Regulated Price Plan Pilot Meta-Analysis

Final Report

Prepared for:

Ontario Energy Board

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TABLE OF CONTENTS

Companion Documents

Meta-Analysis of the Regulated Price Plan Pilots: Output Data Sheets

DISCLAIMER

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ABSTRACT

In 2017, the Ontario Energy Board (OEB) commissioned a set of pilots intended to test the effects of a variety of price plans and non-price tools on residential consumer behaviour. The designs of these price plans were based on the analysis that informs the OEB's Regulated Price Plan Roadmap. That document was developed in response to the findings of a series of studies conducted on the OEB's behalf to better understand key elements of the transition from inclining block (Tiered) pricing to time-of-use (TOU) pricing for Regulated Price Plan consumers in Ontario.

Four pilots were executed over approximately two years by a group of Ontario Local Distribution Companies (LDCs). Alectra Utilities, London Hydro, Oshawa PUC, and CustomerFirst (Greater Sudbury Hydro, Newmarket-Tay Power Distribution, North Bay Hydro Distribution, Northern Ontario Wires, and PUC Services – Sault Ste. Marie) all developed multiple treatment groups[1] to test different pricing and non-price tools of interest to the OEB.

Pricing treatments included: enhancing existing price differentials, a separately priced shoulder season, an overnight rate targeting EV users, critical peak pricing, and variable peak pricing. Non-price treatments included the deployment of mobile applications that inform and educate participants about their electricity use, "Nudge" reports, and enabling technologies (load switches, thermostats) to automate participant response to variable or critical peaks.

The Oshawa PUC and London Hydro pilots were in place between May 1, 2018 and April 30, 2019, as were the Enhanced TOU and Overnight Alectra Utilities treatments. The Alectra Utilities Dynamic pricing treatment was in place between May 1, 2018 and October 31, 2019. The CustomerFirst pilot was in place from October 1, 2018 through August 31, 2019. All pilots were completed well before the COVID-19 pandemic reached Ontario, and so the results of these pilots were unaffected by the changes in consumer behaviour observed in Ontario since mid-March 2020 in response to the pandemic.

Each utility engaged a technical consultant to evaluate the pilots. Guidehouse has used the evaluation reports produced by these technical consultants as the basis for this meta-analysis, developed to provide evidence-based advice to the OEB regarding new or modified pricing plans and non-price tools that may be effective for furthering the renewed policy objectives of the RPP contained in the RPP Roadmap.

After an in-depth analysis of pilot data and the evaluation reports of these pilots, Guidehouse has made a suite of recommendations addressing four key areas:

- **The existing default TOU price plan.** Guidehouse has outlined ways in which this price plan should be updated to better reflect long-term system costs and deliver more meaningful system benefits.
- **Mobile applications related to consumer electricity use.** Guidehouse has identified a set of actions that the OEB can take to improve the availability of mobile apps intended to reduce overall system costs through a variety of consumer engagement strategies.
- **Critical peak pricing.** Guidehouse has identified a significant opportunity to procure behavioural and technology-enabled demand response capability and provided recommendations on how to procure this capability.
- **Decarbonization potential of electricity pricing.** Guidehouse has identified there may be the potential to use an alternative price plan to motivate decarbonization through beneficial electrification and has outlined a set of actions the OEB can take to better quantify the value of such potential.

[1] In a pilot or an experiment, a "treatment" is an external change (e.g., a new price structure, an enabling technology, etc.) applied to participants for the purposes of testing its effect. The group of individuals to whom the treatment is applied is often referred to as a "treatment group".

EXECUTIVE SUMMARY

Since April 2005, the Ontario Energy Board (OEB) has administered the Regulated Price Plan (RPP). The RPP sets the electricity commodity prices for approximately 5.2 million of Ontario's residential and small business consumers.[2] Since 2012, until earlier this year, nearly all RPP consumers were subject to a mandatory time-of-use (TOU) price. The OEB has monitored the impacts of TOU pricing on an on-going basis, and in its 2015 strategy document, the RPP Roadmap, set out the intention to pilot a set of alternative price plans.

In 2017, the OEB commissioned pilots from a group of Ontario local distribution companies (LDCs) to test the effects of a variety of price and non-price treatments, and to provide the OEB with the information required to continue to evolve the RPP and advance its goals. The interim evaluations of these pilots began to be delivered by the participating LDCs to the OEB in the spring of 2019.

