analyzed here, with small effects in mean hourly kW consumption only observed during Treatment years 1 and 2 for Registration Bin 1(-0.067 kW and -0.076 kW respectively), and no differences observed between Treatment and Control for Registration Bin 2.

The differential distribution of the number of CPP events and their duration limits potential inferences of about the effects of CPP impacts across different years. Specifically, the larger number of CPP events in Year 5 (the most recent instantiation of Dynamic pricing) relative to Years 2 and 3, likely yield better estimates of the impact of CPP events on consumption relative to historical impact estimates derived from smaller sets of observations. This is further complicated by the fact that only in Year 5 was price protection removed. Again, while it is possible, and potentially insightful to examine CPP responsiveness over time for Legacy Dynamic pricing households given the data available, caution should be used when interpreting the reduction in magnitude of these effects over time (i.e., in the Summer CPP impact estimates across year).

System-Coincident Peak Demand: We observed no significant differences between Legacy Dynamic pricing Treatment and Control households during any of the Summer or Winter System-Coincident Peak periods.

On-Peak Impacts Across Time: From a descriptive perspective, we do observe that the magnitude of Summer Legacy Dynamic pricing consumption effects (for High On-Peak, Medium On-Peak, and CPP events) between Treatment and Control households diminish across time (Table 92). For example, the High On-Peak registration Bin 1 impacts for Treatment years 2015-2018 are -0.347 kW, -0.345 kW, -0.276 kW, and -0.144 kW mean hourly consumption, respectively, with lower consumption observed for Legacy Dynamic Treatment households relative to Control households in all years. It is important to note that inferential statistical modelling of pricing Treatment impacts over time, incorporating seasonal variations in temperature, are necessary to confirm that these magnitude changes in Summer impacts represent a significant trend rather than natural variability in the data. The magnitudes of all other periods of measurement, including Low On-Peak, Off-Peak, as well as overall Summer do not exhibit this descriptive trend.

Average Conservation Impacts Across Time: Seasonal average conservation impacts are shown in

Table 97 and Table 98. Overall, Legacy Dynamic pricing Treatment customers consumed slightly more electricity than status quo TOU Control customers, but this effect only reached significance in the Treatment years for Bin 1. The use of different matched Control groups during the Summer and Winter periods precludes a year-round analysis of average conservation.

Table 97: Legacy Dynamic Seasonal Average Hourly kW Consumption Impact Analysis (Registration Bins 1 & 2)

Average Consumption (kWh)	2014 Summer 2014-15 Winter	2015 Summer 2015-16 Winter	2016 Summer 2016-17 Winter	2017 Summer 2017-18 Winter	2018 Summer 2018–19 Winter
Summer Bin 1	0.042	0.051^	**0.063***	**0.081****	**0.084****
Summer Bin 2	0.02	0.049	0.057	0.06^	0.059
Winter Bin 1	-0.004	**0.059****	0.059	**0.073****	**0.05***
Winter Bin 2	0.02	0.003	0.032	0.058	0.077

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 98: Legacy Dynamic Seasonal Average Hourly % kW Consumption Impact Analysis (Registration Bins 1 & 2)

Average Consumption (%)	2014 Summer 2014-15 Winter	2015 Summer 2015-16 Winter	2016 Summer 2016-17 Winter	2017 Summer 2017-18 Winter	2018 Summer 2018–19 Winter
Summer Bin 1	4.615	5.433	6.165	9.459	8.601
Summer Bin 2	2.208	5.278	5.787	7.025	6.115
Winter Bin 1	-0.415	6.983	7.163	8.634	5.809
Winter Bin 2	1.562	0.273	2.993	5.215	6.949

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Elasticity of Demand: Daily and Substitution Elasticities are reported in Table 99. Daily elasticity of demand was estimated at -0.072. The daily elasticity of demand was negative and less than 1, indicating an inconsequential change in percent consumption per percent change in price. Substitution elasticity of demand was estimated at -0.004 again indicating an inconsequential change in percent consumption per percent change in price.

Table 99: Legacy Dynamic Pilot Daily and Substitution Elasticities of Demand

	Elasticity Estimate
Daily Elasticity	**-0.072*****
Substitution Elasticity On/Off-Peak	**-0.004*****

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

5.5.3 *Communication Analysis*

In this section we report consumption impacts attributable to the Nudge Reports that were distributed to households in the Legacy Dynamic pricing Treatment group. Starting in May 2018 we randomly selected half of the Legacy Dynamic Treatment households to receive Nudge Reports. Recall that household premise IDs for households in the matched Control groups for the Legacy Dynamic pricing pilot were not available in time to distribute Nudge Reports to any households within this group, meaning that the effects of Nudge Reports for the Legacy Dynamic pilot are assessed within the pricing Treatment group only. We report the effects of the Nudge Reports between Legacy Dynamic Treatment households who did not receive Nudge Reports to the households who did receive Nudge Reports. Following the same rationale as for the preceding analyses, we did not use a difference-in-difference methodology, and instead analyzed consumption behaviour during the Treatment period only. Since Nudge Reports were distributed as part of the most recent instantiation of Advantage Power Pricing, only one year of Treatment data is available and therefore the effects of Nudge Reports are not analyzed across time. As a result of this, we combined both registration Bins for the Nudge Report impact estimations that follow. The breakdown of households to each condition for these analyses are shown in Table 100.

Table 100: Number of Legacy Dynamic participants who received Nudge Reports

	Summer Final N	Winter Final N
Legacy Dynamic, No Nudge Report	574	615
Legacy Dynamic + Nudge Report	593	611

Summary statistics of mean hourly consumption for Legacy Dynamic Treatment households with and without Nudge Report are presented s in Table 90 (Summer) and Table 91 (Winter). Consumption impacts owing to Nudge Reports are shown in

Table 101. Overall, there were small effects in consumption associated with receiving Nudge Reports, but none of those effects reached statistical significance. In terms of magnitude, impact estimates trend towards lower consumption amongst households who received Nudge Reports relative to households who did not.

Table 101: Legacy Dynamic Nudge Report Communication Impact Analysis Results

	Nudge Report Main Effect (Mean Hourly kW)			
	Summer Period		Winter Period	
	Mean Hourly kW	%	Mean Hourly kW	%
High-Peak	-0.005	-0.279	-0.005	-0.404
Medium-Peak	-0.027	-1.842	-0.005	-0.424
Low-Peak	-0.031	-2.997	-0.007	-0.628
Off-Peak	-0.029	-2.865	0.005	0.494
CPP	-0.03	-1.71	-0.013	-0.986
System-Coincident-Peak	-0.011	-0.815	0.007	0.562
Total	-0.024	-1.772	-0.004	-0.352
Year-Round Total	kW = -0.012		% = -1.641	

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; ^ $p < .10$

5.5.4 *Technology Impacts*

Legacy Dynamic pricing households were designated as "Technology" if they registered an eligible smart thermostat for load curtailment at the commencement of the pilot. Objectively verifiable data on smart thermostat ownership exists only for customers who registered their devices through Alectra and therefore our estimation of consumption impacts owing to smart thermostats could only be completed using this verified data. Recall that all registered devices were equipped with some form of load curtailment during peak pricing events in the Legacy Dynamic pilot and so the estimated impacts of smart thermostats (i.e., "Technology") reported here are a measure of the (likely) additive effects of both owning a smart thermostat *and* receiving automatic load curtailment signals. Furthermore, as this analysis was only concerned with the Treatment reporting period (i.e., the 12-month unprotected period of the most recent instantiation of Advantage Power Pricing), we combined both Registration Date Bins.

Frequency of smart thermostat ownership is presented in

Table 102. None of the status-quo TOU pricing participants owned registered smart thermostats with Alectra Utilities; therefore, we compared Technology and No Technology within the Legacy Dynamic pricing Treatment group only.

Table 102: Frequency of registered smart thermostat ownership by Legacy Dynamic condition

	Energate	Ecobee	Nest	Honeywell	Unknown
Summer Period					
Legacy Dynamic Pricing	690	5	4	62	38
Std TOU Control	0	0	0	0	0
Winter Period					
Legacy Dynamic Pricing	731	6	7	66	36
Std TOU Control	0	0	0	0	0

Impact estimates owing to Technology for the Legacy Dynamic Treatment customers for the Summer and Winter months are shown in Table 103 and Table 104**.** For Summer High On-Peak hours, we observed a statistically significant mean hourly consumption effect of -0.127kW owing to smart thermostat possession/registration. Technology was associated with lower electricity consumption for all of the Winter Legacy Dynamic TOU periods, ranging between -0.151 kW (Low On-Peak) and -0.281 kW (High On-Peak; Table 104), including an overall effect of -0.208 kW for the Winter months.

Table 103: Legacy Dynamic Technology Impact Analysis Results (Mean Hourly kW; Summer)

Summer Period (Mean Hourly kW)		Technology	No Technology	Estimates	
				Mean Hourly kW	%
High-Peak	Mean	1.723	1.85	**-0.127***	-6.887
	SD	1.058	1.191		
Medium-Peak	Mean	1.449	1.529	-0.08	-5.211
	SD	0.894	0.998		
Low-Peak	Mean	1.014	1.03	-0.016	-1.59
	SD	0.645	0.698		
Off-Peak	Mean	1.016	0.964	0.052	5.383
	SD	0.613	0.636		
Total	Mean	1.336	1.397	-0.061	-4.379
	SD	0.91	1.017		

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 104: Legacy Dynamic Technology Impact Analysis Results (Mean Hourly kW; Winter)

Winter Period (Mean Hourly kW)		Technology	No Technology	Estimates	
				Mean Hourly kW	%
High-Peak	Mean	1.12	1.402	**-0.281*****	-20.078
	SD	0.706	1.261		
Mid-Peak	Mean	1.081	1.291	**-0.21*****	-16.289
	SD	0.652	1.073		
Low-Peak	Mean	1.046	1.197	**-0.151*****	-12.628
	SD	0.605	0.907		
Off-Peak	Mean	0.946	1.117	**-0.171*****	-15.283
	SD	0.621	1.04		
Total	Mean	1.062	1.27	**-0.208*****	-16.363
	SD	0.672	1.111		

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

5.5.5 *Pledge Analysis*

We sought to examine consumption impacts between households who responded to the On-Peak conservation pledge on the Nudge Report versus households who received the Nudge Reports but did not respond to the pledge. Recall that households had the option to respond to the pledge via SMS text message to commit to reducing their On-Peak electricity consumption. Households who chose to respond to the pledge were offered a $5 rebate. The number of participants in each of the comparison groups is shown in Table . As is evident, there is insufficient cell size to derive statistically meaningful impacts owing to customers signing versus not signing the pledge within the Legacy Dynamic pricing Treatment groups.

Table 107: Pledge Numbers – Legacy Dynamic Customers that Received Nudge Reports

	Pledge Not Signed	Pricing Pledge Signed
Summer Period	555	38
Winter Period	571	40

5.5.6 *Overall Summary of Legacy Dynamic Impacts*

Overall, Legacy Dynamic pricing participants consumed less High On-Peak, Medium On-Peak and CPP period electricity during Summer months than the status-quo TOU Control households. However, these differences appear to decrease across time. In terms of non-price interventions, Nudge Reports were associated with small, but non-significant reductions in energy consumption and smart thermostat ownership/registration was associated with lower electricity consumption for Summer High On-Peak periods and all Winter On-Peak periods.

In terms of the diminishing magnitude of the impact estimates during High On-Peak and Critical Peak events in the Summer months, inferential statistical modelling would be required in order to confirm any effect of time on the impact of Legacy Dynamic pricing; however, we offer two interpretations of this hypothesized diminishing behavioural response to peak pricing:

Hypothesis 1 - Impact of prior extended price protection: Customers in Legacy Dynamic pricing have been enrolled in Advantage Power Pricing since 2015 or 2016 (depending on whether they are in registration bin 1 or 2) and have been enjoying full price protection until the start of the current pilot program in April 2018. It is therefore possible that these customers decreased responsiveness to pricing signals over time precisely because there was no material financial penalty associated with doing so. In other words, customers may have learned that failure to maintain on-peak consumption reductions would not end up costing them more (at least in terms of total bill amount) than they were used to paying under status-quo TOU.

Hypothesis 2 - Impact of declining technology use: Over the course of the Legacy Dynamic pricing initiatives undertaken by Alectra Utilities, formerly branded and marketed as Advantage Power Pricing, as well as in the current instantiation, participating customers have been offered subsidized smart thermostats (including procurement and installation). The rationale behind these thermostat incentive programs was that customers would exhibit greater demand response to High On-Peak and Critical Peak Pricing events. Response to these events for customers owning eligible devices (i.e., Energate) could be achieved by adjusting the devices 'comfort' settings during programming, and/or by consenting to load curtailment. The latter involves allowing the utility to remotely adjust thermostat settings to lower consumption during high-demand times of day, thus allowing the customer to realize bill savings without having to take any action. The observed decline in behavioural response to Dynamic pricing for Legacy customers, may therefore be driven, at least in part, by differential use/acquisition of smart thermostat devices over the 4-5 years in which participating Legacy customers have been enrolled.

There are three ways in which differential use of technology may have mitigated behavioural response to Critical Peak Pricing events:

1. *Lower uptake of devices across the three Dynamic pricing enrollment periods:* While it is true that uptake of the thermostat incentives offered in the current instantiation of Dynamic pricing is lower than the historical uptake observed in the Legacy programs, this is unlikely to be a major factor in driving lower High On-Peak and CPP period responsiveness. If lowered behavioural response was due to a drop in device acquisition,

we would expect to see sharp declines in behavioural response to CPP events that coincide with the program registration periods. Instead we see a fairly steady decline over the course of the program.

2. *Increasing use of thermostat comfort settings:* It is possible that as time in the Dynamic pricing program increases, customers become increasingly likely to increase the comfort settings on their thermostats, thus increasing consumption during peak hours in order to enjoy warmer or cooler homes (in Winter and Summer respectively). At the time of the submission of this report, we do not possess thermostat settings data from registered devices and so cannot speak to the reality of this hypothesis.

3. *Increasing opt-out rates associated with load curtailment:* Load curtailment, in which the utility has permission from the customer to automatically adjust thermostat settings in response to Peak Pricing events, is perhaps the most effective way to realize consumption reductions during especially high-priced times of day. The observation of decreasing responsiveness to such events over time for Legacy Dynamic customers may therefore owe to an increase in the proportion of customers opting out of curtailment over the course of their participation in Dynamic pricing. Unfortunately, at the time of this submission, historical load curtailment participation data (with respect to activation/deactivation dates) is not available.

In summary, the apparent change in impact of Dynamic pricing across time is an interesting potential area of future investigation and should include statistical evaluation of any such effects. Note that such an analysis would not be particularly informative here owing to the fact that the switch from full price protection to unprotected participation in Year 5 represents a significant qualitative change in program design. In addition, differential exposure duration to Dynamic pricing (owing to different registration periods) and inconsistency in the frequency of CPP events across season and year further complicates what would otherwise be a simple time-series analysis. Although we have posited several potential mechanisms to explain a potential reduction in behavioural response to Dynamic pricing over time, a detailed analysis of these mechanisms is not possible at present. A forthcoming impact evaluation will however, examine the impacts owing to Dynamic pricing across a second Summer season (Summer 2019), which will shed at least some light on this issue.

6. Survey Findings

In service of the broader objectives of the RPP Pilot Program, customer-facing surveys were administered to all participating customers along with households in the randomly assigned (in the case of the Enhanced pricing pilot) or matched Control groups (in the case of the Dynamic and Overnight pilots). The purpose of the surveys was to measure overall levels of comprehension of TOU pricing plans, motivation to change behaviour, subjective experience with APP price plans, and to capture relevant demographic data and household characteristics (e.g. electric vehicle (EV) ownership and use of a programmable thermostat). What follows are the survey results for the Enhanced, Overnight and Dynamic pricing pilots.

To estimate the effects of the RPP Pricing pilots over time on the above metrics, surveys were deployed at the beginning of the pilot (April 2018) (*baseline*), at the six-month mark (October 2018) (*midterm/interim*), and at the end of the pilot (June 2019) (*final*). Each of these surveys remained active for approximately one month in order to gather as much participant response data as possible without sacrificing the temporal specificity of each survey (i.e., if the baseline survey were active for too long, it would no longer be a valid 'baseline' survey). For the Dynamic pricing pilot, the 'final' survey was deployed in November 2019 to accommodate for the fact that Dynamic pricing was extended an additional five months beyond the end of the 12-month reporting period that this report entails. Unfortunately, a single survey link was distributed to all Dynamic pricing pilot participants regardless of whether they were newly enrolled or part of the Legacy Dynamic program. This means that survey results for the Dynamic pricing plan comprise a mixture of responses from both "new" and Legacy participants. This section of the report will discuss the results of all three surveys in order to assess potential changes in comprehension, motivation, and self-reported behaviour change (1) across time, and (2) between Treatment and Control groups within each pricing pilot, where applicable and feasible. Note that survey responses were solicited via direct mail and email marketing initiatives undertaken by Alectra and therefore the evaluator had no control over the response rate. In some instances (particularly for Control participants within each pilot), response rates were too low to allow for any meaningful analyses.

Overall, there were 2,762 survey responses. Since survey data was provided in an anonymous form, we cannot determine how many households provided unique responses. That is, some households may have responded to surveys at just a single time-point, any two of the three time-points, or all three time-points.

Table shows the number of survey completions across all conditions.

Table 109 shows the number of survey completions across all conditions *and* survey timepoints.

Table 108: Total Number of Survey Responses per Condition Overall

Pricing Pilot Group	No Nudge Report	Nudge Report	**Total**
Enhanced Pricing Control	562	573	**1135**
Enhanced Pricing Treatment	325	335	**660**
Overnight Pricing Control	12	N/A	**12**
Overnight Pricing Treatment	331	N/A	**331**
Dynamic Pricing Control	17	8	**25**
Dynamic Pricing Treatment	541	58	**599**
Total			**2762**

Table 109: Number of Survey Responses per Condition Baseline, Midterm, and Final

Number of Completions for Baseline Survey			
Treatment Group	No Nudge Report	Nudge Report	**Total**
Enhanced Pricing Control	90	97	**187**
Enhanced Pricing Treatment	94	82	**176**
Overnight Pricing Control	12	0	**12**
Overnight Pricing Treatment	90	0	**90**
Dynamic Pricing Control	12	8	**20**
Dynamic Pricing Treatment	83	58	**141**
Total			**626**
Number of Completions for Midterm Survey			
Enhanced Pricing Control	80	227	**307**
Enhanced Pricing Treatment	106	103	**209**
Overnight Pricing Control	0	0	**0**
Overnight Pricing Treatment	158	0	**158**
Dynamic Pricing Control	5	0	**5**
Dynamic Pricing Treatment	235	166	**401**
Total			**1080**
Number of Completions for Final Survey			
Enhanced Pricing Control	392	249	**641**
Enhanced Pricing Treatment	125	150	**275**
Overnight Pricing Control	0	0	**0**
Overnight Pricing Treatment	83	0	**83**
Dynamic Pricing Control	0	0	**0**
Dynamic Pricing Treatment	223	0	**223**
Total			**1222**

6.1 Comprehension

The first research question was whether households who received a price Treatment and/or a Nudge Report had higher levels of comprehension regarding electricity prices and the TOU period structure in the Province of Ontario relative to those who did not receive Nudge Reports. It was hypothesized that with prolonged exposure to Nudge Reports over the duration of the pilot, that customers would increase their level of comprehension of prices and TOU period times relative to customers who were not exposed to these reports. To answer this question, households were asked the same four comprehension questions on the baseline (before treatment), midterm (six months after receiving pricing treatment/Nudge Report), and final surveys (twelve months after receiving pricing treatment/Nudge Report). The four comprehension questions that appeared on all three surveys are listed below as well as in Appendix K:

1. Please select the pricing model that you think best describes how electricity is currently priced for the majority of residential customers in Ontario **(Answer: "Time-Of-Use: The price of electricity varies depending on the time of day")**

2. Electricity usage is split into different Time-Of-Use periods. The cost of electricity varies between these periods. What do you think the daily Time-Of-Use Periods are called in Ontario? **(Answer: "Three different TOU periods: Off-Peak, Mid-Peak, On-Peak")**

3. Select the top 3 household items that you believe consume the most electricity **(Answer: "Washing machine / Dryer, Heating and Cooling unit, Fridge")**

4. What do you think is the most effective way to reduce your electricity bill in the Summertime? **(Answer: Raise the temperature on your A/C unit by 2 degrees Celsius between the hours of 1pm and 7pm during hot months)**

Each survey response was coded as correct or incorrect and a comprehension score out of 4 was obtained for each respondent. Survey respondents were given one mark for correct answers on questions 1, 2, and 4 and 1/3 of a mark for each correctly listed item in question 3. The final comprehension score was then converted into a percentage.

This section will compare percentage of correct responses between the Baseline, Midterm (Interim), and Final Surveys for Treatment and Control groups separated by each pricing pilot (e.g. Enhanced, Overnight, Dynamic) and by communication condition (i.e. whether or not they received a Nudge Report).