In July of 2019, the OEB engaged Guidehouse[3] to conduct a review – a meta-analysis – of these documents and the pilots on which they were based. The goal of this meta-analysis is for Guidehouse to provide evidence-based advice to the OEB regarding new or modified pricing plans and non-price tools that may be effective for furthering the renewed policy objectives of the RPP contained in the RPP Roadmap.

Guidehouse's approach for developing its recommendations was twofold. Guidehouse:

- Conducted an in-depth review of the final pilot evaluation reports.
- Evaluated the performance of each treatment group against a set of seven metrics, six of which are derived directly from the RPP objectives.

The two key deliverables for Guidehouse's analysis are this report document and a set of Output Data Sheets available in a separate document, referred to in aggregate as "the ODS".

The ODS is the repository for the treatment group-specific detail that underlies the analysis presented in this document. This is not essential information for most reviewers of this report, and comprehension of the recommendations and findings of this report should not depend on a reviewer's familiarity with the ODS.

This Executive Summary is divided into three sections:

- **Summary of RPP Pilots.** A short summary of the key features of the treatment groups reviewed for this analysis.
- **Meta-Analysis Approach.** A description of the analytical approach used by Guidehouse to develop the conclusions and recommendations of this meta-analysis.
- **Summary Findings and Recommendations.** A summary of Guidehouse's four recommendations, and of the findings from the analysis that support them.

[2] Ontario Energy Board, *Yearbook of Electricity Distributors*, 2019
https://www.oeb.ca/utility-performance-and-monitoring/natural-gas-and-electricity-utility-yearbooks
[3] When Guidehouse was engaged for this work it was operating under its former name, Navigant Consulting, Ltd.

Summary of RPP Pilots

In commissioning its pilots, the OEB sought to test a diverse set of price and non-price treatments, treatments first defined either implicitly or explicitly by the Roadmap and the analytic work synthesized by that document. The four LDCs or groups of LDCs that deployed pilots as part of this effort were: Alectra Utilities,[4] CustomerFirst,[5] London Hydro, and Oshawa PUC.

The Oshawa PUC and London Hydro pilots were in place between May 1, 2018 and April 30, 2019, as were the Enhanced TOU and Overnight Alectra Utilities (Alectra) treatments. The Alectra Dynamic pricing treatment was in place between May 1, 2018 and October 31, 2019. The CustomerFirst pilot was in place from October 1, 2018 through August 31, 2019. All pilots were completed well before the COVID-19 pandemic reached Ontario, and so the results of these pilots were unaffected by the changes in consumer behaviour observed in Ontario since mid-March 2020 in response to the pandemic.

In Table ES-1 below Guidehouse has summarized treatment types and some other key information regarding each of the pilots. A description of each of these treatments (and explanation for some of the abbreviations used in the table below) can be found in the numbered list below the table.

Table ES-1: Tabular Summary of Piloted Treatment Groups

LDC	Treatment Group	Mobile App	Enhanced TOU Ratios	Alternative TOU Structure	Variable Peak Pricing	Critical Peak Pricing	DR Enabling Technology	Enrolment Type	Achieved Enrollment	Attrition
Alectra	Enhanced TOU		●					Opt-Out	7000	21%
Alectra	Dynamic				●	●	✦	Opt-In	770	20%
Alectra	Overnight			●				Opt-In	440	12%
CustomerFirst	Enhanced TOU		●					Opt-In	529	10%
CustomerFirst	Seasonal TOU			●				Opt-In	562	5%
London Hydro	CPP and CPP/RT	✦				●	●	Opt-In	658	8%
London Hydro	RT-Only	●						Opt-In	1135	2%
Oshawa PUC	Super-Peak			●				Opt-Out	1996	33%
Oshawa PUC	Seasonal TOU with CPP			●		●		Opt-In	508	15%
Oshawa PUC	Information Only	●						Opt-In	512	7%

Source: Guidehouse analysis of pilot evaluation reports

The four-pointed stars indicate that the treatment type is not applied (or not applied in the same way) to all participants within the treatment group.

The “Achieved Enrollment” refers to the number of participants enrolled in the treatment group at the outset of the pilot. The attrition rate is the percentage of initially enrolled participants that exited the program prior to its completion, for any reason. All electricity prices referenced below, and, more generally, in this report, refer only to the commodity price of electricity, unless explicitly noted otherwise.

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[4] The piloted treatments were all deployed in Alectra’s PowerStream service territory, a set of suburban municipalities north of Toronto.

[5] CustomerFirst is an energy solutions company that provides local distribution companies with program management services. CustomerFirst managed the deployment and evaluation of piloted treatments for Greater Sudbury Hydro, Newmarket-Tay Power Distribution, North Bay Hydro Distribution, Northern Ontario Wires, and PUC Services (Sault Ste. Marie). Although not an LDC, CustomerFirst is, for concision, referred to as such in this report.

The key characteristics of each of the piloted treatment groups[6] are provided below. Additional detail regarding the treatments applied to each of these groups may be found in the ODS.[7]

1) **Alectra Utilities.** Alectra deployed three treatment groups, some of which included sub-groups subject to alternative informational treatments, and one of which (Dynamic) included participants enrolled years previously for an earlier iteration of that pilot.

   a) ***Enhanced TOU. An opt-out pilot*.** Participants were allocated to this group by the LDC but could elect to leave the pilot (opt out). Participants were subject to the status quo TOU structure, but with a larger differential (a 4:3:1 ratio of On-Peak: Mid-Peak: Off-Peak compared to the status quo ratio of 2:1.4:1) between higher and lower-priced periods. A random sample of half of the participants were provided with monthly “Nudge” reports to encourage conservation and shifting.

   b) ***Dynamic. An opt-in pilot*.** Participants volunteered to participate.[8] Participants in this group were subject to a variable peak price (VPP) between 3pm and 9pm on non-holiday weekdays and six critical peak pricing events per season, each lasting four hours. Daily variable peak price periods can be High (~40 cents/kWh, 20% of days), Medium (~20 cents/kWh, 30% of days) or Low (10 cents/kWh, 50% of days). During critical peak price (CPP) events participants were subject to a price of ~50 cents/kWh. Participants were provided day-ahead notification of events.

      The Dynamic price plan differs from all the other price plans in one important respect: it was extended for an additional five months (through to the end of September 2019) to allow for an assessment of the persistence of CPP and VPP impacts.

      Some participants were supplied with enabling technology (an Energate Foundation thermostat) to automate price response; others were encouraged to register their smart thermostats to enable automatic price response during critical peak events. A random sample of participants were provided with monthly “Nudge” reports to encourage conservation and shifting.

   c) ***Overnight. An opt-in pilot*.** Participants volunteered to participate. Volunteers accepted a higher On-Peak (~18 cents/kWh) price in exchange for a price (2 cents/kWh) in the period from midnight to 6am that was less than one third the status quo TOU Off-Peak rate. Otherwise the price structure matched that of the status quo TOU. This pilot initially targeted recruiting EV owners (43% of participants own or lease EVs), and customers that might benefit from the price plan “*due to shift work, lifestyle, etc.*”). [9]

2) **CustomerFirst** CustomerFirst divided the two treatment groups across its five client LDCs. Greater Sudbury Hydro, North Bay Hydro, and PUC services contributed participants to the Enhanced TOU treatment group, and Newmarket-Tay Power and Northern Ontario Wires contributed participants to the Seasonal TOU treatment group.

   a) ***Enhanced TOU. An opt-in pilot*.** Participants volunteered to participate. Participants were subject to the status quo TOU structure, but with a larger differential (a 4:3:1 ratio of On-Peak:

[6] In this report, “treatments” refer to individual elements whose effectiveness is being tested by pilots: a price plan, a technology, or a non-price intervention. “Treatment groups” refers to groups of participants subject to some combination of different treatments.

[7] It should be noted that the status quo RPP TOU prices have changed considerably since the period in which the RPP pilots were in the field (in most cases May 2018 through April 2019).

The prices in place beginning on May 1, 2018 were: On-Peak – 13.2 cents/kWh, Mid-Peak – 9.4 cents/kWh, and Off-Peak – 6.5 cents/kWh.