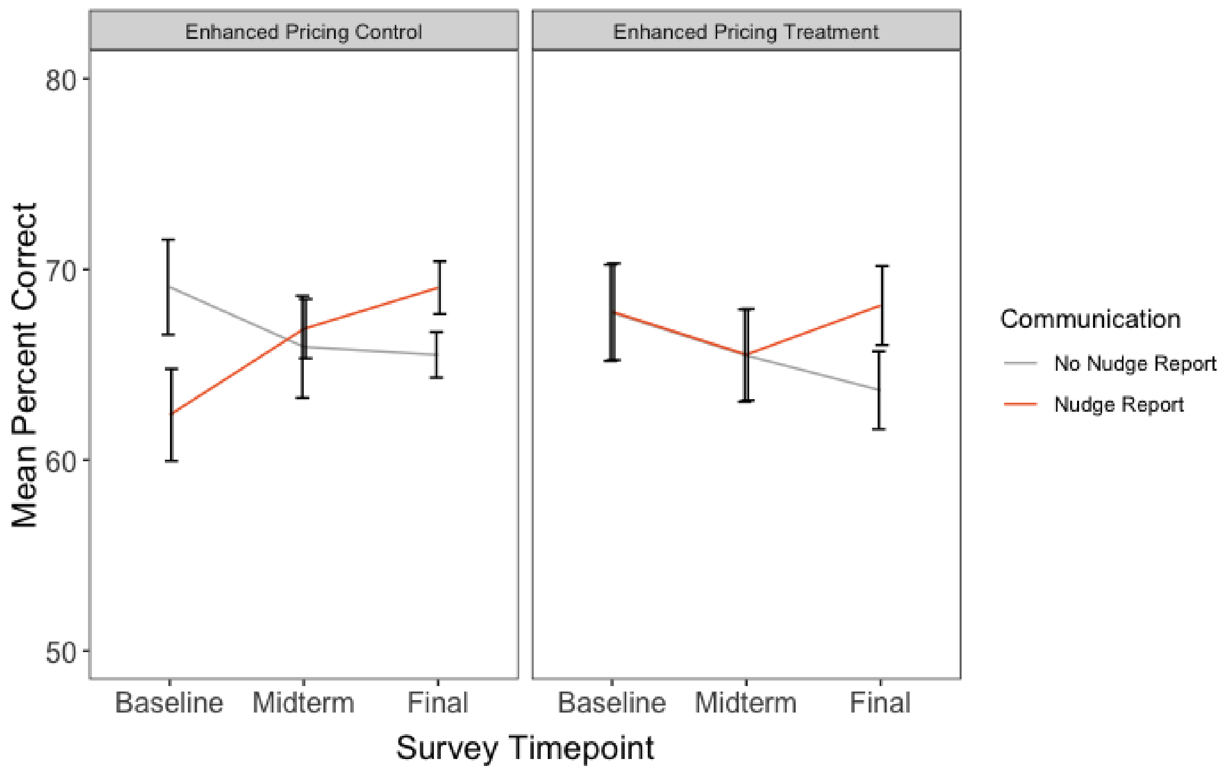
6.1.1 *Comprehension: Enhanced Pricing Pilot*

Table 110 and Figure 1 show the mean percentage of correct responses on the comprehension survey questions for the Enhanced pricing pilot. There was a significant positive interaction between timepoint and communication condition (i.e. receiving a Nudge Report) at the final survey timepoint, indicating that those who received a Nudge Report had greater comprehension of TOU pricing and associated time-periods at the time of the final survey compared to those who did not receive a Nudge Report. Results of the statistical model are shown in Table 1 of Appendix J. In other words, households scored significantly higher on comprehension at the end of the pilot period, but only when they concurrently received the Nudge Report. Overall, the data shows no significant main effect of pricing condition (status quo TOU vs. Enhanced pricing) or time (Baseline vs. Midterm vs. Final) on comprehension.

Table 110: Comprehension Scores for Enhanced Pricing Pilot (Mean Percent Correct)

	Enhanced Pricing Control		Enhanced Pricing Treatment	
Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	69.1%	62.4%	67.7%	67.8%
Midterm	65.9%	66.9%	65.5%	65.5%
Final	65.5%	69.0%	63.7%	68.1%

Figure 1: Comprehension Scores for the Enhanced Pricing Pilot (Mean Percent Correct)



6.1.2 *Comprehension: Overnight Pricing Pilot*

Table 111 shows the comprehension scores (mean percent correct responses) for the Overnight pricing pilot. No participants in the Overnight pricing pilot received a Nudge Report, and therefore we did not assess the effect of communication on comprehension for this pilot. Further, since there were too few survey responses for Control participants at the baseline, midterm and final survey timepoints, we only tested for the effect of timepoint on comprehension for the Overnight pricing Treatment group, and not the Control group.

There was no effect of timepoint on comprehension scores in the Overnight pricing pilot. Results of the statistical model are displayed in Table 2 of Appendix J.

Table 111: Comprehension Scores for Overnight Pricing Pilot (Mean Percent Correct)

	Overnight Pricing Control		Overnight Pricing Treatment	
Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	59.7%	N/A	73.1%	N/A
Midterm	N/A	N/A	70.9%	N/A
Final	N/A	N/A	70.7%	N/A

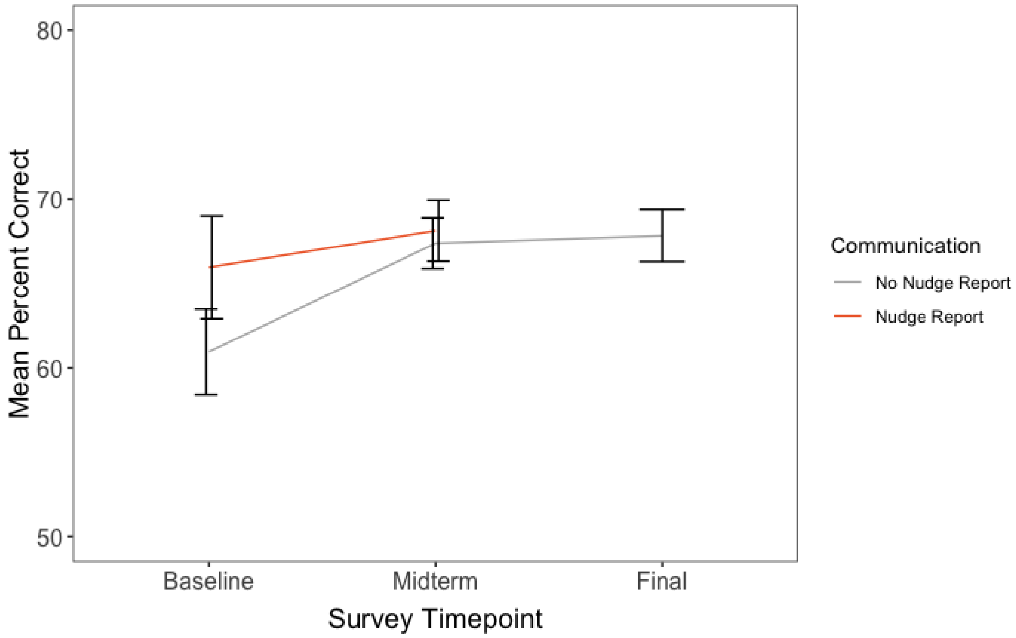
6.1.3 *Comprehension: Dynamic Pricing Pilot*

Table 112 and Figure 2 show the comprehension scores (mean percent correct responses) for the Dynamic pricing pilot. There were too few survey completes for Dynamic pricing Controls at baseline and midterm, therefore comprehension was analyzed in the Dynamic pricing Treatment group only. There was a significant effect of timepoint on comprehension scores for all participants in the Dynamic pricing Treatment group. Overall, participants performed significantly better on comprehension at the midterm and final timepoints compared to baseline. There was no effect of communication (i.e. Nudge report) on comprehension scores.
In summary, participants in the Dynamic pricing pilot performed significantly better on the comprehension portion of the survey over time. Results of the statistical model for the Dynamic pricing pilot are shown in Table 3 of Appendix J.

Table 112: Comprehension Scores for Dynamic Pricing Pilot (Mean Percent Correct)

	Dynamic Pricing Control		Dynamic Pricing Treatment	
Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	70.8%	78.1%	60.9%	65.9%
Midterm	68.3%	N/A	67.4%	68.1%
Final	N/A	N/A	67.8%	N/A

Figure 2: Comprehension Scores for the Dynamic Pricing Pilot (Mean Percent Correct)



6.1.4 *Conclusions: Comprehension*

There were sufficient numbers of survey responses in the Enhanced pricing pilot for both the Treatment and Control groups, therefore we were able to do a complete analysis across all three timepoints of the pricing pilot: baseline, midterm, and final. In the Enhanced pricing pilot, we saw a significant interaction effect between Nudge Report and timepoint, where comprehension scores were significantly higher at the final timepoint. On average, those who received the Nudge Report performed better at the final timepoint compared to those who did not receive a Nudge Report. Thus, receiving a Nudge Report had beneficial effects on comprehension of TOU pricing over the course of the pilot.

In the Overnight pricing pilot, there were no responses from the Control group for the midterm or final timepoint, so instead, we assessed comprehension in the Overnight pricing Treatment group over time only. There was no effect of time on comprehension in the Overnight pricing Treatment group. In the Dynamic pricing pilot, there was a significant effect of timepoint on comprehension, with all participants showing significantly higher comprehension scores at the final survey timepoint. In summary, the results indicate that comprehension for the Enhanced and Dynamic pricing pilots improved over time, and that receiving a Nudge Report is likely beneficial for improving TOU pricing comprehension.

6.2 Motivation

6.2.1 *Motivations to Shift Energy Consumption*

The second research question addressed by the customer-facing surveys pertains to whether pricing Treatment and/or the Nudge Report were able to increase household motivation to alter electricity consumption behaviour. Households were asked for their opinions regarding their motivation to either shift or not shift their electricity usage in accordance with their TOU schedule (APP TOU schedule for pricing Treatment customers and status quo TOU schedule for pricing Control customers). The purpose of this assessment was to determine whether any of pricing Treatments and/or Nudge Report communications had any effect on these motivations. To measure motivation, respondents were asked the following six questions (note: questions are also listed in Appendix K):

1. Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I don't think it is fair for the utility company to ask me to change my energy consumption behaviour.

2. Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel like I am already doing everything I can to conserve energy.

3. Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel motivated to conserve On-Peak electricity and/or shift my electricity usage to Off-Peak.

4. Respond with "Yes" or "No": Has TOU pricing affected how you consume energy?

5. How much do you agree or disagree with each of the following reasons for why you have NOT shifted your consumption behaviour from On-peak to Off-peak (on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree")?

    a. I didn't know Ontario had a Time-of-use pricing structure for electricity consumption
    b. It is too difficult for me to schedule electricity consuming activities during Off-Peak hours (such as overnight)
    c. I don't think the cost savings are worth the effort
    d. I don't think it contributes much to the province's electricity conservation efforts
    e. I'm not too concerned about the environmental impact of my electricity consumption
    f. I don't think anyone else does it, so I don't either
    g. It's too complicated for me to understand

6. How much do you agree or disagree with each of the following reasons for why you have shifted your consumption behaviour from On-peak to Off-peak? (on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree"):
    a. To save money on my monthly bills
    b. It was the environmentally responsible thing to do
    c. To be a good role model for others
    d. Because others I know were also doing it
    e. It was convenient for me to shift my electricity consumption
    f. I purchased smart thermostats to automatically shift my electricity consumption

6.2.2 *Motivation: Enhanced Pricing Pilot*

Question 1: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I don't think it is fair for the utility company to ask me to change my energy consumption behaviour.*

There were no significant differences in responses between pricing Treatment and Control, timepoint, or communication (i.e. Nudge Report) conditions (Table 4 of Appendix J). The mean level of agreement with this statement for Enhanced Pricing participants was 3.91 (+/-1.55) on a scale of 1 to 7.

Question 2: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel like I am already doing everything I can to conserve energy.*

There was a significant effect of timepoint on responses to Question 2, where participants increasingly reported feeling more strongly that they were "already doing everything they can to conserve energy" over the course of the Enhanced Pricing Pilot. Specifically, participants had higher ratings in response to Question 2 at the midterm survey timepoint, and even higher ratings at the final survey timepoint compared to baseline (Figure 3, Table 113). There was no effect of Treatment group (i.e. Enhanced Pricing Treatment or Control) or communication (i.e. Nudge Report) on responses to Question 2. Statistical results are displayed in Table 5 of Appendix J.

Figure 3: Mean level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement "I feel I am already doing everything I can to conserve energy."

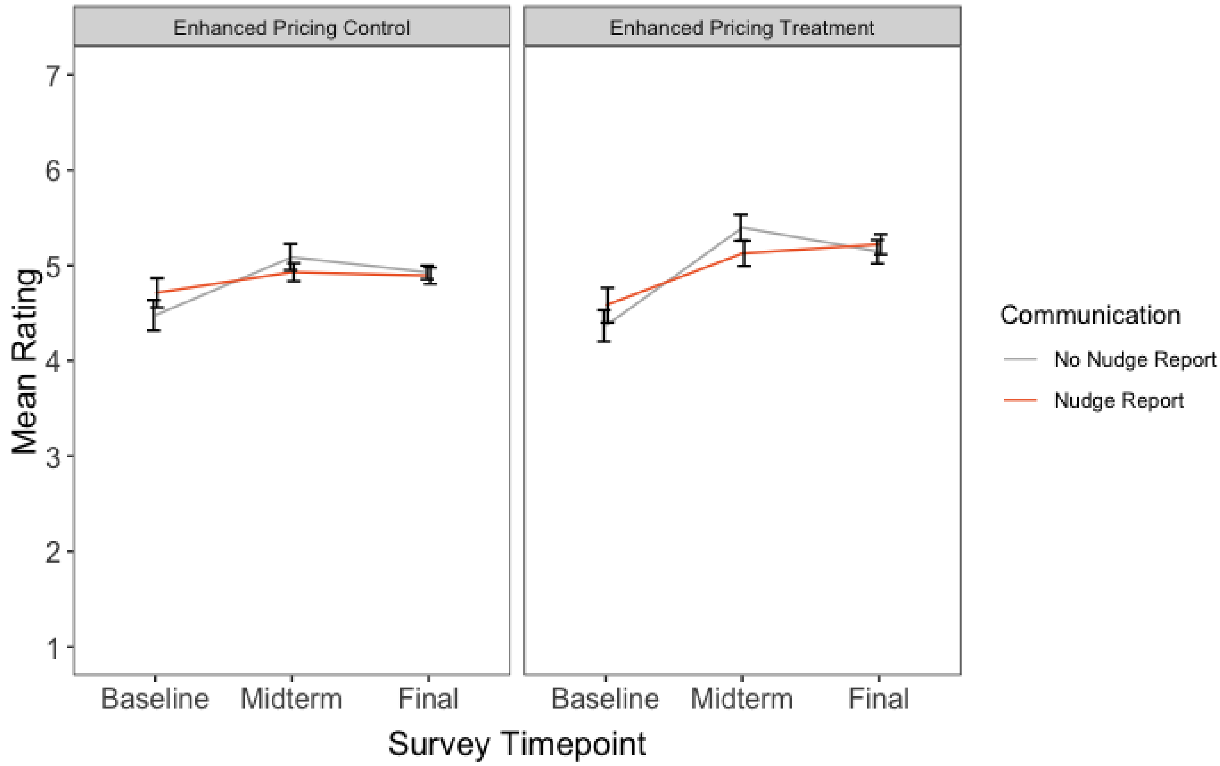


Table 113: Mean household level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement "I feel I am already doing everything I can to conserve energy."

	Enhanced Pricing Control		Enhanced Pricing Treatment	
Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	4.5	4.7	4.4	4.6
Midterm	5.1	4.9	5.4	5.1
Final	4.9	4.9	5.1	5.2

Question 3: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel motivated to conserve On-Peak electricity and/or shift my electricity usage to Off-Peak.*

There were no significant effects of pricing condition, communication (i.e. Nudge Report) or timepoint on responses to Question 3 (Table 6 of Appendix J). Participants generally reported feeling motivated to conserve On-Peak electricity and/or shift electricity usage to Off-Peak. Mean responses for each group/condition are shown in Table 114.

Table 114: Mean household level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement " I feel motivated to conserve On-Peak electricity and/or shift my electricity usage to Off-Peak."

	Enhanced Pricing Control		Enhanced Pricing Treatment	
Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	5.6	5.7	5.3	5.5
Midterm	5.6	5.5	5.5	5.4
Final	5.4	5.5	5.3	5.5

Question 4: *Respond with "Yes" or "No": Has TOU pricing affected how you consume energy?*

Participants in the Enhanced pricing pilot Treatment group were less likely to report that TOU pricing affected how they consume energy than the Enhanced pricing Control group. There was also a significant timepoint by Treatment group interaction, where participants in the Enhanced pricing Treatment group were less likely to report that TOU pricing affected how they consume electricity compared to the status quo TOU Control group at the final survey timepoint (Figure 4, Table 115). There was no effect of communication (i.e. Nudge Report) on the likelihood of reporting that TOU pricing had affected how participants consume electricity. Statistical results are displayed in Table 7 of Appendix J.

Figure 4: Proportion of households for each condition who responded that TOU pricing has affected their energy consumption

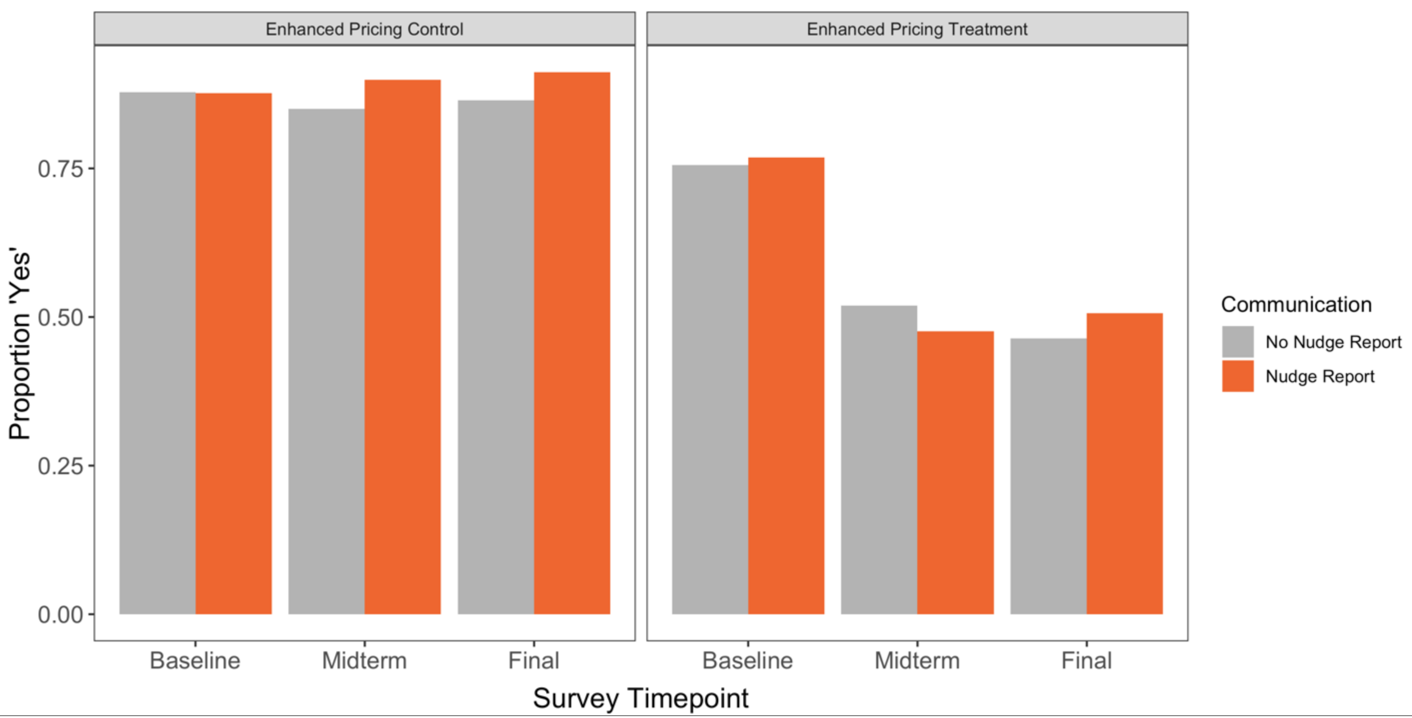


Table 115: Percentage of households for each condition who responded that TOU pricing has affected their energy consumption

	Enhanced Pricing Control	Enhanced Pricing Treatment

Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	87.8%	87.6%	75.5%	76.8%
Midterm	85.0%	89.9%	51.9%	47.6%
Final	86.5%	91.2%	46.4%	50.7%

Question 5: *Factors that influence why participants reported they did not shift their energy consumption behaviour.*

We conducted an analysis to examine the differences between groups for timepoint, pricing group, and communication group on responses given for why participants reported they did not shift their energy consumption behaviour (1-7 rating scale):

1. I didn't know Ontario had a Time-of-use pricing structure for electricity consumption (lack of awareness)

2. It is too difficult for me to schedule electricity consuming activities during Off-Peak hours (such as overnight) (difficulty)

3. I don't think the cost savings are worth the effort (cost)

4. I don't think it contributes much to the province's electricity conservation efforts (provincial)

5. I'm not too concerned about the environmental impact of my electricity consumption (environment)

6. I don't think anyone else does it, so I don't either (social)

7. It's too complicated for me to understand (comprehension)

Overall, mean ratings for various motivational factors affecting why Enhanced pricing pilot participants did not shift their energy consumption behaviour significantly differed from one another (Table 8 of Appendix J). Difficulty in shifting energy consumption behaviour (i.e. 'It's too difficult for me to schedule electricity consuming activities during Off-Peak hours') was rated most highly as the reason for why participants did not shift their behaviour, followed by provincial reasons (i.e. does not contribute to provincial energy conservation). Mean ratings for each factor are presented in Figure 5 and summarized in Table 116.

Figure 5: Participants mean ratings for how much each factor influenced them not to shift energy consumption behaviour (1-7 scale)

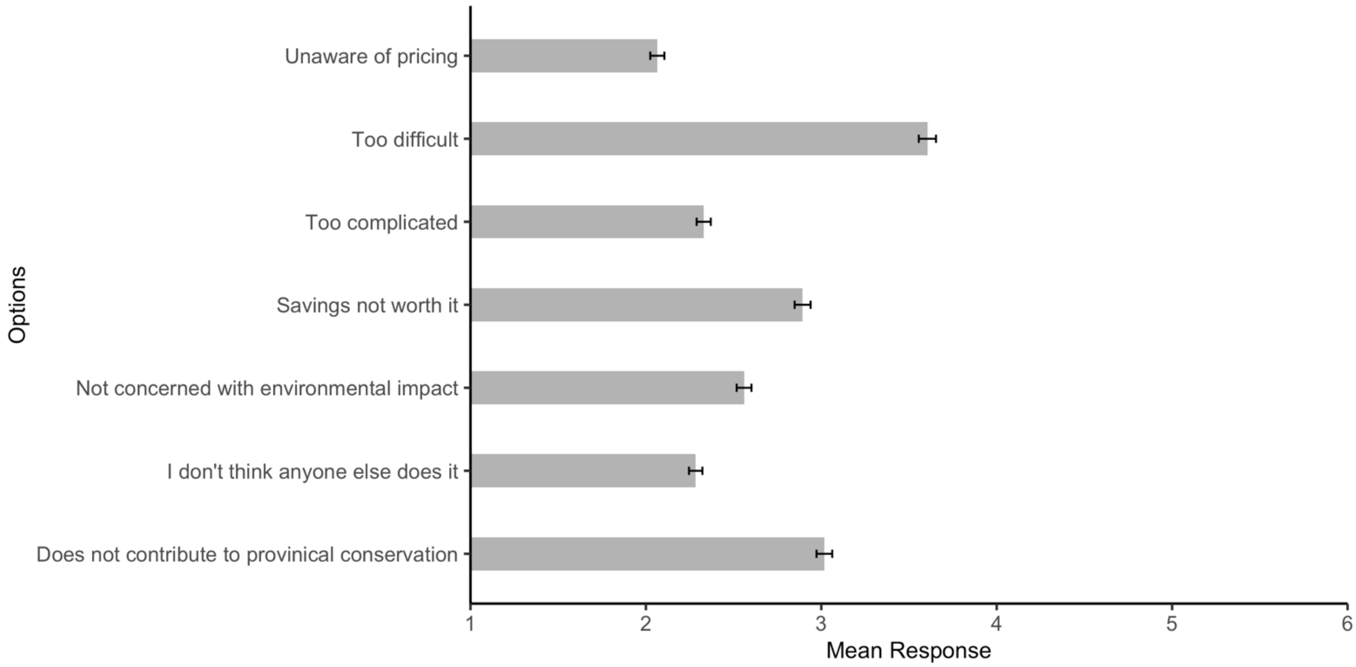
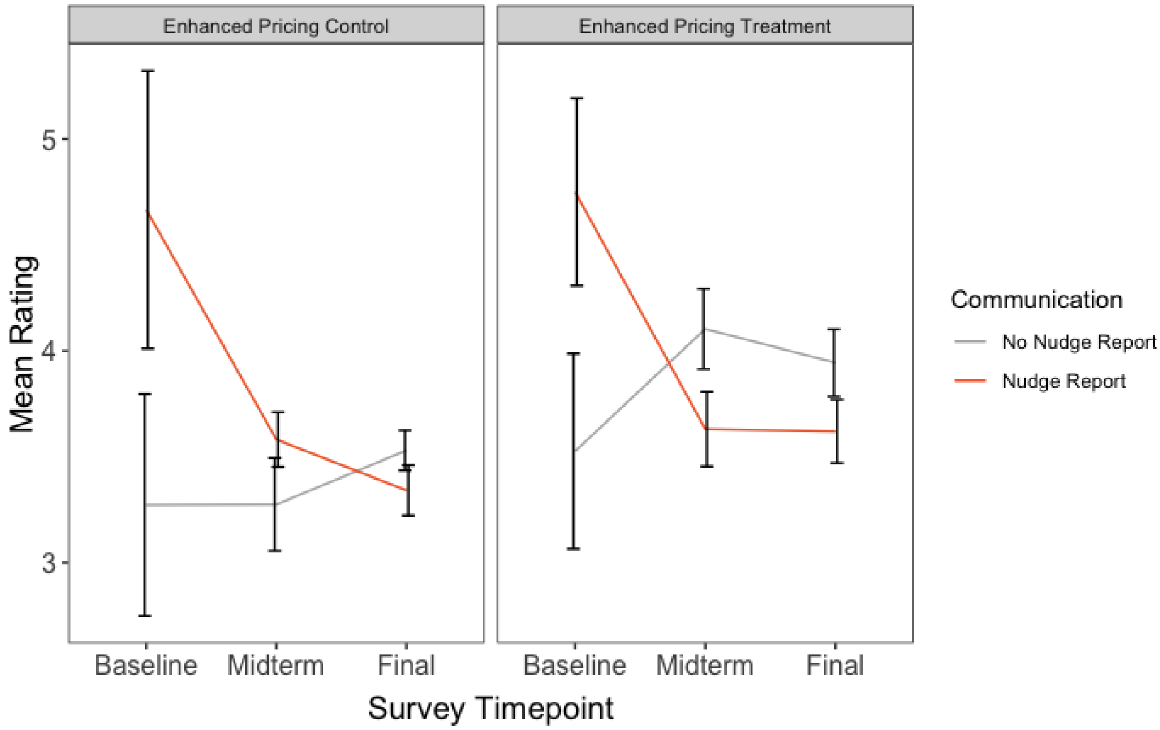


Table 116: Mean ratings for agreement with statements reflecting motivational reasons for why participants did not shift energy consumption behaviour

		Enhanced Pricing Control		Enhanced Pricing Treatment	
Motivation	Timepoint	No Nudge	Nudge	No Nudge	Nudge
Awareness	Baseline	2.8	2.1	2.6	1.8
	Midterm	1.9	2.1	2.2	2
	Final	2	1.9	2.2	2.3
Difficulty	Baseline	3.3	4.7	3.5	4.8
	Midterm	3.3	3.6	4.1	3.6
	Final	3.5	3.3	3.9	3.6
Cost	Baseline	3.5	3.2	3.3	4.5
	Midterm	2.4	2.8	3.4	3.3
	Final	2.8	2.6	3.2	3
Provincial	Baseline	3.3	2.9	3.2	3.7
	Midterm	2.7	2.9	3.7	3.2
	Final	3	2.8	3.1	3
Environment	Baseline	3.3	2.6	2.3	2.9
	Midterm	2.6	2.6	2.8	2.8
	Final	2.6	2.3	2.4	2.5
Social	Baseline	3	2.3	2.3	2.9
	Midterm	2	2.3	2.4	2.5
	Final	2.2	2.2	2.3	2.3
Comprehension	Baseline	2.5	2.1	2.5	2.7
	Midterm	2.2	2.3	2.7	2.6
	Final	2.2	2.1	2.6	2.4

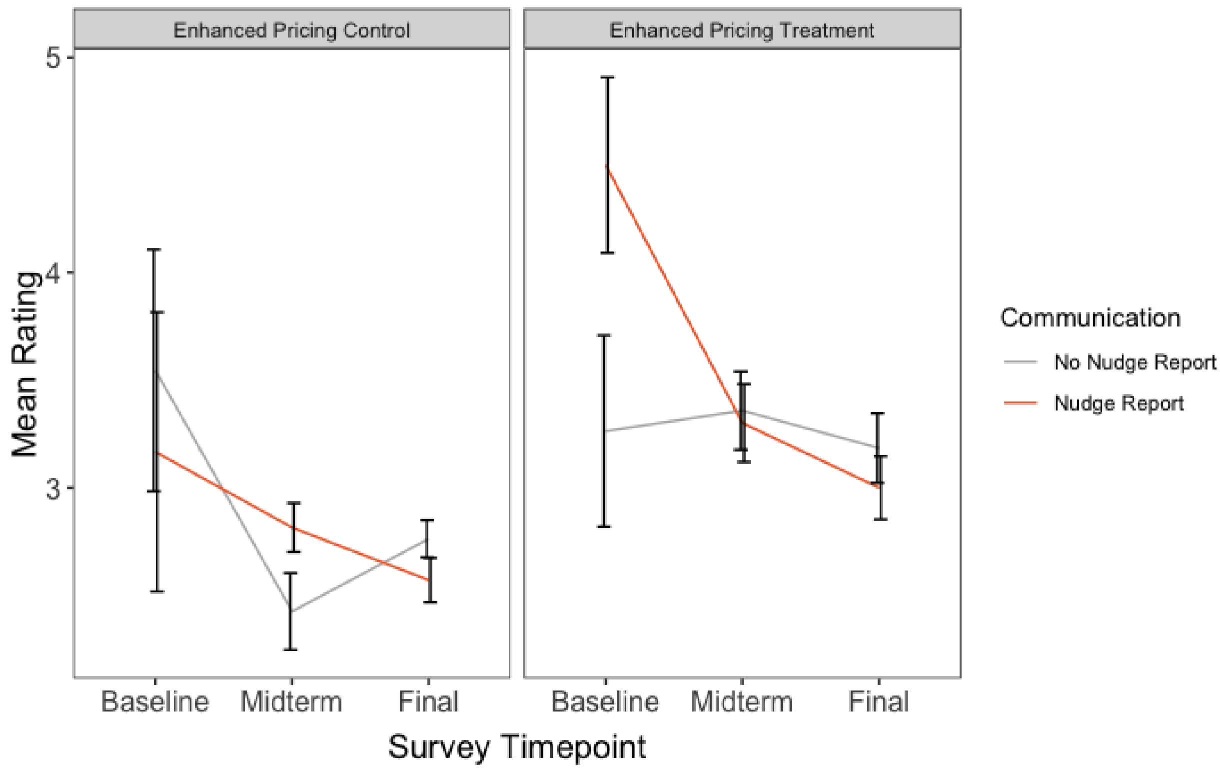
There was also a an effect of timepoint, where participants who received a Nudge report rated ‘difficulty’ lower at the final survey timepoint compared to baseline as a reason for why they did not shift their electricity consumption behaviour (Figure 6; Table 10 of Appendix J).

Figure 6: Mean level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement 'It's too difficult for me to schedule electricity consuming activities during Off-Peak hours'



Participants were significantly less likely to report 'cost' as the reason for not shifting their electricity consumption behaviour at the midterm survey timepoint relative to other time-points. This effect is qualified by an interaction between pricing group, communication group, and timepoint, where participants in the Enhanced pricing Treatment group who received a Nudge Report were less likely to report that they 'don't think cost savings are worth the effort' as a reason for not shifting their behaviour at the midterm survey timepoint compared to Enhanced pricing Controls and those who did not receive a Nudge Report (Figure 7; Table 11 of Appendix J).

Figure 7: Mean level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement 'I don't think the cost savings are worth the effort.'



There was a marginally significant effect of timepoint, where all participants were less likely to report 'I don't think anyone else does it, so I don't either' as a reason for not shifting their energy consumption behaviour at the midterm survey timepoint compared to baseline or final timepoints (Table 14, Appendix J).

There were no significant differences between groups with respect to awareness (i.e. 'I didn't know Ontario had a Time-of-use pricing structure for electricity consumption'), provincial reasons (i.e. 'I don't think it contributes much to the province's electricity conservation efforts'), environmental reasons (i.e. 'I'm not too concerned about the environmental impact of my electricity consumption'), or comprehension reasons (i.e. 'It's too complicated for me to understand') for why they didn't shift their energy consumption behaviour.

Question 6: *Factors that influence why participants reported they did shift their energy consumption behaviour.*

We investigated how the three independent variables (***Timepoint***, ***Pricing group***, ***Communication group***) differed on ratings (1-7 scale) of agreement with five motivational factors:

1. To save money on my monthly bills *(cost)*

2. It was the environmentally responsible thing to do *(environmental)*

3. To be a good role model for others *(role model)*

4. Because others I know were also doing it *(social)*

5. It was convenient for me to shift my electricity consumption *(convenience)*

6. I purchased smart thermostats to automatically shift my electricity consumption *(thermostat)*

Overall, mean ratings for various motivational factors affecting why Enhanced pricing pilot participants did shift their energy consumption behaviour significantly differed from one another (Table 16 of Appendix J). Saving money was rated most highly as a factor for why participants shifted their behaviour followed by the fact that it was ‘Environmentally Responsible’. Mean ratings for each factor are presented in Figure 8.

Figure 8: Participants mean ratings for how much each factor influenced them to shift energy consumption behaviour (1-7 scale)

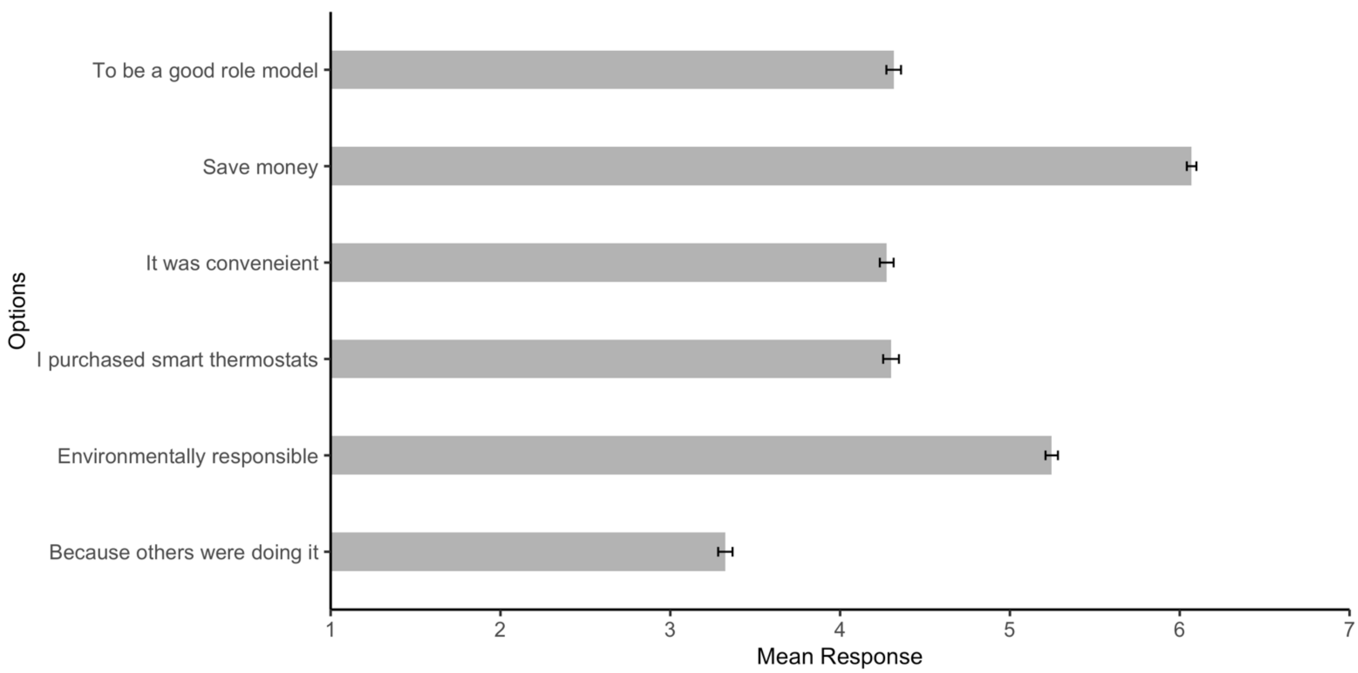


Table 117: Mean ratings for agreement with statements reflecting motivational reasons for why participants did shift energy consumption behaviour

		Enhanced Pricing Control		Enhanced Pricing Treatment	
Motivation	Timepoint	No Nudge	Nudge	No Nudge	Nudge
Cost	Baseline	6.3	6.4	6	6.3
	Midterm	6.1	6	5.9	6.1
	Final	6	6.1	6	6
Environment	Baseline	5.4	5.3	5.7	5.3
	Midterm	5	5.2	5.2	5.2
	Final	5.1	5.3	5.3	5.3
Role model	Baseline	4.4	4.4	4.6	4.5
	Midterm	4.2	4.4	3.8	4.2
	Final	4.3	4.4	4.3	4.4
Social	Baseline	3.1	3.4	3.3	3.1
	Midterm	3.2	3.3	3.1	3
	Final	3.6	3.5	3.2	3.2
Convenience	Baseline	4.6	4.3	4.3	4.6
	Midterm	4.3	4.1	3.8	4.3
	Final	4.2	4.4	4.1	4.5
smart thermostat	Baseline	4.4	4.1	4.4	4.7
	Midterm	4.3	4.1	4.5	4.2
	Final	4.4	4.3	4	4.3

The results of a multivariate analysis assessing the effects of timepoint, pricing group, and communication group on ratings for all six motivational factors show a significant effect of timepoint on cost (i.e. 'saving money') as a motivation for shifting electricity consumption (Table 17 of Appendix J). Participants in the Enhanced pricing pilot were less likely to agree with this statement at the final survey timepoint compared to baseline and midterm survey timepoints (Figure 9). Participants in the Enhanced pricing pilot were also marginally less likely to agree with social motivation (i.e. 'because others I know were also doing it') as a factor affecting a shift in their energy consumption behaviour (Figure 10; Table 20 of Appendix J).

Figure 9: Mean level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement 'To save money on my monthly bills.'

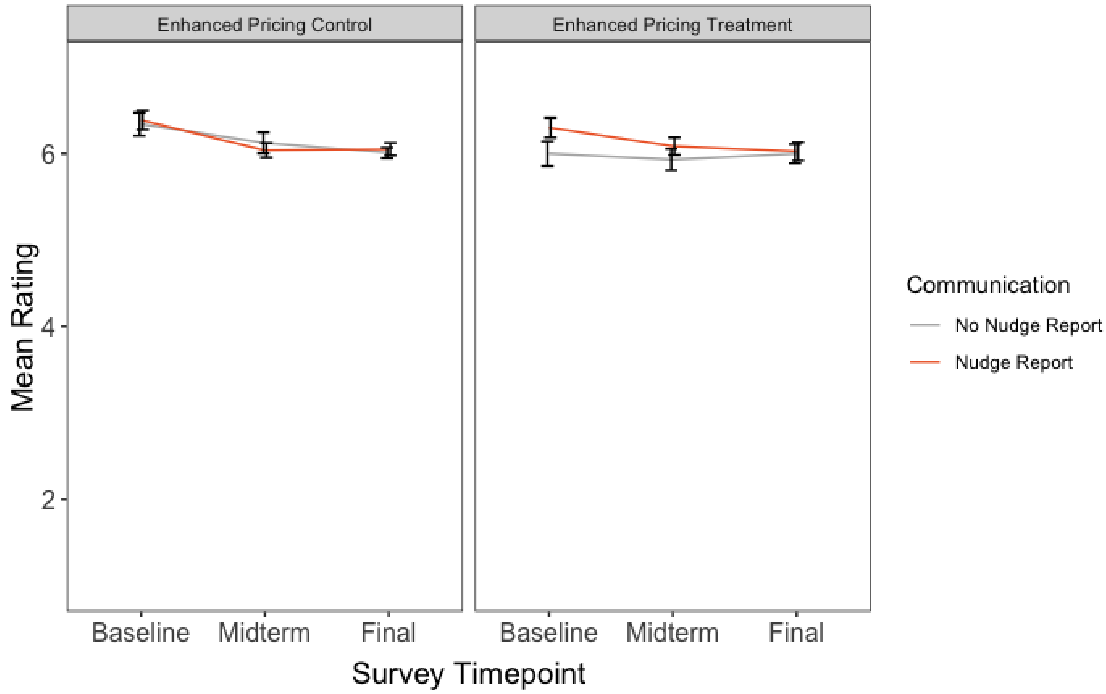
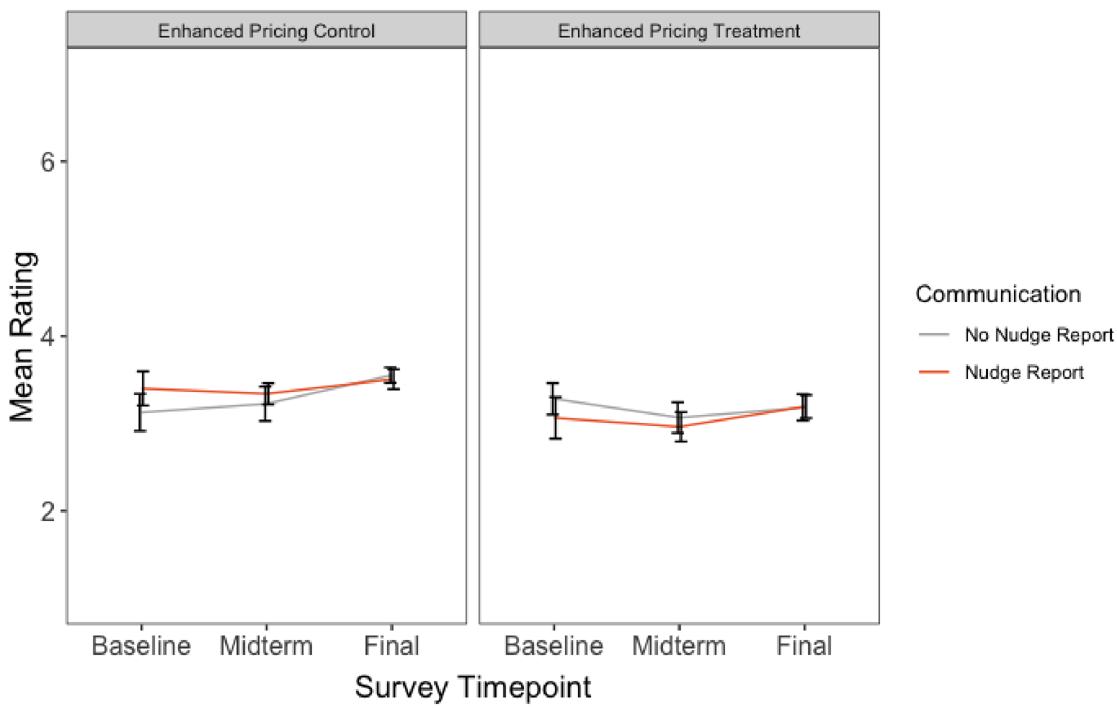


Figure 10: Mean level of agreement (from 1: 'strongly disagree' to 7: 'strongly agree') with the statement 'because others I know were also doing it.'