[8] Participants are divided into two distinct groups: new participants, those enrolled specifically for this pilot and legacy participants, those enrolled in a previous iteration of this pilot, prior to June 2016. Unless otherwise explicitly noted, the analysis in this report refers to the new participant group, the group recruited specifically for the OEB-sponsored pilot period. The second group of legacy participants is referred to in Alectra’s evaluation report as the Legacy Dynamic group.

[9] BEWorks [on behalf of Alectra Utilities] prepared for the Ontario Energy Board, *Regulated Price Plan Pilot Evaluation, Measurement, & Verification Plan*, June 2018 (redline).

Mid-Peak: Off-Peak compared to the status quo ratio of 2:1.4:1) between higher and lower-priced periods. Participants received a smart thermostat as an incentive to participate. Half received it prior to the start of the pilot, half following its completion.

b) ***Seasonal TOU***. ***An opt-in pilot*****.** Participants volunteered to participate. In the periods from December through February and June through August, participants were subject to a 12-hour On-Peak period (7am to 7pm) with a price of 13.5 cents/kWh. In the same months the Off-Peak period (all other hours) was discounted (by 1.1 cents/kWh). In the six remaining months, participants paid 8.1 cents per kWh in all hours, all days of the week. Participants received a smart thermostat as an incentive to participate. Half received this incentive prior to the start of the pilot, half following its completion.

3) London Hydro. London Hydro's pilot included three treatment groups, one provided with real-time information only ("RT-Only") via a mobile app, one subjected to critical peak pricing ("CPP") and one to which both treatments were applied ("CPP/RT"). Due to the outcome of the impact evaluation of this pilot[10], the CPP and CPP/RT groups are treated, in this meta-analysis, as a single treatment group. This treatment group (CPP and CPP/RT) is subject to the treatment "Quick-Ramp CPP".

a) ***RT-Only*****.** ***An opt-in pilot*****.** Participants volunteered to participate. Participants were subject to the status quo TOU structure without any changes in price. Participants were provided with a mobile application (an "app") called "*Trickl*" that allowed them to track their consumption in real-time, and provided goal reporting based on historical electricity consumption.

b) ***CPP and CPP/RT (Quick-Ramp CPP)***. ***An opt-in pilot.*** Participants volunteered to participate. Participants agreed to be subject to 18 one-hour critical peak events in each season, called with fifteen minutes' notice, over a twelve-month period and received a 0.5 cent discount to Off-Peak consumption charges. During the critical peak periods, the price was nearly 60 cents per kWh. Participants were equipped with a panel-mounted load switch (connected to a circuit of the participant's choice) that activates when London Hydro dispatches the critical peak signal. Participants were provided with the Trickl app. Participants could control their load switch remotely with this app and receive push notifications of critical peak events. CPP/RT participants also had access to the real-time information functionality provided to the RT-only group.

4) Oshawa PUC. Digital engagement is the centerpiece of the Oshawa PUC pilot. All participants were provided access to a mobile app ("*Peak*") that provided daily consumption summaries, daily consumption benchmarking (against the participant's own weather normalized historical consumption), competitive peer-group savings benchmarking ("gamification") and personalized energy saving tips.

a) ***Super-Peak. An opt-out pilot.*** Participants were allocated to this group by the LDC and could elect to leave the pilot should they so choose. In June through August participants were subject to a price of approximately 25 cents/kWh from 1pm to 7pm on non-holiday weekdays (the Super-Peak period). In the remaining non-Off-Peak periods participants paid 9.5 cents per kWh. Off-Peak prices were very slightly discounted (0.2 cents/kWh) from status quo TOU.

b) ***Seasonal TOU with CPP. An opt-in pilot*****.** Participants volunteered to participate. In the periods from December through February, and June through August, participants were subject to a 12-hour On-Peak period (7am to 7pm) with a price equivalent to the status quo On-Peak price. In the same months the Off-Peak period (all other hours) was discounted (by 1.2 cents/kWh). In the six remaining months, participants paid 7.9 cents per kWh in all hours, all days of the week. Participants were subject to 10 four-hour critical peak events in summer and 10 in winter. Each

[10] The technical consultant found that there was no statistically significant difference between the impacts estimated for the CPP and CPP/RT groups.

event lasted four hours. Participants were notified more than 24 hours in advance and paid approximately 25 cents per kWh during events.

c) ***Information Only***. ***An opt-in pilot*****.** Participants volunteered to participate. Participants were subject to the status quo TOU structure without any changes in price and were provided (as were all participants) with the “Peak” app.