There were no significant differences between groups in ratings for any other motivational factors for why participants shifted their electricity consumption behaviour.

Conclusions - Enhanced Motivations: Participants in the Enhanced pricing pilot increasingly reported that they 'were already doing everything they can' to conserve electricity across the three survey timepoints. Participants in the Enhanced pricing Treatment group were less likely to report that TOU pricing affected how they consume electricity compared to the Control group over time.

Overall, motivation to *not* shift electricity consumption behaviour in the Enhanced pricing pilot was related to difficulty with shifting electricity use to Off-Peak hours, and the feeling that consumption shifts do not contribute to provincial energy conservation efforts. Participants rated 'difficulty' as a reason for not shifting their consumption behaviour lower over the course of the pilot. Enhanced pricing participants were less likely to report cost as the reason for not shifting their consumption behaviour at the midterm survey timepoint and Enhanced pricing Treatment participants who received a Nudge Report were even less likely to report cost as a reason for not shifting their behaviour at the midterm survey timepoint compared to status quo TOU Controls and those who did not receive a Nudge Report.

Enhanced pricing pilot participants were most motivated to shift their electricity consumption behaviour in order to save money and to be environmentally responsible. Enhanced pricing participants were less likely to report saving money and social reasons (i.e. because others are doing it) as motivations for shifting their consumption behaviour over time.

6.2.3 *Motivation: Overnight Pricing Pilot*

A lower than anticipated number of surveys were completed by Control participants for the Overnight pricing pilot. This is perhaps unsurprising since these matched Control participants did not know that their electricity consumption behaviour was being analyzed as part of the broader RPP pilot and because there were fewer potential respondents to begin with relative to the other two pilots. Therefore, we were only able to examine how scores on motivational factors changed across time within the Overnight pricing Treatment group.

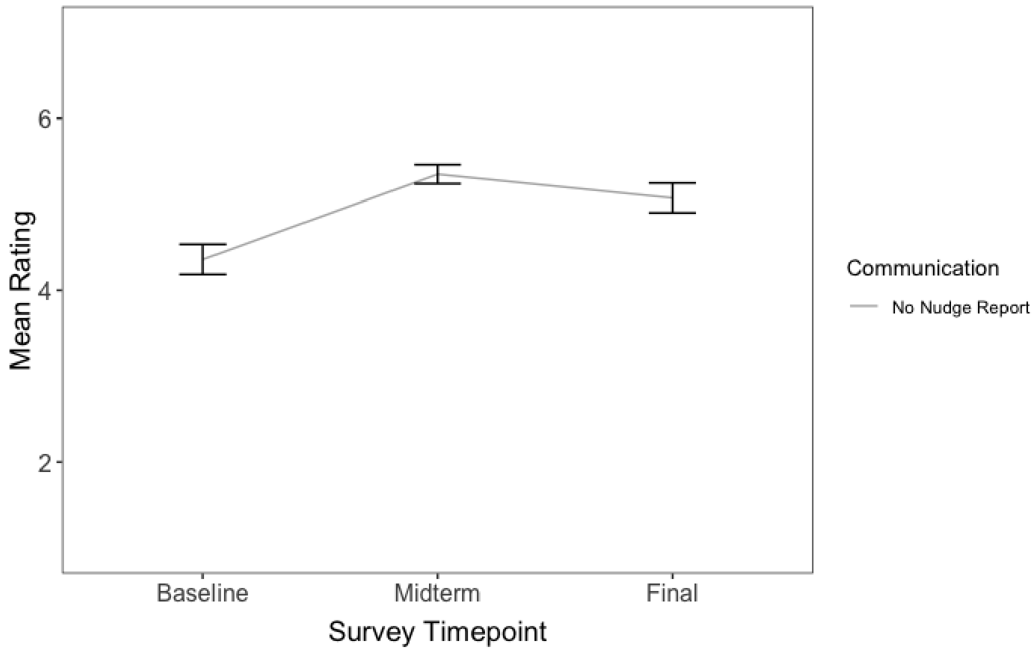
Question 1: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I don't think it is fair for the utility company to ask me to change my energy consumption behaviour.*

There was no effect of timepoint on responses to Question 1 in the Overnight pricing Treatment group. The mean level of agreement with this statement amongst Overnight pricing participants was 3.66 (+/- 1.69) on a scale of 1 to 7.

Question 2: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel like I am already doing everything I can to conserve energy.*

Participants in the Overnight pricing pilot had significantly higher ratings over time on their responses to Question 2. They reported feeling more strongly that they were doing everything they could to conserve energy at the midterm and final survey timepoints compared to baseline (Figure 11; Table 24 of Appendix J).

Figure 11: Participant reported scores (1-7 scale) for agreement with the statement: 'I feel like I am already doing everything I can to conserve energy'



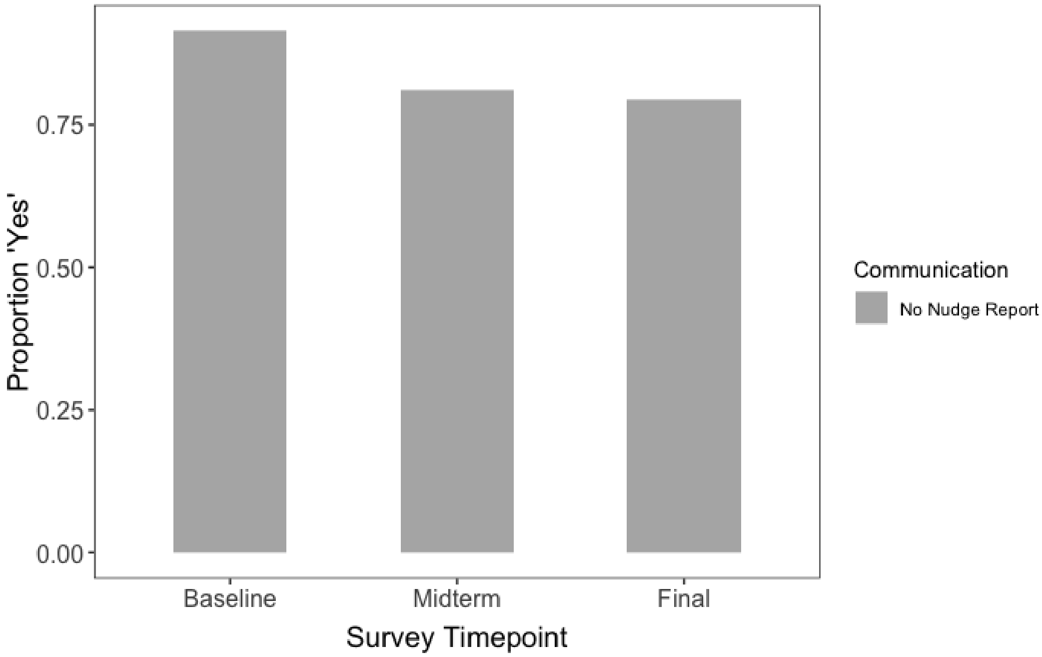
Question 3: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel motivated to conserve On-Peak electricity and/or shift my electricity usage to Off-Peak.*

There was no effect of timepoint on agreement levels with Question 3. Participants had similar levels of motivation to conserve On-Peak electricity in the Overnight pricing pilot across all three survey timepoints. The mean level of agreement for Overnight pricing participants was 5.81 (+/- 1.19) on a scale of 1 to 7.

Question 4: *Has TOU affected your energy consumption?*

Overnight pricing Treatment participants were more likely to report 'Yes', that TOU pricing did affect their energy consumption at baseline compared midterm or final survey timepoints (Figure 12, Table 26 of Appendix J).

Figure 12: Proportion of Overnight Pricing Pilot participants who responded 'Yes' to the question "Has TOU pricing affected your energy consumption?"



Question 5: *Factors that influence why participants reported that they did not shift their energy consumption behaviour.*

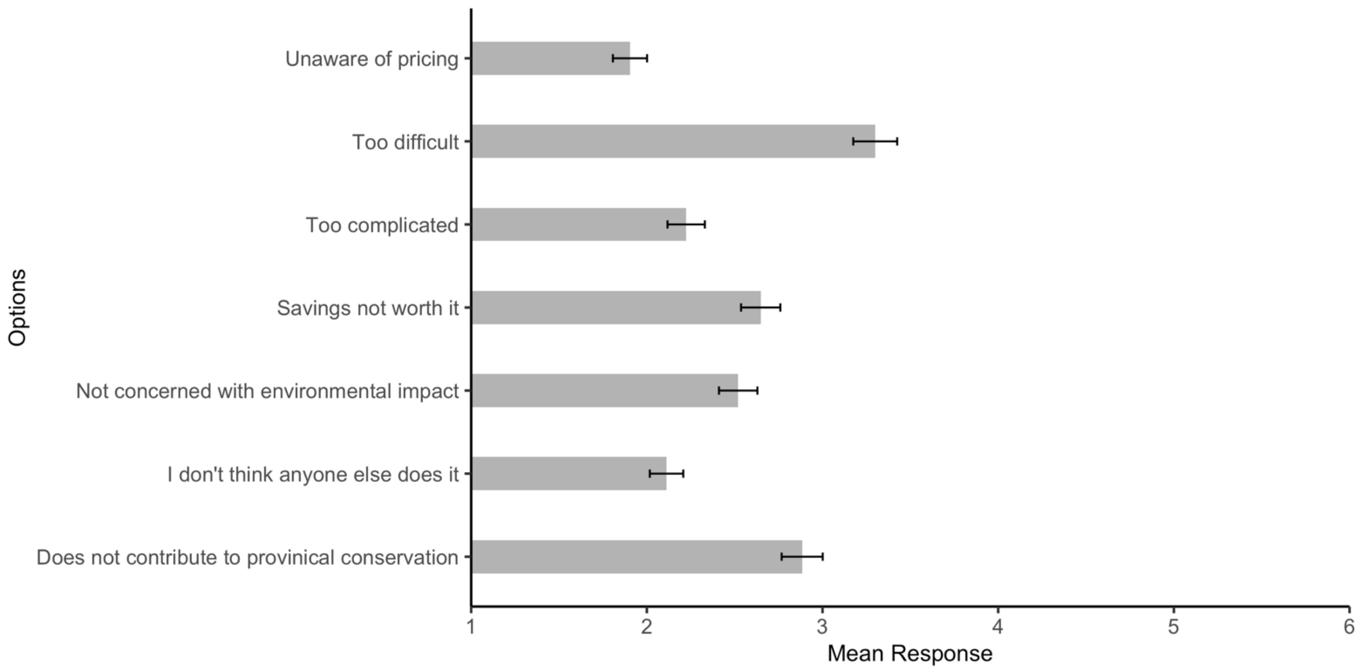
Motivational factors affecting why participants in the Overnight pricing pilot did not shift their consumption behaviour significantly differed from one another in terms of ratings of agreement (Table 27 of Appendix J). Difficulty shifting electricity consumption behaviour to Off-Peak hours received the highest ratings, followed by provincial reasons (i.e. does not contribute to provincial conservation). Mean ratings for each motivational factor are presented in

Figure 13 and summarized in Table 118.

Table 118: Mean levels of agreement (1-7 scale) with motivational factors for not shifting energy behaviour in Overnight Pricing Treatment participants

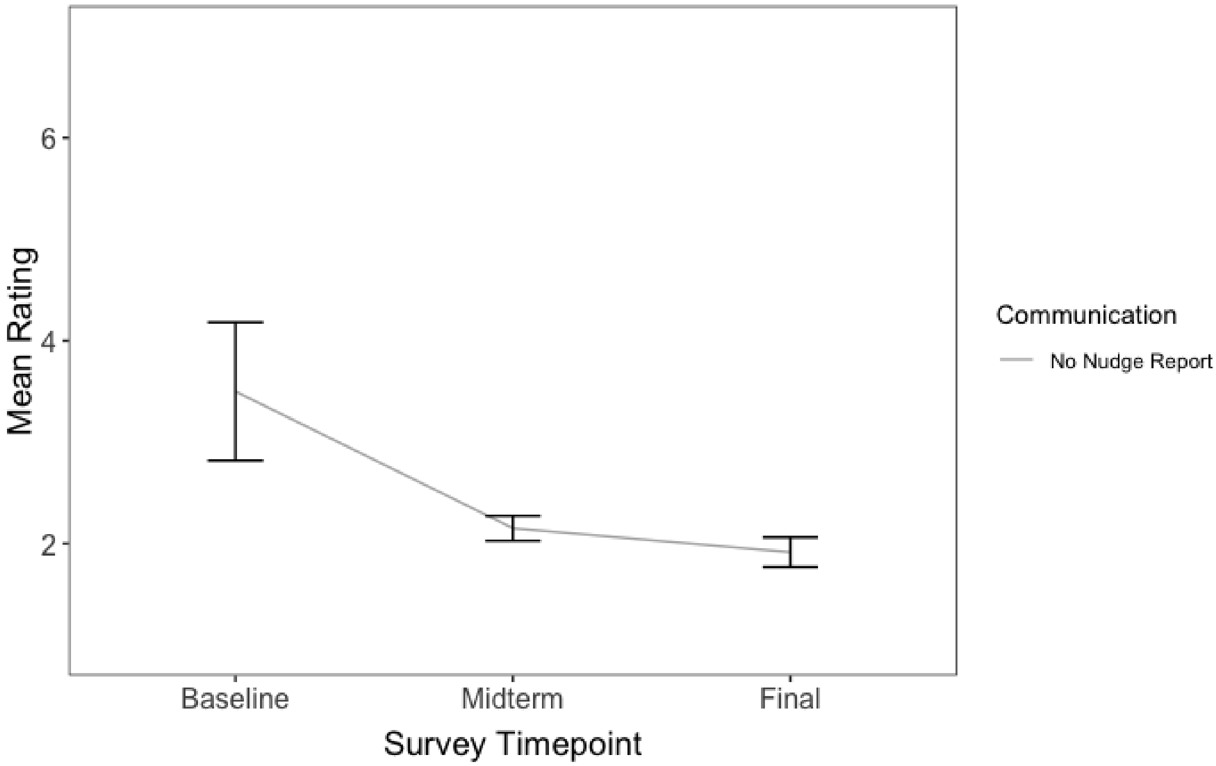
Motivation	Timepoint	Overnight Pricing Treatment
Awareness	Baseline	1.9
	Midterm	1.9
	Final	1.9
Difficulty	Baseline	4.1
	Midterm	3.3
	Final	3.2
Cost	Baseline	3.3
	Midterm	2.6
	Final	2.7
Provincial	Baseline	3.5
	Midterm	2.9
	Final	2.9
Environment	Baseline	3.6
	Midterm	2.5
	Final	2.5
Social	Baseline	3.5
	Midterm	2.2
	Final	1.9
Comprehension	Baseline	3.3
	Midterm	2.2
	Final	2.1

Figure 13: Participants mean ratings for how much each factor influenced them to not shift energy consumption behaviour (1-7 scale)



There was a significant effect of timepoint on reported agreement with the statement 'I don't think anyone else does it, so I don't either' (social) in the Overnight pricing pilot, where participants had lower agreement with this statement at midterm compared to baseline, and even lower agreement with this statement at the final survey timepoint compared to baseline (Figure 14; Table 33 of Appendix J).

Figure 14: Mean level of agreement with the statement 'I don't think anyone else does it, so I don't either' as a motivation for why participants did not shift energy consumption behaviour



There were no significant differences between groups for any other motivational factor affecting why participants did not shift their electricity consumption behaviour.

Question 6: *Factors that influence why participants reported that they did shift their energy consumption behaviour.*

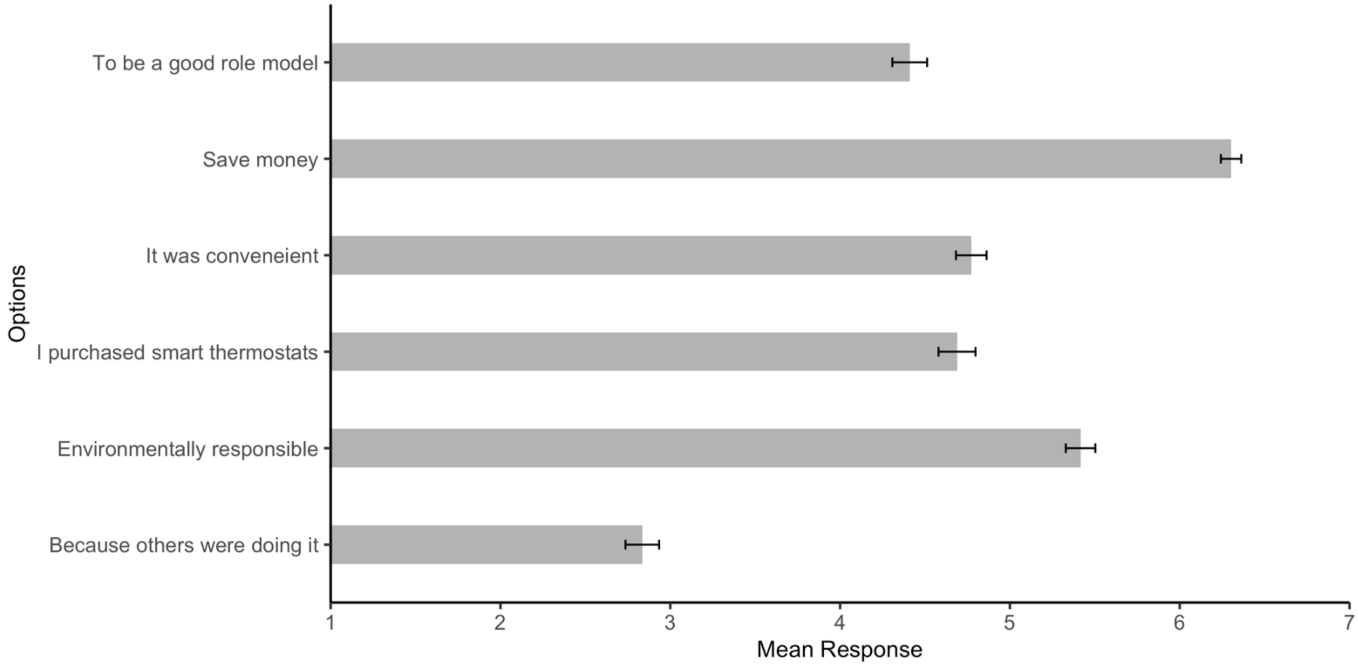
Overall, mean ratings for various motivational factors affecting why Overnight Pricing Pilot participants did shift their electricity consumption behaviour significantly differed from one another (Table 35 of Appendix J). Agreement with 'saving money' as a motivational factor for influencing a shift in behaviour was highest amongst Overnight pricing pilot participants. Environmental responsibility was rated the second highest as a motivation for shifting consumption behaviour. Mean ratings for each factor are presented in

Figure 15 and summarized in Table 119.

Table 119: Mean levels of agreement (1-7 scale) with motivational factors for shifting energy behaviour in Overnight Pricing Treatment participants

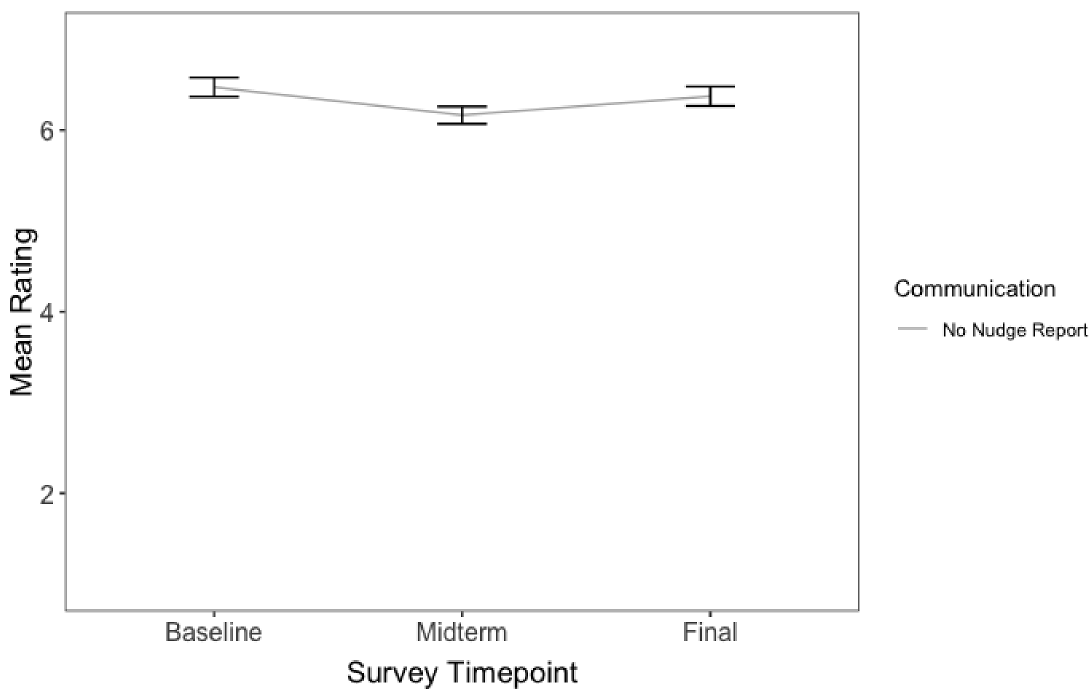
Motivation	Timepoint	Overnight Pricing Treatment
Cost	Baseline	6.5
	Midterm	6.2
	Final	6.4
Environment	Baseline	5.6
	Midterm	5.4
	Final	5.4
Role model	Baseline	4.4
	Midterm	4.4
	Final	4.6
Social	Baseline	2.6
	Midterm	2.9
	Final	2.8
Convenience	Baseline	4.6
	Midterm	5.1
	Final	4.5
smart thermostat	Baseline	4.9
	Midterm	4.7
	Final	4.5

Figure 15: Participants mean ratings for how much each factor influenced them to shift energy consumption behaviour (1-7 scale)



There was a significant effect of timepoint on level of agreement with the statement 'To save money on my monthly bills' (cost) as a reason for why participants in the Overnight Pricing Pilot claimed to have shifted their electricity consumption behaviour (Figure 16). Participants rated this reason for why they shifted their behaviour lower at the midterm survey timepoint compared to baseline (Table 36 of Appendix J).

Figure 16: Participants mean ratings for how much cost influenced them to shift energy consumption behaviour (1-7 scale)



There were no other significant effects of timepoint on motivational factors for why participants claimed to have shifted their electricity consumption in the Overnight Pricing Treatment group.

Conclusions - Overnight Motivations: Based on the small number of surveys completed by the matched Control group we were only able to examine Overnight pricing Treatment survey responses over time. Further, no participants received a Nudge Report in the Overnight pricing pilot, so unlike with the other pilots, this was not a factor in our analysis.

Overnight pricing Treatment participants agreed more with the statement ‘I’m already doing everything I can to change my energy consumption behaviour’ over time and felt less that TOU pricing had changed their energy consumption behaviour over time. Overnight pricing pilot participants rated ‘difficulty’ and ‘doesn’t contribute to provincial energy conservation’ most highly as motivations for not shifting their energy consumption behaviour. Overnight pricing Treatment participants agreement with social motivations as a reason for not shifting their energy behaviour decreased over time.

Participants rated ‘saving money’ and ‘because others are doing it’ most highly as motivations for why they feel they shifted their electricity consumption behaviour in response to Overnight pricing. Overnight pricing participants rated ‘saving money’ as a reason for shifting their behaviour lower at the midterm survey timepoint relative to the other survey timepoints.

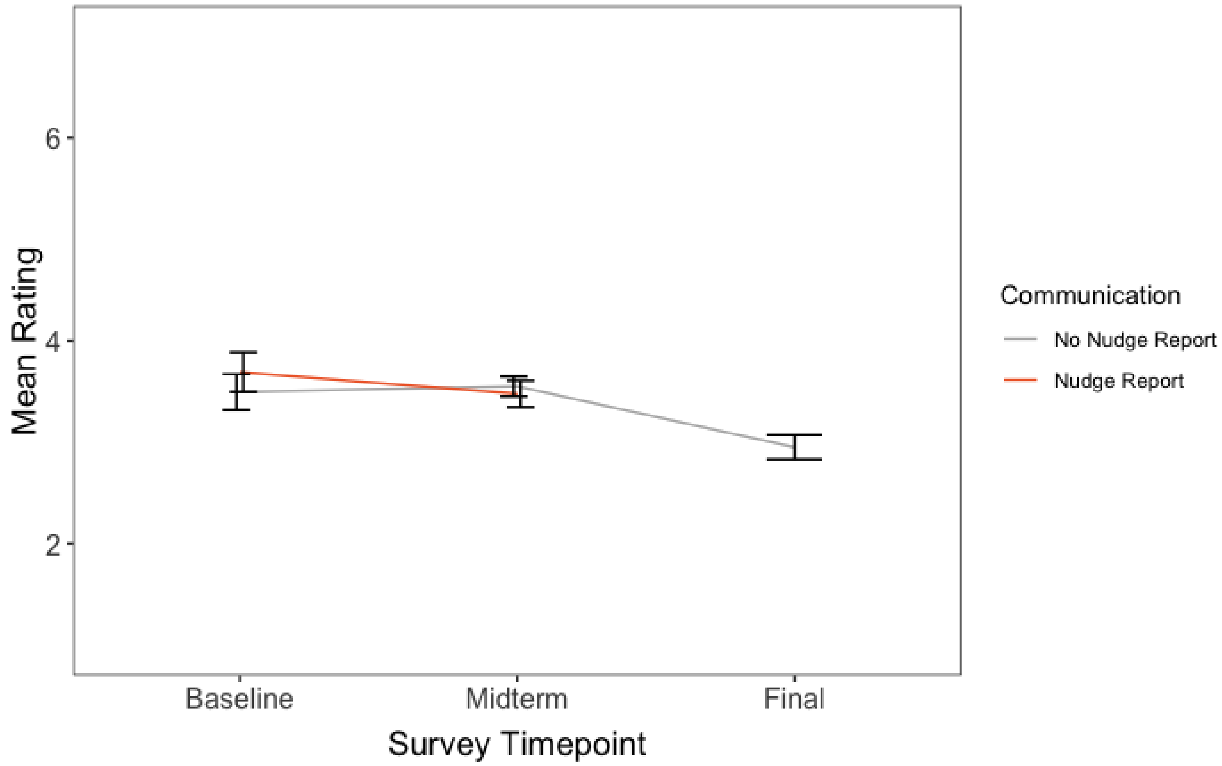
6.2.4 *Motivation: Dynamic Pricing Pilot*

There were not enough survey completions at the baseline and midterm survey timepoints for Dynamic pricing Control households, and therefore we only analyzed survey responses for the Dynamic pricing Treatment respondents over time.

Question 1: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I don’t think it is fair for the utility company to ask me to change my energy consumption behaviour.*

Participants in the Dynamic pricing Treatment group had lower ratings of agreement with the statement ‘I don’t think it is fair for the utility company to ask me to change my energy consumption behaviour’ at the final survey timepoint compared to baseline (Figure 17; Table 41 of Appendix J).

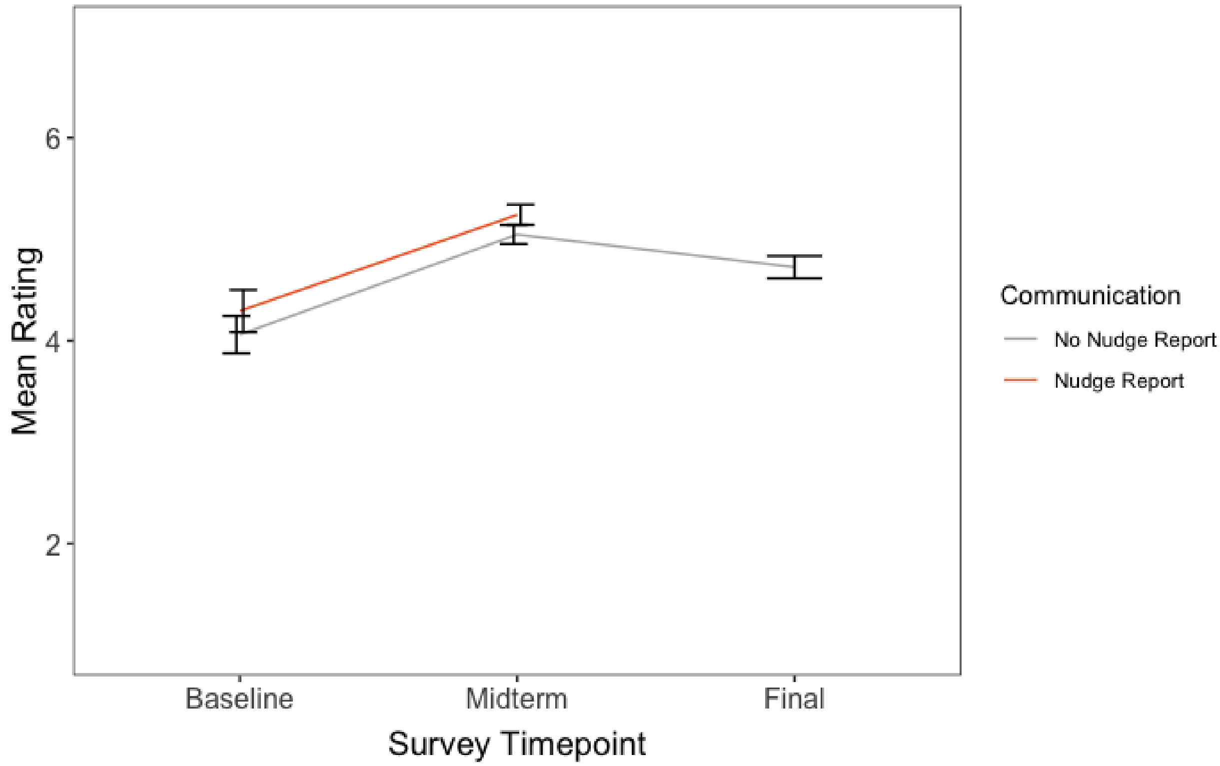
Figure 17: Participants mean ratings for agreement with the statement 'I don't think it is fair for the utility company to ask me to change my energy consumption behaviour' (1-7 scale)



Question 2: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel like I am already doing everything I can to conserve energy.*

There was a significant effect of timepoint on level of agreement with the statement 'I feel like I am already doing everything I can to conserve energy' whereby participants in the Dynamic pricing Treatment group had higher levels of agreement with this statement at the midterm and final survey timepoints compared to baseline (Figure 18; Table 42 of Appendix J).

Figure 18: Participants mean ratings for agreement with the statement 'I feel like I am already doing everything I can to conserve energy' (1-7 scale)



Question 3: *Rate your level of agreement with the following statement on a scale from 1: "Strongly Disagree" to 7: "Strongly Agree": I feel motivated to conserve On-Peak electricity and/or shift my electricity usage to Off-Peak.*

There were no differences between Dynamic pricing groups on responses to Question 3. Participants agreed with this statement on average, with a mean level of agreement of 5.70 (+/- 1.25) on a scale of 1 to 7.

Question 4: *Has TOU affected your energy consumption?*

There were no significant differences between groups in terms of likelihood of reporting that TOU pricing affected electricity consumption. Proportion who reported 'Yes' for each group/condition are recorded in Table 120.

Table 120: Percentage of participants for each condition who responded that TOU pricing has affected their energy consumption

	Dynamic Pricing Control	Dynamic Pricing Treatment

Survey Timepoint	No Nudge	Nudge	No Nudge	Nudge
Baseline	100.0%	100.0%	95.2%	86.2%
Midterm	100.0%	N/A	90.2%	85.5%
Final	N/A	N/A	91.0%	N/A

Question 5: *Factors that influence why participants reported that they did not shift their energy consumption behaviour.*

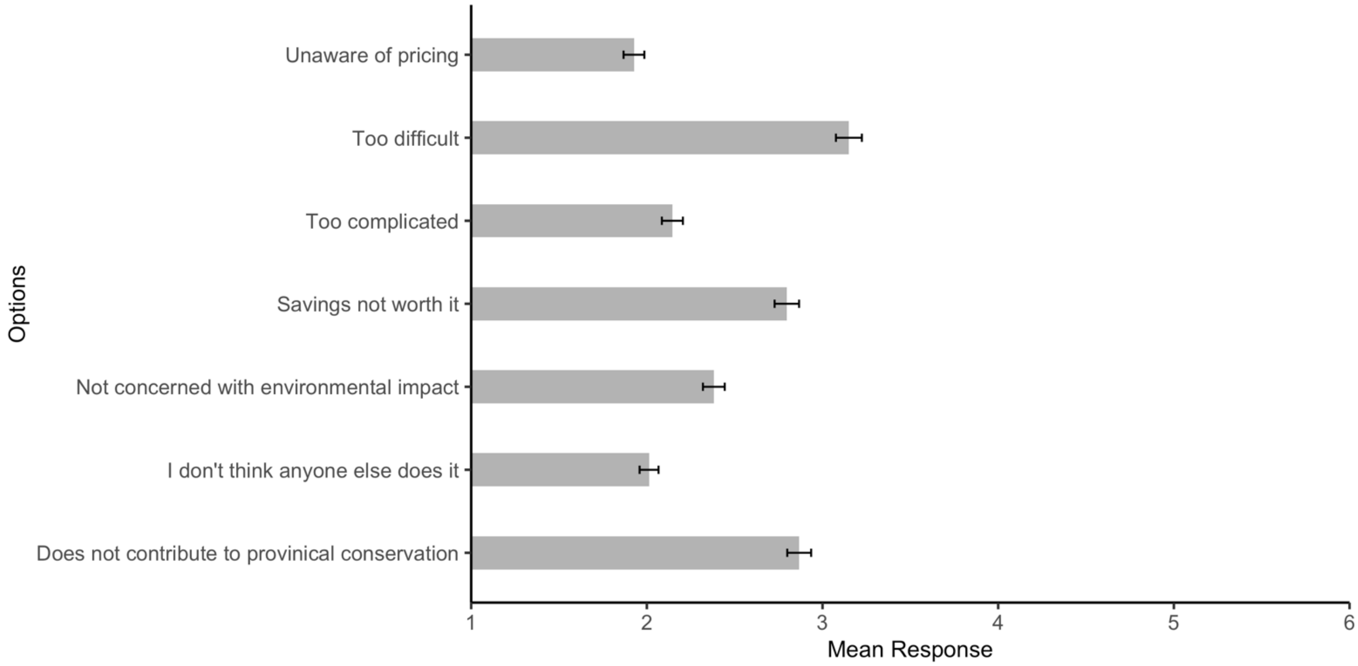
Overall, mean ratings for various motivational factors affecting why Dynamic pricing Treatment participants claim they did not shift their electricity consumption behaviour in response to Dynamic pricing significantly differed from one another (Table 45 of Appendix J). Difficulty in shifting energy consumption behaviour was rated most highly as a factor for why participants did not shift their behaviour followed by provincial reasons (i.e. does not contribute to provincial energy conservation). Mean ratings for each factor are displayed in

Figure 19 and summarized in Table 121.

Table 121: Mean levels of agreement (1-7 scale) with motivational factors for not shifting energy behaviour in Dynamic Pricing Treatment participants

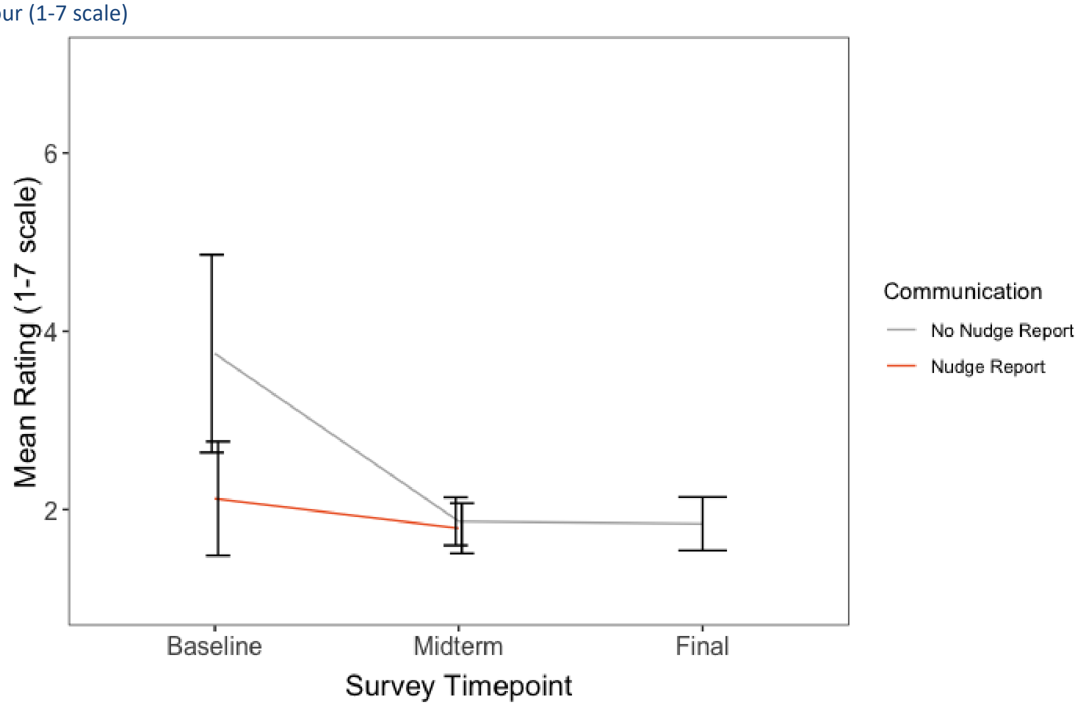
Motivation	Timepoint	Dynamic Pricing Treatment
Awareness	Baseline	2.7
	Midterm	1.8
	Final	1.8
Difficulty	Baseline	3.0
	Midterm	3.9
	Final	3.7
Cost	Baseline	2.5
	Midterm	3.8
	Final	3.7
Provincial	Baseline	3.3
	Midterm	3.7
	Final	3.8
Environment	Baseline	2.3
	Midterm	3.1
	Final	2.3
Social	Baseline	2.0
	Midterm	2.3
	Final	2.1
Comprehension	Baseline	2.8
	Midterm	3.0
	Final	2.5

Figure 19: Participants mean ratings for how much each factor influenced them to not shift energy consumption behaviour (1-7 scale)



Participants in the Dynamic pricing pilot had reduced feelings of ‘lack of awareness’ as a motivation for why they did not shift their electricity consumption behaviour over the course of the Dynamic pricing pilot. Specifically, their level of agreement with the statement ‘I didn’t know Ontario had a Time-of-use pricing structure for electricity consumption’ decreased at the midterm and final survey timepoints compared to baseline (Figure 20; Table 46 of Appendix J).

Figure 20: Participants mean ratings for how much ‘lack of awareness’ influenced them not to shift energy consumption behaviour (1-7 scale)



No other responses to Question 5 differed significantly different between groups (pricing Treatment, Control; Nudge Report, no Nudge Report) or across time in the Dynamic pricing pilot.

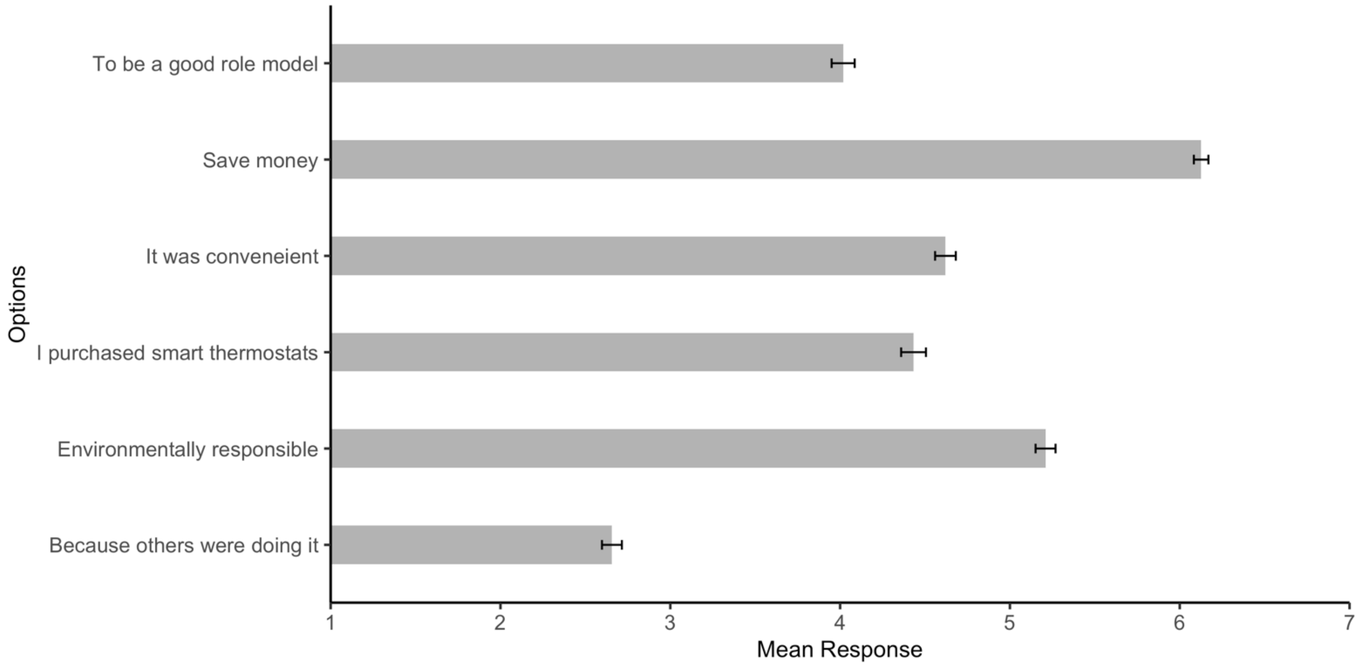
Question 6: *Factors that influence why participants reported that they did shift their energy consumption behaviour.*

Overall, mean ratings for various motivational factors affecting why Dynamic pricing pilot Treatment participants feel they *did* shift their electricity consumption behaviour significantly differed from one another (Table 53 of Appendix J). 'Saving money' was rated most highly as factor for why participants shifted their behaviour followed by environmental responsibility. Mean ratings for each factor are presented in Figure 21 and summarized in Table 122.