Meta-Analysis Approach

Guidehouse’s recommendations in this report are informed by two parallel streams of analysis: a review of the findings of the pilot evaluation reports, and the comparison of each of the piloted treatment groups across a common set of metrics. The two are not wholly distinct: the inputs used by Guidehouse to evaluate its metrics are often outputs of the pilot evaluations, and the outcomes of some metrics help to inform and clarify the findings of the evaluation reports.

The first workstream – Guidehouse’s review of the evaluation reports – is self-explanatory.

The second workstream merits some additional explanation. The raw inputs of this analysis are complex, and the considerations are multi-dimensional. Combinations and iterations of piloted treatments can sometimes be unclear and the effects difficult to disentangle. The goals that the treatments are ultimately meant to support (the renewed RPP objectives of the RPP Roadmap) can sometimes be in tension with one another and need to be balanced. A strong formal structure, with distinct categories defined mostly by the RPP objectives, provides a robust and transparent framework from which conclusions may be developed.

To enable an analysis of the treatment groups, over and above the synthesis of the most important findings and outputs of the pilot evaluation reports, Guidehouse developed seven distinct evaluation metrics, and ranked each treatment group’s performance for each metric. The first six of these metrics align with the renewed RPP objectives. The seventh relates to concerns of practical and technical feasibility. Guidehouse evaluated each treatment group against the following seven metrics:

1. **Cost Recovery.** How well does the treatment price recover the average RPP supply cost?
2. **Cost Reflectiveness.** How closely do the hourly changes in treatment price reflect the hourly changes in the supply cost, both short-term and long-term?
3. **Cost Minimizing.** To what degree will each treatment group, if implemented at the provincial level, reduce overall system costs?
4. **Predictability.** Which price treatments have price structures that deliver the most predictable prices to consumers?
5. **Comprehensibility.** How easy are the price treatments for consumers to understand?
6. **Opportunity for Bill Savings.** What opportunity for bill savings does each price plan offer?
7. **Ease of Implementation.** What technical hurdles, particularly related to billing systems and customer care, would local distribution companies (LDCs) need to surmount to offer the given price plan to their customers?

Each metric is ranked from 1 (worst) to 5 (best). Ties are possible. Guidehouse has intentionally not rolled up individual metric scores into a total treatment group specific value for three reasons:

- Firstly, the purpose of Guidehouse’s analysis is not to pick a “winner”. Each pilot offers different lessons learned, and each may include different elements worthy of expansion into a wider offering to a larger population. Ultimately it is the quality of the individual features of each pilot, rather than the pilot as a whole that is of most interest.
- Secondly, such a scoring, by relegating some pilots to a lower rank than others, could unintentionally obscure benefits that elements of such (nominally) poorly performing pilots may

offer, benefits that may be evident only through a nuanced comparison of the metric results *and* the evaluation report findings.

- Thirdly, developing a final overall rank for each pilot would require assigning weights to each metric. The development, and ultimate values, of such weights could – due to their inevitably subjective nature – distract from the final recommendations, even when the evidence underlying those recommendations (from the evaluation reports, and from individual metrics) is often clear and unambiguous.

The detail of Guidehouse's recommendations clearly spells out the evidence that drives them and explicitly identifies areas where uncertainty or ambiguity exist.

Summary Findings and Recommendations

This section of the Executive Summary provides Guidehouse's recommendations to the Ontario Energy Board. Our recommendations are informed across two dimensions. They draw on design elements across the different pilots based on observations made by Guidehouse while reviewing the pilot evaluation reports (Chapter 2), and Guidehouse's quantitative and qualitative assessment of the results of the scoring metrics (Chapter 4). These findings were synthesized into feature-level findings and conclusions in Chapter 5. The four recommendations are developed in detail in Chapter 6 and summarized below. Guidehouse, in developing the recommendations below, has considered the effects of COVID-19 on consumer behaviour as well as the increased optionality available to consumers as of November 1, 2020 at which point consumers were provided the opportunity to opt out of the default TOU price plan and into a Tiered price plan.

These recommendations are informed by a perspective that views COVID-motivated changes in consumer and societal behaviour as largely temporary – the embedded expectation being that the most significant behavioural changes (office work, schooling, travel, etc.) are likely to revert to pre-pandemic patterns within two to three years.