Table 122: Mean levels of agreement (1-7 scale) with motivational factors for shifting energy behaviour in Dynamic Pricing Treatment participants

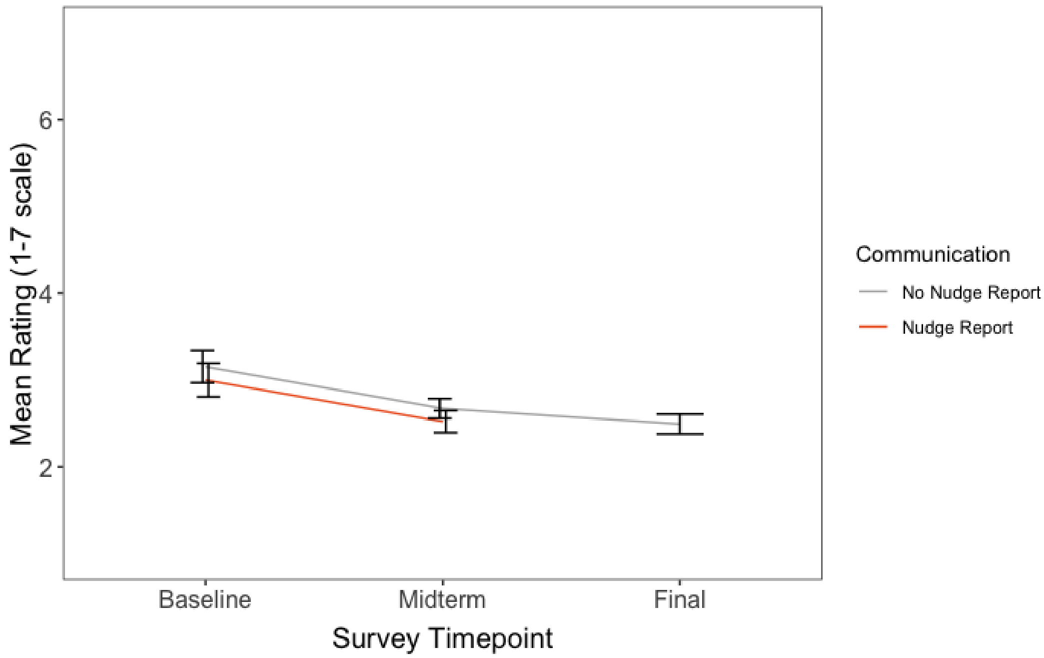
Motivation	Timepoint	Dynamic Pricing Treatment
Cost	Baseline	6.2
	Midterm	6.1
	Final	6.3
Environment	Baseline	5.3
	Midterm	5.1
	Final	5.4
Role model	Baseline	4.2
	Midterm	4.0
	Final	4.1
Social	Baseline	3.1
	Midterm	2.6
	Final	2.5
Convenience	Baseline	4.8
	Midterm	4.4
	Final	5.1
smart thermostat	Baseline	4.8
	Midterm	4.3
	Final	4.6

Figure 21: Participants mean ratings for how much each factor influenced them to shift energy consumption behaviour (1-7 scale)



There was a significant effect of timepoint on agreement levels with social motivation (i.e. 'because others I know were also doing it') as a reason for why participants in the Dynamic pricing pilot shifted their electricity consumption behaviour (Table 57 of Appendix J). Participants in the Dynamic pricing Treatment group had significantly lower agreement ratings for this factor at the midterm survey compared to baseline and even lower agreement at the final survey timepoint compared to baseline (Figure 22).

Figure 22: Participants mean ratings for how much social factors influenced them to shift energy consumption behaviour (1-7 scale)



There was a significant effect of timepoint on agreement with convenience (i.e. 'it was convenient for me to shift my energy consumption') and purchasing smart thermostats as motivational factors for why participants in the Dynamic pricing Treatment group shifted their electricity consumption behaviour. Agreement ratings with both of these factors were lower at the midterm survey timepoint compared to baseline (Figure 23, Table 58, Appendix J & Figure 24, Table 59, Appendix J).

Figure 23: Participants mean ratings for how much convenience influenced them to shift energy consumption behaviour (1-7 scale)

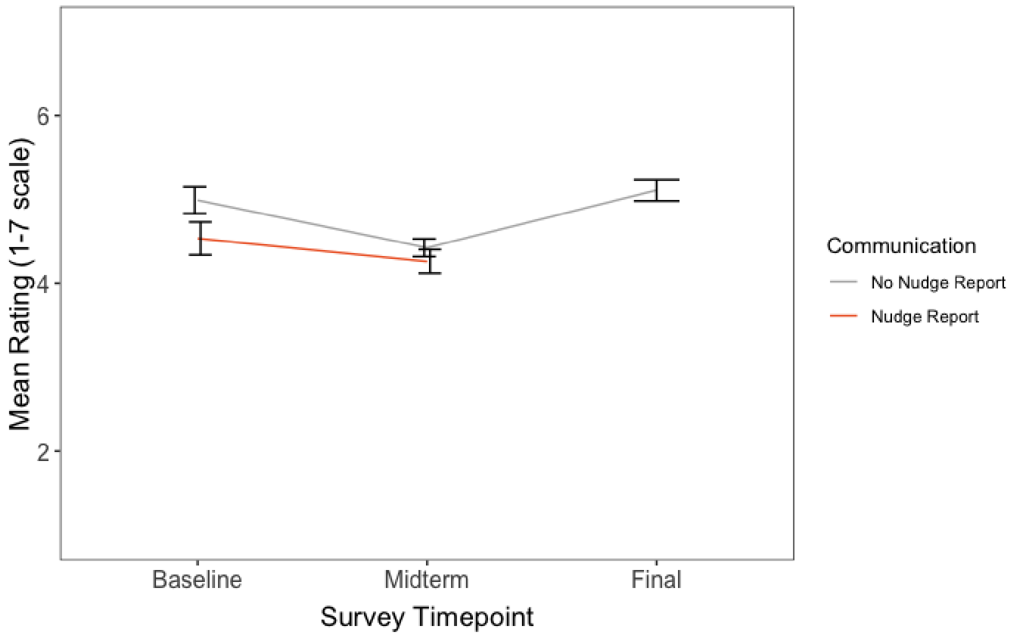
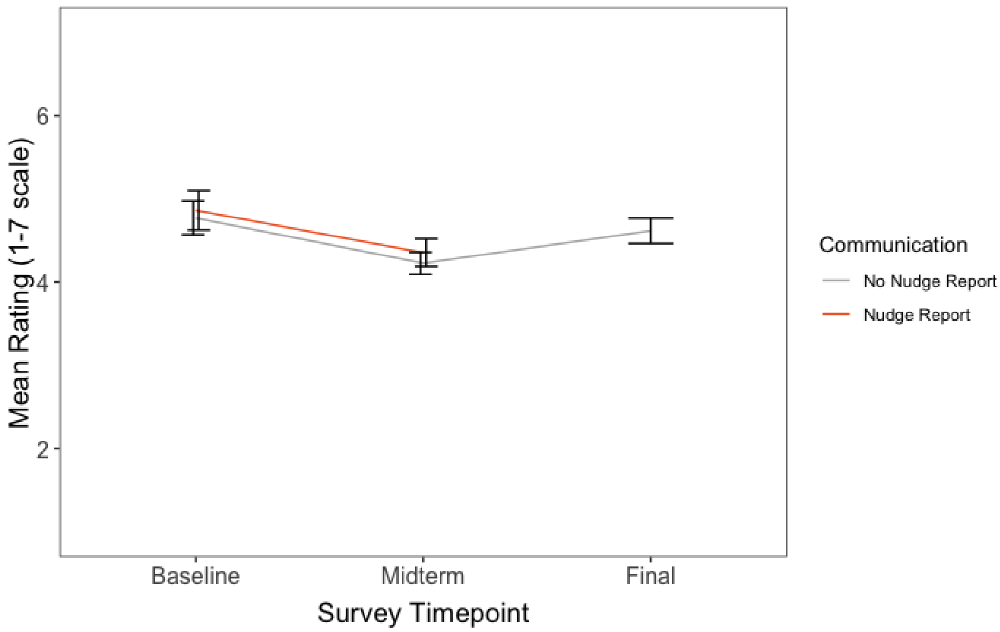


Figure 24: Participants mean ratings for how much purchasing a smart thermostat influenced them to shift energy consumption behaviour (1-7 scale)



Conclusions - Dynamic Pricing Pilot Motivations: Based on the small number of surveys completed by the Dynamic pricing Control group, we were only able to examine Dynamic pricing Treatment participant responses *over time.*

Dynamic pricing Treatment participants had lower agreement with the statement 'I don't think it is fair for the utility company to ask me to change my energy consumption behaviour' over time and also felt more strongly that they were 'doing everything they can' to conserve electricity over the course of the Dynamic pilot. Most Dynamic pricing participants felt that TOU pricing did affect their consumption behaviour. For those who reported that TOU pricing did not affect their consumption behaviour, ‘difficulty shifting energy consumption to Off-Peak hours’ and ‘doesn’t contribute to provincial energy conservation’ were rated most highly as motivations for not shifting their behaviour.

In terms of what Dynamic pricing participants felt *did* affect their electricity consumption behaviour, saving money and environmental responsibility were rated most highly as reasons for shifting behaviour. Participants rated social reasons for shifting their behaviour lower over the course of the pilot, and also reported convenience and the use of smart thermostats lower at the midterm survey timepoint compared to baseline and final survey timepoints.

6.3 Participant Experience

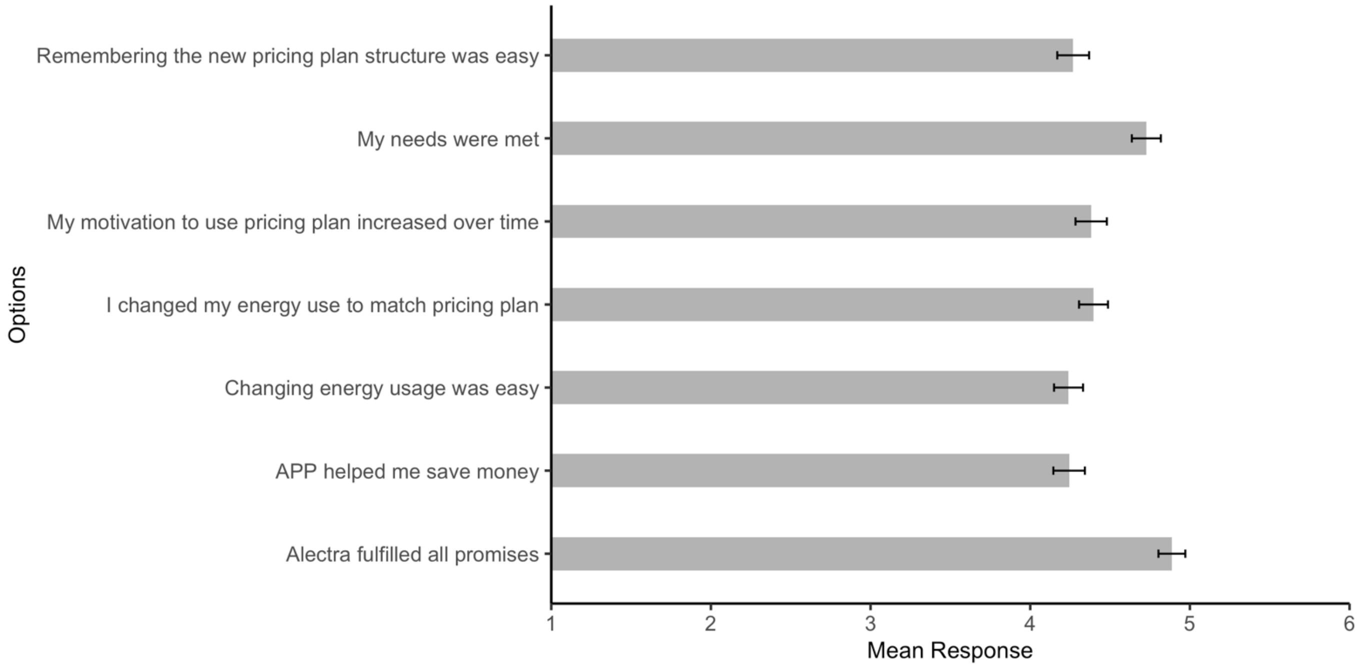
Participants in each of the Advantage Power Pricing (APP) Treatment groups were asked several questions related to their experience in the APP program at the final survey timepoint (questions are listed in Appendix K). Here we review responses to these questions in each pricing pilot in order to quantify their subjective experience with APP.

6.3.1 *Participant Experience: Enhanced Pricing Pilot*

There were significant differences in the degree to which participants in the Enhanced pricing Pilot agreed with the seven statements related to their subjective experience (

Figure 25, Tables 60-67 of Appendix J). On average, participants in the Enhanced pricing pilot agreed that Alectra fulfilled all of their promises related to APP, and that their needs were met as customers throughout their participation in the program.

Figure 25: Enhanced Pricing participant mean levels of agreement with key subjective aspects of Alternative Pricing Plan participation



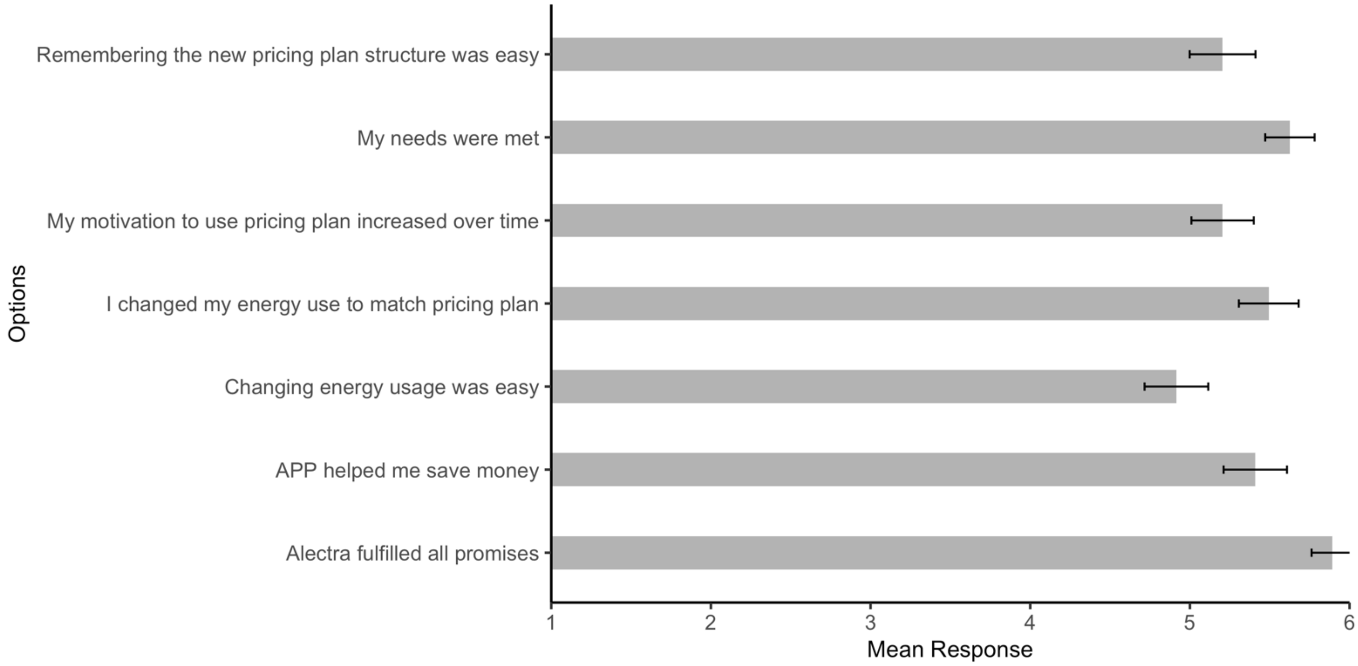
Overall, participants in the Enhanced pricing pilot were satisfied with their experience in the APP program with a mean rating of 4.63 (+/- 1.56) on a scale of 1 to 7. There was no significant difference in mean rating between communication groups (those who did versus those who did not receive Nudge Reports) in the Enhanced pricing pilot (Table 68 of Appendix J). Participants in the Enhanced pricing Treatment group were also likely to recommend (i.e. above neutral) APP to others, with a mean rating of 4.59 (+/- 1.62) on a 1 to 7 scale. Most survey respondents (93.8%) in the Enhanced pricing Treatment group did not contact Alectra with any issues over the course of the pilot.

6.3.2 *Participant Experience: Overnight Pricing Pilot*

There were significant differences in the degree to which participants in the Overnight pricing pilot agreed with the seven statements related to their subjective experience (

Figure 26; Table 69 of Appendix J). Overall, participants in the Overnight pricing pilot most strongly agreed with the statement that Alectra fulfilled all promises related to APP and that their needs were met as customers throughout their experience.

Figure 26: Overnight Pricing participant mean levels of agreement with key subjective aspects of Alternative Pricing Plan participation



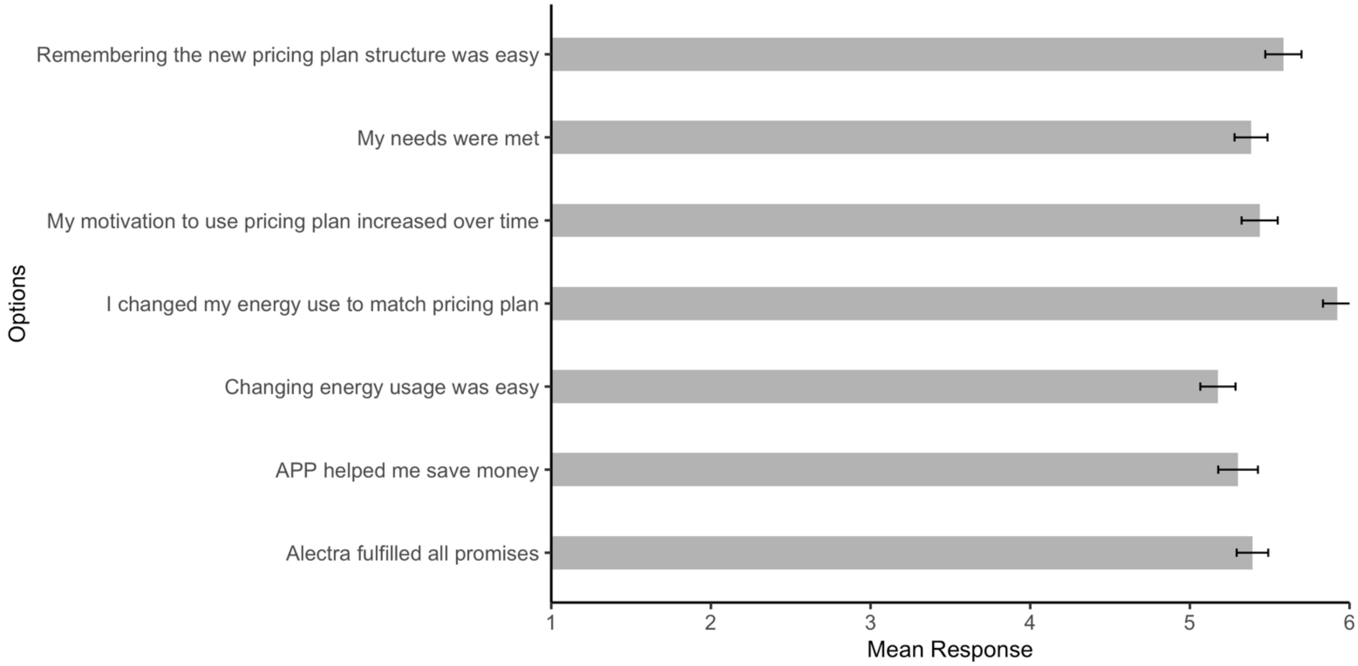
Overall, the participants in the Overnight pricing pilot were satisfied with their experience in APP with a mean rating of 5.59 (+/- 1.54) on a scale of 1 to 7. Participants in the Overnight pricing Treatment group were also likely to recommend (i.e. above neutral) APP to others, with a mean rating of 5.66 (+/- 1.68) on a 1 to 7 scale. Most survey respondents (81.9%) in the Overnight pricing Treatment group did not contact Alectra with any issues over the course of the pricing pilot.

6.3.3 *Participant Experience: Dynamic Pricing Pilot*

There were significant differences in the degree to which participants in the Dynamic pricing pilot agreed with the seven statements related to their subjective experience (

Figure 27; Table 70 of Appendix J). Overall, participants had the highest ratings of agreement with the statement ‘I changed my energy use behaviour to match my new pricing plan’ and ‘Remembering the new pricing plan structure was easy’ suggesting that they were able to successfully remember and adopt new electricity consumption behaviours.

Figure 27: Dynamic Pricing participant mean levels of agreement with key subjective aspects of Alternative Pricing Plan participation



Overall, the participants exposed to Dynamic pricing had the highest numerical levels of satisfaction (relative to the other pricing pilots, although ratings on these subjective experiential statements were not statistically compared between pilots) with their experience in APP, with a mean rating of 5.64 (+/- 1.55) on a scale of 1 to 7. Participants in the Dynamic pricing Treatment group were also likely to recommend (i.e. above neutral) APP to others, with a mean rating of 5.64 (+/- 1.66) on a 1 to 7 scale. Most survey respondents (76.7%) in the Dynamic pricing Treatment group did not contact Alectra with any issues over the course of the pilot.

6.4 Participant Demographics

Participants were asked a series of demographic questions at the end of each survey. The primary purpose of these questions was to provide a comprehensive picture of the make-up of the APP participants. These demographic responses should provide useful information for the scalability of the APP price plans to other markets. As with any pilot project, the interpretability and generalizability of the behavioural findings are limited to the characteristics of the sample with whom the pilot was conducted. A few of the noteworthy observations from the demographic questionnaire: (1) over 79% of respondents across all three pilots report owning some type of programmable thermostat, (2) less than 7% of respondents across all three pilots indicate heating their homes primarily with electricity, (3) over 90% of respondents across all three pilots indicate having central Air Conditioning, and (4) while the reported incidence of electric vehicle ownership is relatively low in the Enhanced and Dynamic pilots (approximately 4% and 7% respectively) a relatively high proportion of respondents in the Overnight pilot report owning an electric vehicle (43%) suggesting that Overnight pricing holds special appeal to this customer segment. We note however, that since survey responses were completely voluntary, sample characteristic data from respondents may be somewhat skewed due to selection bias; caution should be used when interpreting the demographic responses as will all other survey-derived insights reported here. A full list of demographic survey questions can be found in Appendix K.

6.4.1 *Participant Demographics: Enhanced Pricing Pilot*

Table 123: Enhanced Pricing Pilot Demographics

	Enhanced Pricing Control (N=1135)	Enhanced Pricing Treatment (N=660)	Total (N=1795)
Residence			
N-Missing	0 (0.0%)	7 (1.1%)	7 (0.4%)
Duplex or two-family home	52 (4.6%)	34 (5.2%)	86 (4.8%)
High-rise apartment or condo building	3 (0.3%)	4 (0.6%)	7 (0.4%)
Low-rise apartment or condo building	17 (1.5%)	12 (1.8%)	29 (1.6%)
Other (please enter)	6 (0.5%)	3 (0.5%)	9 (0.5%)
Single-family home	845 (74.4%)	435 (65.9%)	1280 (71.3%)
Townhouse or row-house	208 (18.3%)	162 (24.5%)	370 (20.6%)
What type of residence do you live in? - Selected Choice	0 (0.0%)	0 (0.0%)	0 (0.0%)
Other (please indicate)	4 (0.4%)	3 (0.5%)	7 (0.4%)
Year Home Built			
N-Missing	0 (0.0%)	7 (1.1%)	7 (0.4%)
1920 or before	7 (0.6%)	2 (0.3%)	9 (0.5%)
1921 - 1945	6 (0.5%)	4 (0.6%)	10 (0.6%)
1946 - 1960	33 (2.9%)	13 (2.0%)	46 (2.6%)

	Enhanced Pricing Control (N=1135)	Enhanced Pricing Treatment (N=660)	Total (N=1795)
Year Home Built			
1961 - 1970	44 (3.9%)	24 (3.6%)	68 (3.8%)
1971 - 1980	80 (7.0%)	38 (5.8%)	118 (6.6%)
1981 - 1985	100 (8.8%)	67 (10.2%)	167 (9.3%)
1986 - 1990	118 (10.4%)	68 (10.3%)	186 (10.4%)
1991 - 1995	78 (6.9%)	36 (5.5%)	114 (6.4%)
1996 - 2000	129 (11.4%)	71 (10.8%)	200 (11.1%)
2001 - 2005	162 (14.3%)	115 (17.4%)	277 (15.4%)
2006 - 2011	182 (16.0%)	99 (15.0%)	281 (15.7%)
2012 - 2016	25 (2.2%)	30 (4.5%)	55 (3.1%)
2012 - 2017	146 (12.9%)	70 (10.6%)	216 (12.0%)
Unsure	25 (2.2%)	16 (2.4%)	41 (2.3%)
Thermostat			
N-Missing	0 (0.0%)	7 (1.1%)	7 (0.4%)
No	233 (20.5%)	131 (19.8%)	364 (20.3%)
Yes	902 (79.5%)	522 (79.1%)	1424 (79.3%)
Thermostat Type			
N-Missing	170 (15.0%)	96 (14.5%)	266 (14.8%)
ecobee	167 (14.7%)	101 (15.3%)	268 (14.9%)
Energate Foundation	53 (4.7%)	44 (6.7%)	97 (5.4%)
Honeywell UtilityPRO or ExpressStat	334 (29.4%)	247 (37.4%)	581 (32.4%)
Nest	222 (19.6%)	87 (13.2%)	309 (17.2%)
Other (please enter)	189 (16.7%)	85 (12.9%)	274 (15.3%)
Primary Heating Method			
N-Missing	0 (0.0%)	176 (26.7%)	176 (9.8%)
Boiler with hot water or steam radiators	14 (1.2%)	5 (0.8%)	19 (1.1%)
Electric baseboard heaters	11 (1.0%)	9 (1.4%)	20 (1.1%)
Electric furnace	66 (5.8%)	37 (5.6%)	103 (5.7%)
Natural gas furnace	1027 (90.5%)	426 (64.5%)	1453 (80.9%)
Other	14 (1.2%)	4 (0.6%)	18 (1.0%)
Propane furnace	3 (0.3%)	3 (0.5%)	6 (0.3%)
Other (please indicate)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Appliances			
Central air conditioning	1057 (93.1%)	596 (90.3%)	1653 (92.1%)
Electric clothing dryer	758 (66.8%)	441 (66.8%)	1199 (66.8%)
Electric water heater	379 (33.4%)	220 (33.3%)	599 (33.3%)
Room or window air conditioner	0 (0%)	0 (0%)	0 (0%)
Electric space heater	166 (14.6%)	107 (16.2%)	273 (15.2%)
Swimming Pool	59 (5.2%)	34 (5.2%)	93 (5.2%)
Electric Vehicle Ownership			
N-Missing	0 (0.0%)	176 (26.7%)	176 (9.8%)

	Enhanced Pricing Control (N=1135)	Enhanced Pricing Treatment (N=660)	Total (N=1795)
Electric Vehicle Ownership			
No	1087 (95.8%)	455 (68.9%)	1542 (85.9%)
Yes	48 (4.2%)	29 (4.4%)	77 (4.3%)
Number of Adults 18 +			
N-Missing	0	7	7
Mean (SD)	2.444 (1.061)	2.317 (0.918)	2.398 (1.013)
Range	0.000 - 10.000	0.000 - 6.000	0.000 - 10.000
Number of Adults 60+			
N-Missing	9	13	22
Mean (SD)	0.401 (0.722)	0.352 (0.672)	0.383 (0.704)
Range	0.000 - 5.000	0.000 - 2.000	0.000 - 5.000
Number of Children			
N-Missing	13	10	23
Mean (SD)	0.820 (0.990)	0.778 (1.018)	0.805 (1.000)
Range	0.000 - 6.000	0.000 - 5.000	0.000 - 6.000
Income Level			
N-Missing	6 (0.5%)	9 (1.4%)	15 (0.8%)
$10,000 to less than $20,000	43 (3.8%)	16 (2.4%)	59 (3.3%)
$100,000 to less than $150,000	174 (15.3%)	104 (15.8%)	278 (15.5%)
$150,000 or more	156 (13.7%)	80 (12.1%)	236 (13.1%)
$20,000 to less than $30,000	48 (4.2%)	36 (5.5%)	84 (4.7%)
$30,000 to less than $40,000	62 (5.5%)	38 (5.8%)	100 (5.6%)
$40,000 to less than $75,000	158 (13.9%)	89 (13.5%)	247 (13.8%)
$75,000 to less than $90,000	87 (7.7%)	58 (8.8%)	145 (8.1%)
$90,000 to less than $100,000	76 (6.7%)	43 (6.5%)	119 (6.6%)
Less than $10,000	28 (2.5%)	17 (2.6%)	45 (2.5%)
Prefer not to say	297 (26.2%)	170 (25.8%)	467 (26.0%)
Education			
N-Missing	10 (0.9%)	14 (2.1%)	24 (1.3%)
College or other non-university certificate or diploma	197 (17.4%)	114 (17.3%)	311 (17.3%)
None, or grade 1-8	21 (1.9%)	6 (0.9%)	27 (1.5%)
Post-graduate or professional schooling after university (e.g., Master’s degree or Ph.D; law or medical school)	238 (21.0%)	158 (23.9%)	396 (22.1%)
Registered Apprenticeship or other trades certificate or diploma	25 (2.2%)	10 (1.5%)	35 (1.9%)
Secondary (high) school graduate	107 (9.4%)	50 (7.6%)	157 (8.7%)
Secondary (high) school incomplete	19 (1.7%)	12 (1.8%)	31 (1.7%)
University certificate, diploma, or degree	518 (45.6%)	296 (44.8%)	814 (45.3%)

	Enhanced Pricing Control (N=1135)	Enhanced Pricing Treatment (N=660)	Total (N=1795)
Education			
What is the last grade or class you completed in school?	0 (0.0%)	0 (0.0%)	0 (0.0%)
Number of People in House			
N-Missing	0 (0.0%)	9 (1.4%)	9 (0.5%)
0	191 (16.8%)	106 (16.1%)	297 (16.5%)
1	350 (30.8%)	194 (29.4%)	544 (30.3%)
2	485 (42.7%)	298 (45.2%)	783 (43.6%)
3	65 (5.7%)	36 (5.5%)	101 (5.6%)
4+	44 (3.9%)	17 (2.6%)	61 (3.4%)
Someone Home Mon-Fri			
N-Missing	0 (0.0%)	7 (1.1%)	7 (0.4%)
No	165 (14.5%)	144 (21.8%)	309 (17.2%)
Yes	970 (85.5%)	509 (77.1%)	1479 (82.4%)

6.4.2 *Participant Demographics: Overnight Pricing Pilot*

Table 124: Overnight Pricing Pilot Demographics

	Overnight Pricing Control (N=12)	Overnight Pricing Treatment (N=331)	Total (N=343)
Residence			
N-Missing	0 (0.0%)	0 (0.0%)	0 (0.0%)
Duplex or two-family home	0 (0.0%)	9 (2.7%)	9 (2.6%)
High-rise apartment or condo building	1 (8.3%)	1 (0.3%)	2 (0.6%)
Low-rise apartment or condo building	0 (0.0%)	1 (0.3%)	1 (0.3%)
Other (please enter)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Single-family home	11 (91.7%)	245 (74.0%)	256 (74.6%)
Townhouse or row-house	0 (0.0%)	75 (22.7%)	75 (21.9%)
Other (please indicate)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Year Home Built			
N-Missing	0 (0.0%)	0 (0.0%)	0 (0.0%)
1920 or before	0 (0.0%)	3 (0.9%)	3 (0.9%)
1921 - 1945	0 (0.0%)	0 (0.0%)	0 (0.0%)
1946 - 1960	0 (0.0%)	6 (1.8%)	6 (1.7%)
1961 - 1970	0 (0.0%)	5 (1.5%)	5 (1.5%)
1971 - 1980	1 (8.3%)	30 (9.1%)	31 (9.0%)
1981 - 1985	0 (0.0%)	23 (6.9%)	23 (6.7%)
1986 - 1990	1 (8.3%)	24 (7.3%)	25 (7.3%)
1991 - 1995	1 (8.3%)	26 (7.9%)	27 (7.9%)
Year Home Built			

	Overnight Pricing Control (N=12)	Overnight Pricing Treatment (N=331)	Total (N=343)
1996 - 2000	2 (16.7%)	37 (11.2%)	39 (11.4%)
2001 - 2005	3 (25.0%)	73 (22.1%)	76 (22.2%)
2006 - 2011	1 (8.3%)	47 (14.2%)	48 (14.0%)
2012 - 2016	3 (25.0%)	11 (3.3%)	14 (4.1%)
2012 - 2017	0 (0.0%)	38 (11.5%)	38 (11.1%)
Unsure	0 (0.0%)	8 (2.4%)	8 (2.3%)
Thermostat			
N-Missing	0 (0.0%)	0 (0.0%)	0 (0.0%)
No	1 (8.3%)	31 (9.4%)	32 (9.3%)
Yes	11 (91.7%)	300 (90.6%)	311 (90.7%)
Thermostat Type			
N-Missing	1 (8.3%)	14 (4.2%)	15 (4.4%)
ecobee	4 (33.3%)	102 (30.8%)	106 (30.9%)
Energate Foundation	0 (0.0%)	40 (12.1%)	40 (11.7%)
Honeywell UtilityPRO or ExpressStat	2 (16.7%)	47 (14.2%)	49 (14.3%)
Nest	4 (33.3%)	84 (25.4%)	88 (25.7%)
Other (please enter)	1 (8.3%)	44 (13.3%)	45 (13.1%)
Primary Heating Method			
N-Missing	0 (0.0%)	4 (1.2%)	4 (1.2%)
Boiler with hot water or steam radiators	0 (0.0%)	3 (0.9%)	3 (0.9%)
Electric baseboard heaters	0 (0.0%)	8 (2.4%)	8 (2.3%)
Electric furnace	0 (0.0%)	11 (3.3%)	11 (3.2%)
Natural gas furnace	12 (100.0%)	302 (91.2%)	314 (91.5%)
Other	0 (0.0%)	2 (0.6%)	2 (0.6%)
Propane furnace	0 (0.0%)	0 (0.0%)	0 (0.0%)
Other (please indicate)	0 (0.0%)	1 (0.3%)	1 (0.3%)
Appliances			
Central air conditioning	11 (91.2%)	318 (96.1%)	343 (95.9%)
Electric clothing dryer	5 (41.7%)	217 (65.6%)	222 (64.7%)
Electric water heater	1 (8.3%)	86 (26.0%)	87 (25.4%)
Room or window air conditioner	0 (0%)	0 (0%)	0 (0%)
Electric space heater	2 (16.7%)	53(16.0%)	55 (16.0%)
Swimming Pool	0 (0%)	24 (7.3%)	24 (7.0%)
Electric Vehicle Ownership			
N-Missing	0 (0.0%)	4 (1.2%)	4 (1.2%)
No	10 (83.3%)	181 (54.7%)	191 (55.7%)
Yes	2 (16.7%)	146 (44.1%)	148 (43.1%)
Number of Adults 18 +			
Mean (SD)	2.417 (0.793)	2.305 (0.842)	2.309 (0.840)
Range	2.000 - 4.000	1.000 - 6.000	1.000 - 6.000

Number of Adults 60+			

	Overnight Pricing Control (N=12)	Overnight Pricing Treatment (N=331)	Total (N=343)
N-Missing	1	2	3
Mean (SD)	0.000 (0.000)	0.231 (0.575)	0.224 (0.567)
Range	0.000 - 0.000	0.000 - 2.000	0.000 - 2.000
Number of Children			
N-Missing	2	0	2
Mean (SD)	0.400 (0.699)	0.940 (1.116)	0.924 (1.109)
Range	0.000 - 2.000	0.000 - 6.000	0.000 - 6.000
Income Level			
N-Missing	0 (0.0%)	2 (0.6%)	2 (0.6%)
$10,000 to less than $20,000	0 (0.0%)	2 (0.6%)	2 (0.6%)
$100,000 to less than $150,000	1 (8.3%)	63 (19.0%)	64 (18.7%)
$150,000 or more	3 (25.0%)	65 (19.6%)	68 (19.8%)
$20,000 to less than $30,000	0 (0.0%)	6 (1.8%)	6 (1.7%)
$30,000 to less than $40,000	0 (0.0%)	6 (1.8%)	6 (1.7%)
$40,000 to less than $75,000	1 (8.3%)	40 (12.1%)	41 (12.0%)
$75,000 to less than $90,000	2 (16.7%)	22 (6.6%)	24 (7.0%)
$90,000 to less than $100,000	1 (8.3%)	34 (10.3%)	35 (10.2%)
Less than $10,000	0 (0.0%)	5 (1.5%)	5 (1.5%)
Prefer not to say	4 (33.3%)	86 (26.0%)	90 (26.2%)
Education			
N-Missing	1 (8.3%)	3 (0.9%)	4 (1.2%)
College or other non-university certificate or diploma	2 (16.7%)	46 (13.9%)	48 (14.0%)
None, or grade 1-8	0 (0.0%)	4 (1.2%)	4 (1.2%)
Post-graduate or professional schooling after university (e.g., Master’s degree or Ph.D; law or medical school)	4 (33.3%)	65 (19.6%)	69 (20.1%)
Registered Apprenticeship or other trades certificate or diploma	0 (0.0%)	1 (0.3%)	1 (0.3%)
Secondary (high) school graduate	0 (0.0%)	9 (2.7%)	9 (2.6%)
Secondary (high) school incomplete	0 (0.0%)	6 (1.8%)	6 (1.7%)
University certificate, diploma, or degree	5 (41.7%)	197 (59.5%)	202 (58.9%)
Num People of People in House			
N-Missing	0 (0.0%)	1 (0.3%)	1 (0.3%)
0	1 (8.3%)	38 (11.5%)	39 (11.4%)
1	2 (16.7%)	78 (23.6%)	80 (23.3%)
2	7 (58.3%)	188 (56.8%)	195 (56.9%)
3	1 (8.3%)	17 (5.1%)	18 (5.2%)
4+	1 (8.3%)	9 (2.7%)	10 (2.9%)
Someone Home Mon-Fri			

	Overnight Pricing Control (N=12)	Overnight Pricing Treatment (N=331)	Total (N=343)
N-Missing	0 (0.0%)	0 (0.0%)	0 (0.0%)
No	4 (33.3%)	72 (21.8%)	76 (22.2%)
Yes	8 (66.7%)	259 (78.2%)	267 (77.8%)

6.4.3 *Participant Demographics: Dynamic Pricing Pilot*

Table 105: Dynamic Pricing Pilot Demographics

	Dynamic Pricing Control (N=25)	Dynamic Pricing Treatment (N=765)	Total (N=790)
Residence			
N-Missing	0 (0.0%)	1 (0.1%)	1 (0.1%)
Duplex or two-family home	0 (0.0%)	28 (3.7%)	28 (3.5%)
High-rise apartment or condo building	0 (0.0%)	3 (0.4%)	3 (0.4%)
Low-rise apartment or condo building	0 (0.0%)	6 (0.8%)	6 (0.8%)
Other (please enter)	0 (0.0%)	12 (1.6%)	12 (1.5%)
Single-family home	22 (88.0%)	613 (80.1%)	635 (80.4%)
Townhouse or row-house	3 (12.0%)	100 (13.1%)	103 (13.0%)
Other (please indicate)	0 (0.0%)	2 (0.3%)	2 (0.3%)
Year Home Built			
N-Missing	0 (0.0%)	1 (0.1%)	1 (0.1%)
1920 or before	0 (0.0%)	13 (1.7%)	13 (1.6%)
1921 - 1945	0 (0.0%)	3 (0.4%)	3 (0.4%)
1946 - 1960	2 (8.0%)	20 (2.6%)	22 (2.8%)
1961 - 1970	2 (8.0%)	42 (5.5%)	44 (5.6%)
1971 - 1980	3 (12.0%)	89 (11.6%)	92 (11.6%)
1981 - 1985	1 (4.0%)	64 (8.4%)	65 (8.2%)
1986 - 1990	2 (8.0%)	90 (11.8%)	92 (11.6%)
1991 - 1995	2 (8.0%)	45 (5.9%)	47 (5.9%)
1996 - 2000	2 (8.0%)	89 (11.6%)	91 (11.5%)
2001 - 2005	1 (4.0%)	103 (13.5%)	104 (13.2%)
2006 - 2011	4 (16.0%)	110 (14.4%)	114 (14.4%)
2012 - 2016	4 (16.0%)	24 (3.1%)	28 (3.5%)
2012 - 2017	1 (4.0%)	65 (8.5%)	66 (8.4%)
Unsure	1 (4.0%)	7 (0.9%)	8 (1.0%)
Thermostat			
N-Missing	0 (0.0%)	1 (0.1%)	1 (0.1%)
No	2 (8.0%)	84 (11.0%)	86 (10.9%)
Yes	23 (92.0%)	680 (88.9%)	703 (89.0%)
Thermostat Type			
N-Missing	1 (4.0%)	46 (6.0%)	47 (5.9%)

	Dynamic Pricing Control (N=25)	Dynamic Pricing Treatment (N=765)	Total (N=790)
ecobee	4 (16.0%)	96 (12.5%)	100 (12.7%)
Energate Foundation	0 (0.0%)	246 (32.2%)	246 (31.1%)
Honeywell UtilityPRO or ExpressStat	6 (24.0%)	133 (17.4%)	139 (17.6%)
Nest	6 (24.0%)	130 (17.0%)	136 (17.2%)
Other (please enter)	8 (32.0%)	114 (14.9%)	122 (15.4%)
Primary Heating Method			
N-Missing	0 (0.0%)	6 (0.8%)	6 (0.8%)
Boiler with hot water or steam radiators	0 (0.0%)	4 (0.5%)	4 (0.5%)
Electric baseboard heaters	0 (0.0%)	20 (2.6%)	20 (2.5%)
Electric furnace	1 (4.0%)	25 (3.3%)	26 (3.3%)
Natural gas furnace	24 (96.0%)	693 (90.6%)	717 (90.8%)
Other	0 (0.0%)	7 (0.9%)	7 (0.9%)
Propane furnace	0 (0.0%)	3 (0.4%)	3 (0.4%)
Other (please indicate)	0 (0.0%)	7 (0.9%)	7 (0.9%)
Appliances			
Central air conditioning	23 (92.0%)	694 (90.7%)	717 (90.8%)
Electric clothing dryer	17 (68.0%)	526 (8.8%)	543 (68.7%)
Electric water heater	9 (36.0%)	190 (24.8%)	199 (25.2%)
Room or window air conditioner	0 (0%)	0 (0%)	0 (0%)
Electric space heater	0 (0%)	155(20.3%)	155 (19.6%)
Swimming Pool	0 (0%)	0 (0%)	61 (8.0%)
Electric Vehicle Ownership			
N-Missing	0 (0.0%)	6 (0.8%)	6 (0.8%)
No	24 (96.0%)	702 (91.8%)	726 (91.9%)
Yes	1 (4.0%)	57 (7.5%)	58 (7.3%)
Number of Adults 18+			
N-Missing	0	1	1
Mean (SD)	2.400 (0.707)	2.356 (0.987)	2.357 (0.979)
Range	1.000 - 4.000	0.000 - 7.000	0.000 - 7.000
Number of Adults 60+			
N-Missing	0	6	6
Mean (SD)	0.320 (0.690)	0.705 (0.887)	0.693 (0.883)
Range	0.000 - 2.000	0.000 - 3.000	0.000 - 3.000
Number of Children			
N-Missing	1	2	3
Mean (SD)	0.542 (0.884)	0.699 (0.999)	0.694 (0.996)
Range	0.000 - 2.000	0.000 - 9.000	0.000 - 9.000
Income Level			
N-Missing	0 (0.0%)	7 (0.9%)	7 (0.9%)
$10,000 to less than $20,000	2 (8.0%)	9 (1.2%)	11 (1.4%)
Income Level			
$100,000 to less than $150,000	5 (20.0%)	120 (15.7%)	125 (15.8%)

	Dynamic Pricing Control (N=25)	Dynamic Pricing Treatment (N=765)	Total (N=790)
$150,000 or more	4 (16.0%)	122 (15.9%)	126 (15.9%)
$20,000 to less than $30,000	0 (0.0%)	19 (2.5%)	19 (2.4%)
$30,000 to less than $40,000	0 (0.0%)	31 (4.1%)	31 (3.9%)
$40,000 to less than $75,000	1 (4.0%)	103 (13.5%)	104 (13.2%)
$75,000 to less than $90,000	3 (12.0%)	83 (10.8%)	86 (10.9%)
$90,000 to less than $100,000	0 (0.0%)	53 (6.9%)	53 (6.7%)
Less than $10,000	2 (8.0%)	5 (0.7%)	7 (0.9%)
Prefer not to say	8 (32.0%)	213 (27.8%)	221 (28.0%)
Education			
N-Missing	1 (4.0%)	7 (0.9%)	8 (1.0%)
College or other non-university certificate or diploma	5 (20.0%)	140 (18.3%)	145 (18.4%)
None, or grade 1-8	0 (0.0%)	5 (0.7%)	5 (0.6%)
Post-graduate or professional schooling after university (e.g., Master’s degree or Ph.D; law or medical school)	8 (32.0%)	197 (25.8%)	205 (25.9%)
Registered Apprenticeship or other trades certificate or diploma	0 (0.0%)	19 (2.5%)	19 (2.4%)
Secondary (high) school graduate	0 (0.0%)	56 (7.3%)	56 (7.1%)
Secondary (high) school incomplete	0 (0.0%)	8 (1.0%)	8 (1.0%)
University certificate, diploma, or degree	11 (44.0%)	333 (43.5%)	344 (43.5%)
What is the last grade or class you completed in school?	0 (0.0%)	0 (0.0%)	0 (0.0%)
Number of People in House			
N-Missing	0 (0.0%)	2 (0.3%)	2 (0.3%)
0	2 (8.0%)	214 (28.0%)	216 (27.3%)
1	5 (20.0%)	240 (31.4%)	245 (31.0%)
2	17 (68.0%)	261 (34.1%)	278 (35.2%)
3	0 (0.0%)	31 (4.1%)	31 (3.9%)
4+	1 (4.0%)	17 (2.2%)	18 (2.3%)
Someone Home Mon-Fri			
N-Missing	0 (0.0%)	1 (0.1%)	1 (0.1%)
No	5 (20.0%)	51 (6.7%)	56 (7.1%)
Yes	20 (80.0%)	713 (93.2%)	733 (92.8%)

7. Summary and Conclusions

This pilot program assessed the impacts of three separate pricing Treatments (Enhanced pricing, Dynamic pricing, and Overnight pricing) in combination with two non-price interventions (communications in the form of Nudge Reports as well as Technology in the form of programmable smart thermostats with load curtailment enablement). This report covers the reporting period May 2018 – April 2019 inclusive. In May 2019, the Ontario Energy Board opted to extend the reporting period for the Dynamic pricing plan for an additional 5 months based on a desire to obtain additional insights after reviewing the impacts reported during the interim reporting period (April 2018 – October 2018 inclusive). This extension will also allow exploration of customer response to a greater number of CPP events by splitting the Dynamic group into two groups, one receiving 6 CPP events, and the other receiving 9. As a result, additional impact analyses will be reported for Dynamic pricing covering the final 5 months of the pilot.

Below, we first summarize the key behavioural findings with respect to electricity consumption impacts stemming from the pricing interventions tested under the current RPP pilot program, followed by the non-pricing interventions. We then summarize the findings obtained from the three customer-facing surveys administered over the course of this pilot. Finally, we make some general conclusions and recommendations pertaining to the future of the Regulated Price Plan in the Province of Ontario.

Summary of Pricing Interventions

Dynamic pricing pilot summary

It was hypothesized that the high On- to Off-Peak pricing differential in the Dynamic pricing pilot would provide a strong incentive for customers to reduce their electricity consumption behaviour during On-Peak periods in order to realize bill savings. This could be accomplished either through simple curtailment of On-Peak consumption, or through load shifting behaviours in which customers perform certain actions (such as laundry, pre-cooling air conditioning etc.) during Off-Peak as opposed to On-Peak hours. The observed impacts were highly consistent with the former, as Dynamic pricing customers exhibited lower electricity consumption relative to matched Control participants during Low, Medium, and High-On-Peak hours, without exhibiting an increase in Off-Peak consumption.

The most significant consumption reduction impacts observed in this pilot owe to the Critical Peak Pricing events in which Dynamic pricing customers were subjected to six 4-hour events in each of the Summer and Winter reporting periods. These customers were notified via email or SMS text (according to each customer's preference) of upcoming CPP events, provided a minimum of 2 hours in advance of such events. Customers were charged an hourly price per kWh of 49.8 cents during these event hours. Dynamic pricing Treatment customers consumed substantially less electricity during CPP event hours compared to matched Controls during those same hours. The overall electricity consumption reductions owing to Dynamic pricing during On-Peak and CPP periods also yielded a small net decrease in overall average consumption in the Summer and Winter periods respectively.

The sizeable impacts of CPP days on peak consumption reduction for Dynamic pricing participants is noteworthy. Understanding the optimal frequency and/or duration of CPP events to maximize peak consumption reductions will be a focus of the Dynamic pricing pilot extension period. By subjecting different groups of program participants to different frequencies of CPP events (6 vs. 9), peak consumption reductions relative to Control participants will be assessed as a function of CPP event frequency. The research question of interest is whether there is a limit to participant responsiveness to CPP events. It is likely that if CPP events occur too frequently, participants will be unable (or unwilling) to curb consumption behaviours during CPP event hours or may leave the program.

With respect to pricing signals therefore, Dynamic pricing as currently structured is an effective means of driving conservation and demand management objectives in the Province of Ontario. Moreover, the persistence in year-over-year On-Peak conservation impacts observed for the Legacy Dynamic participants (albeit with a decline in observed effect size) suggests that customer responsiveness to Dynamic pricing is not merely driven by short-lived novelty effects. Dynamic pricing may therefore provide a viable alternative price plan for Ontarians in the future that can serve to curb On-Peak consumption for at least some populations.

Overnight pricing pilot summary

The Overnight pricing pilot was designed and marketed to customers with the expectation that it would appeal to customers who would benefit from shifting some of their electricity consumption to overnight hours (12am – 6am). These might include customers with atypical work schedules or electric vehicle owners. Indeed, survey data show that the self-reported incidence of EV ownership in the Overnight Treatment group is about ten times higher than that observed in either of the Enhanced or Dynamic Treatment groups, suggesting that this pricing plan was successful at attracting EV owners. However, since overall uptake of this pricing program was quite low, it is reasonable to conclude that Overnight pricing holds limited appeal for the average Ontario residential customer. Nonetheless, this may change in the future as electric vehicle and electricity storage equipment become more prevalent. Regardless, the impact analyses derived from the Overnight pricing pilot seem to suggest that this pricing structure holds mixed potential for significant load-shifting and/or conservation impacts even among a potentially small sub-population of Ontario residents. Specifically, the higher On-Peak price *did* result in lower On-Peak consumption for Overnight pricing Treatment customers relative to matched Control, but only for the Summer reporting period. No Peak reductions were observed for the Winter period. The most striking finding from the Overnight pilot is the large increase in consumption during the Off-Peak and Super Off-Peak periods relative to Standard Time-of-Use matched Control customers. The net result of these impacts is a net *increase* in overall electricity consumption owing to the Overnight pricing plan. While the Overnight plan was not extended, additional research into the cause of the increased consumption would be worthwhile to understand. The system impact of consistent higher Off-Peak consumption should be considered alongside the inconsistent reduction of On-Peak consumption. A more detailed segmentation of customers in this plan could suggest why on-peak consumption was not reduced under this plan.

Enhanced pricing pilot summary

The Enhanced pricing pilot was the simplest of the three pricing pilots tested under the current RPP pilot program. It did not involve any alterations to the Standard Time-of-Use pricing schedule, but simply increased the On-to-Off Peak pricing differential relative to Standard TOU. As a result, this pricing pilot was the only one run as an opt-out Randomized Controlled Trial. Traditional economic theory would posit that as the price of a commodity increases, consumption of that commodity should decrease by some measurable proportion. It was therefore hypothesized that higher On-Peak prices would dis-incentivize consumption among Enhanced pricing customers during On-Peak times of day and that lower Off-Peak prices would incentivize consumption during Off-Peak times of day, resulting in load shifting behaviours, On-Peak consumption reductions, or overall consumption reductions, consistent with the province's conservation and demand management objectives. The derived impacts over the 12-month reporting period for the Enhanced pricing pilot fail to support this hypothesis. Despite almost doubling the On-to-Off Peak price differential relative to Standard Time-of-Use pricing, pricing under the Enhanced plan failed to realize On-Peak consumption reductions or overall conservation impacts. It seems therefore that the increase in On-Peak price relative to Standard Time-of-Use pricing did not provide enough of a financial incentive for program participants to alter their daily consumption behaviours in order to realize bill savings.

Given that the Enhanced pricing pilot was run as an opt-out RCT, one may hypothesize that the lack of behavioural response may be at least partly due to awareness of participation in the program (recall that Enhanced pricing participants did not have to actively sign-up for the program). We posit that this is unlikely for two reasons: (1) participants were sent several rounds of communications regarding their selection for Enhanced pricing throughout the duration of the pilot, (2) participants were exposed to a salient material change in their monthly consumption-related communications in the form of shadow reports. Thus, while simple and scalable, Enhanced pricing does not seem to hold much potential for increasing the level of attainment of the objectives of the Regulated Price Plan. Future initiatives could however endeavor to pilot Enhanced pricing plans in which the On-to-Off Peak kWh commodity price ratio is increased relative the current instantiation of Enhanced pricing.

Summary of Non-Pricing Interventions

Nudge Reports

One of the aims of the current RPP pilot program was to explore the potential impacts of non-price means by which to drive conservation and demand management behaviours. To that end, Alectra and its partners, BEworks and Bidgley, designed and distributed monthly communications in the form of Nudge Reports to randomly selected pricing Treatment and Control customers in each of the Enhanced and Dynamic pricing pilots. These reports featured a mix of (1) conservation pledges, (2) salient TOU schedules, (3) personalized conservation tips (derived from load disaggregation data by Bidgely), and (4) personalized On-Peak consumption feedback. These Nudge Reports were designed based on the principles of behavioural economic theory which holds that individuals do not always respond rationally to pricing signals, act in their own best interests, or follow through with intended actions. For randomly selected customers in the Enhanced and Dynamic pricing Treatment conditions, these Nudge Reports appeared on the back page of the monthly Shadow Bills. For randomly selected Enhanced and Dynamic pricing Control participants (i.e., customers who remained on Standard Time-of-Use pricing), these reports were distributed via direct mail as single-page monthly communications under the program name Power Insights.

Impact analyses reveal that for the Enhanced pilot, customers who received Nudge Reports realized savings in their On-Peak consumption relative to customers who did not receive these reports (in both the Summer and Winter reporting periods). This is an important finding since pricing signals alone failed to produce measurable On-Peak consumption reductions among Enhanced pricing Treatment customers. Moreover, the impacts of Nudge Reports on On-Peak consumption were similar in magnitude across Enhanced pricing Treatment and Control customers.

Dynamic pricing Treatment and Control customers who received Nudge Reports exhibited similar consumption patterns to customers who did not receive Nudge Reports during Low, Medium, and High On-Peak periods. In addition, during CPP event hours, customers receiving Nudge Reports exhibited lower consumption of electricity on 1 of the 6 CPP days in the Summer months relative to Control customers who did not receive Nudge Reports (although these effects were small).

Taken together, non-price communications informed by behavioural economics yield behavioural change among Ontario households that contribute toward achieving Ontario's electricity conservation objectives. These findings lend credence to the hypothesis that individuals do not always respond to changes in commodity prices, but can and will alter their consumption of those commodities for other reasons (as evidenced by the significant effects of Nudge Reports and the insignificant effects of price in the Enhanced pilot). Given that the Nudge Reports deployed in the current pilot program contained several behavioural interventions, it is impossible to disentangle the independent or interactive effects of each feature of the Nudge Reports on customer behaviour. It could be that the conservation pledge provided non-financial intrinsic motivation to conserve On-Peak electricity, that personalized conservation tips provided a more tangible and actionable means for customers to alter their behaviour, or that personal benchmarking and feedback simply allowed customers to follow-through on pre-existing motivations to conserve. Future work would be needed to better understand the specific mechanisms by which these non-price communications impacted conservation behaviours and perhaps seek to further optimize their potential impact via testing of a wider suite of behavioural nudges.

Smart Thermostats

The effects of programmable smart thermostats on conservation and load shifting behaviours in the present pilot program were assessed quasi-experimentally. That is, these devices were not randomly assigned to Treatment and Control customers, but instead, data was gathered (where available) for ownership and registration of these devices within the pre-existing pilot population, as well as for a subset of the population who received a free programmable, communicating thermostat that was made available as an incentive to participate in the program. It was hypothesized that customers within each of the pricing Treatment groups would be able to program these devices to semi-automate their ability to avoid high kWh consumption during On-Peak times of day as well as benefit from the load curtailment functionality enabled by these devices. The Energate Foundation thermostat had the most ability in this regard, being able to respond to varying price levels with different levels of response, with a sophisticated and flexible setting that allowed customers to specify their preferred level of price-response.

We observed that Enhanced Pricing customers who participated in Alectra's smart thermostat incentive program exhibited lower electricity consumption relative to Enhanced pricing customers who did not report smart thermostat ownership. Similarly, Dynamic Pricing costumers who reported smart thermostat ownership generally exhibited reduced electricity consumption relative to Dynamic Pricing customers who did not report smart thermostat ownership. smart thermostat possession in the Overnight Pilot was generally related to an increase in electricity consumption during both the Summer and Winter periods.

It seems therefore, that smart thermostats provide an additional non-price means of driving electricity consumption reductions among populations who choose to purchase these devices. However, we recommend caution when interpreting the effects of smart thermostats on consumption behaviour. Specifically, households were not randomly assigned to receive smart thermostats. Instead, all pricing participants had the opportunity to self-select themselves into smart thermostat ownership by taking advantage of thermostat incentive offers. Due to this inherent selection bias, we cannot attribute a causal relation between smart thermostat ownership and incremental sensitivity to pricing signals displayed by the subset of households designated as 'Technology' households. Indeed, some unknown proportion of the observed variance in consumption behaviour owing to smart thermostat ownership/usage is almost certainly driven by the fact that individuals who choose to acquire such devices are likely different from individuals who do not acquire such devices in many other material ways. Specifically, smart thermostat owners are likely more engaged, motivated, tech-savvy etc. than their non-technology adopting counterparts, and it may be these inherent individual difference characteristics that drive incremental changes in consumption behaviour. Only a true RCT or a recruit-and-deny experimental approach would be able to quantify the unique contribution of smart thermostat Technology to demand response among residential customers.

Summary of Customer-Facing Surveys

Customer-facing surveys were administered to RPP pilot program participants at three time-points during the course of the 12-month reporting period: within the registration period and first 2 months of the pilot (baseline) at the 6-month mark (mid-term) and at the conclusion of the pilot at the 12-month mark (final). There were 3 primary objectives of these surveys: (1) to capture relevant demographic and socio-economic information about the samples, (2) to assess whether comprehension of Time-of-Use pricing differs among Treatment and Control groups, and whether there are any changes in Comprehension of TOU pricing over time, and (3) to assess whether motivations to alter electricity consumption behaviour differs among Treatment and Control groups, and whether there are any changes in stated motivations to alter consumption behaviour over time.

In terms of comprehension of TOU pricing, we found that comprehension scores increased over the duration of the Enhanced pricing pilot, but only for participants who received Nudge Reports. This may indicate that at least part of the impact of Nudge Reports on consumption behaviour was exerted through the salient TOU schedule that appeared on the reports. In contrast, there were no changes in TOU comprehension over time for Overnight pricing participants (recall that they did not receive Nudge Reports), but there was a marginally higher overall rate of TOU comprehension among Overnight Treatment customers relative to matched Controls. This marginal effect may simply reflect higher pre-Treatment TOU comprehension among the Overnight Treatment customers, and it may also point to individual differences among populations who choose to sign up for innovative pricing pilots versus those who do not. In terms of personal motivations to shift consumption behaviour to Off-Peak times of day and/or to reduce electricity consumption overall, customers receiving Nudge reports in the Enhanced pricing pilot were less likely to say they were 'doing everything they can' to reduce On-Peak consumption. This may suggest that the personalized tips and simple monthly feedback may have affected customer perceptions regarding consumption behaviours. Interestingly, both Enhanced and Overnight pricing Treatment customers were less likely than Control to say that Time-of-Use pricing (in general, not specifically the TOU period structure they were charged under Enhanced and Overnight price plans) affects consumption behaviour. This finding is somewhat counter-intuitive but may be taken to suggest that when faced with detailed and salient consumption feedback (delivered through Shadow Bills), customers are more accurate in their ability to reflect on their actual behaviours (recall that there were no observed behavioural impacts observed for Enhanced pricing).

Taken together, the customer-facing surveys provide evidence that exposure to non-price communications in the form of Nudge Reports can increase customer comprehension of TOU pricing over time. In addition, monthly feedback in the form of Shadow bills may serve to close the gap between actual and perceived conservation efforts among Ontario residents.

Final Conclusions and Recommendations

The present impact evaluation yields important and novel insights regarding the future of the Regulated Price Plan in the Province of Ontario. It is clear that strong pricing signals, typified by Variable Peak Pricing and Critical Peak Pricing events are in fact sufficient to drive On-Peak conservation behaviours. When the differential between the highest and lowest priced TOU periods was comparatively smaller, as was the case in the Enhanced pricing pilot and the Overnight pricing pilot, On-Peak electricity consumption reductions were absent or minimal. This raises two important considerations when considering the scalability of new pricing structures such as Dynamic pricing: (1) electricity is a basic commodity to which all Ontario residents have a reasonable expectation of access. Given this, there must be careful consideration given to the use of price as the sole or primary lever to achieve conservation objectives. Specifically, there will be limits on the extent to which LDCs are able or willing to increase the price of peak electricity and there are surely limits on consumers' willingness to pay for On-Peak electricity as well as limits on their tolerance to frequent Critical Peak events. (2) Statistically significant behavioural response to alternative pricing structures in the current program design were restricted to the two pilots in which participants had to actively 'opt-in', suggesting that providing customers with choice regarding their Time-of-Use pricing plan may be necessary in the future in order to realize maximum conservation and/or load shifting impacts. In order to further validate this latter point, future pilots could experimentally manipulate whether Variable Peak pricing plans are administered on an opt-in vs. opt-out basis.

Finally, non-price interventions such as behaviourally informed customer communications and availability of smart thermostat Technology hold promise as additional, complementary methods for further realizing On-Peak consumption reductions among Ontarians. The impacts of these interventions suggest that more LDCs should seek to optimize their current customer communications with respect to consumption feedback (either through existing electricity invoices or through separate communications) as well as potentially devoting more resources to the marketing and provision of automated load control devices such as smart thermostats. The availability of funding support through conservation programs would aid utilities to encourage customer adoption of this Technology, which essentially amplifies the benefit that customers receive from, and provide to, the electricity system through their response to well-designed price plans.

How to contact us

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

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