Guidehouse's four recommendations relate to:

1. **Existing TOU Price Structure and Price Differentials.** Guidehouse's recommendation for adjustments to the existing default TOU price plan.

2. **Informational Support for Price Plans**. Guidehouse's recommendations for the use of informational treatments (Nudge reports and mobile applications) to support existing and potential alternative price plans.

3. **Opt-Out Technology-Enabled Critical Peak Pricing.** Guidehouse's recommendation for the development and deployment of an opt-out critical peak pricing pilot for smart thermostat owners.

4. **Better Understanding the Decarbonization Potential of the Overnight Price Plan.** Guidehouse's recommendation for some additional analysis to ensure that the societal benefits of the Overnight price plan are not being understated and to assess whether there is any value in a price plan that may incent decarbonization.

Existing TOU Price Structure and Price Differentials

Guidehouse has considered carefully what pricing elements tested in the RPP pilots would be appropriate to replace or augment the default status quo TOU price plan.

The Dynamic and CPP elements are inappropriate for integration into the default TOU price plan. These price elements offer significant benefits (see Section 4.4) but require the consumer to have central air-conditioning to respond effectively (see Section 2.2.4), and in any case score very poorly in the predictable (see Section 4.5) and comprehensible (see Section 4.6) metrics.

The price differentials of the Super-Peak rate were relatively extreme and deliver savings only from a fraction of consumers (see Section 2.2.3). The relatively minor avoided cost benefit would be small compared to the magnitude of potential consumer discontent (attrition for this price plan was 33%[11]), given the price differentials. The Super-Peak price plan is, at this time, an inappropriate price plan for the provincial default TOU price plan, despite being the most long-term cost-reflective price plan without a CPP element. Given the ability of consumers now[12] to opt-out of the default TOU price plan to a Tiered price plan, a price plan borrowing some features of the Super-Peak structure (e.g., higher price differentials) may be worth reconsidering in the future, once the initial wave of default TOU opt-outs is complete, and the overall level of engagement of consumers that have elected to remain on the default TOU can be assessed.

The results of the longer-term cost-reflectiveness analysis (Section 4.3), indicate that the Enhanced TOU price plan is more cost-reflective than the status quo TOU price plan, and could potentially be made even more so by beginning the Off-Peak period at 9pm and increasing the price differentials of the summer On-Peak and Mid-peak, and the winter On-Peak.

That is, there is an opportunity to adjust the existing TOU price plan to be more reflective of the long-term costs (as defined here by the hourly allocation of Global Adjustment costs developed by OEB staff).[13] Such an adjusted price plan could have the following characteristics:

a) **Later Off-Peak.** Extend the summer Mid-Peak period and winter On-Peak period to 9pm, to avoid providing a low-price during periods when long-term system costs are very high.

   Adjusting the existing TOU price plan by extending the summer/winter Mid-

   peak/On-Peak period by two hours would require a change in regulation (O. Reg. 95/05 currently requires Off-Peak prices apply after 7pm). However, the mechanics of implementing the adjustments would be much simpler than for the Dynamic price plan (see Section 4.8), or any other alternative price plan that doesn't share the same structure as the current TOU price plan. In fact, this change in TOU period timing is simply a reversion to the TOU price structure in place provincially until May of 2011.

b) **Price Differentials.**[14] In the summer months, increase the absolute level of On-Peak and Mid-Peak prices such that they better reflect the long-term costs. In the winter months, increase On-

[11] Approximately two-thirds of those participants that opted out of this price plan did so before June 1 – before they actually became subject to the elevated summer Super-Peak price. Nearly all participants that exited this pilot (93% of the 33% that dropped out) did so prior to November 1.

[12] As of November 1, 2020, RPP consumers may elect to opt out of the default TOU price plan and into the Tiered price plan.

[13] This demand-based hourly allocation of GA was developed as part of an OEB staff paper, and it was found to be the most economically efficient allocation of GA, of the nine pricing prototypes examined. OEB continues to do research in this area.

Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, February 2019

https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

[14] OEB staff are continuing to study alternative demand-based allocations of the GA that better reflect long-term system costs in an economically efficient manner. While it is clear from this on-going analysis that a price plan in which the Off-Peak period begins at 9pm instead of 7pm is more reflective of long-term costs, the question of the relative *magnitude* of these costs (and thus the appropriate TOU period price differentials) remains open. Guidehouse's recommendation with respect to price differentials is conditional on the most recently available information at the time of writing, and as a result, may need to be reconsidered as this work of the OEB's progresses.

Peak prices, and consider reducing Mid-Peak as well as Off-Peak prices to better reflect the intra-daily distribution long-term costs.

Increasing the differentials between On-Peak and Off-Peak periods will improve consumers' opportunity for bill savings and thus the motivation to respond to the (more aggressive) price signal in the late afternoon/early evening period when long-term system costs are highest. Although neither of the piloted Enhanced TOU price plans delivered any short-term behavioural energy savings, a set of more aggressive On-Peak and (summer) Mid-Peak prices could accelerate longer-term structural price response by increasing the incentive for consumers to acquire more efficient appliances, particularly more efficient space-cooling equipment.

Furthermore, since (as of November 1, 2020) RPP consumers will have the option to opt out of the default price plan and on to a Tiered (inclining block) price plan, increased TOU period price differentials will not "trap" consumers into higher bills. If consumers believe they cannot effectively respond to a higher On-Peak/Off-Peak ratio, they have the opportunity to opt out of the default TOU price plan into the lower risk Tiered plan.

Such changes identified above would be considerably less disruptive for consumers than some of the other price plans contemplated by the OEB in its RPP pilots and could act as an effective stepping-stone to other alternative price plans with more novel designs or wider price differentials. Guidehouse's recommendation here is driven by considerations of price plan long-term cost-reflectiveness and the longer-term benefits of pursuing incremental, rather than radical, change.

Some consideration may be given to eliminating the summer Mid-Peak period entirely and making the entire 7am to 9pm period On-Peak. The current relative long-term cost-reflectiveness of the winter Mid-Peak period argues against its elimination. The OEB may also wish to consider offering RPP consumers a risk-free trial period for a new default TOU price plan, three to six months, to allow risk-averse consumers an opportunity to observe how effectively they can respond to such a TOU rate, rather than simply abandon it.

Based on the findings of the cost-reflectiveness analysis, Guidehouse recommends:

- **Increasing the summer On-Peak and Mid-Peak and winter On-Peak price differentials to improve long-term cost-reflectiveness and provide consumers with more opportunity to reduce their bills.**

- **Adjusting the default TOU price plan to better reflect long-term system costs by restoring the pre-May 2011 TOU period definitions and starting the Off-Peak period at 9pm.**

- **Consider offering consumers subject to a new default price plan some period of bill protection to mitigate against high levels of initial attrition due to consumer risk-aversion. Guidehouse expects that bill protection would be most important for default price plans that are materially more aggressive in price differentials than the status quo default TOU price plan in force on November 1, 2019.**

Informational Support for Price Plans

Two types of informational support were tested: Nudge reports and mobile applications (apps). Each is discussed in the two sub-sections below. The third sub-section summarizes Guidehouse's recommendations with respect to both types of informational support.

Nudge Reports

Nudge reports were found to deliver savings both for participants in Alectra's Enhanced TOU price plan, as well as consumers subject to the status quo default TOU price plan. Overall conservation savings were not, however, statistically significant, though estimated TOU period impacts in the On-Peak period (summer and winter) and Mid-Peak period (winter only) were statistically significant, if modest, with estimated reductions during the On-Peak period of 1.1% (summer) and 0.8% (winter) and winter Mid-Peak reductions of 1.8%.

Estimating the TRC of the price plans or of elements of the price plans was not an evaluation requirement for any of the LDCs that participated in the pilots. As a result, Alectra's evaluation report did not contain an estimated total resource cost (TRC) ratio[15] identifying the cost-effectiveness of this component of its pilot design Given the estimated savings of the Nudge reports in Alectra's pilot, and the current very low level of Ontario's avoided costs of electric energy, it is very unlikely that this treatment, applied only to electricity, would be cost-effective from a societal point of view.

Guidehouse would not recommend a wider deployment of Nudge reports, unless it could be demonstrated that such a wider deployment would be likely to deliver savings more in line with the average values typically observed for home energy reports (e.g., 2% or more).

Mobile Applications (Apps)

Mobile applications (apps) appear to deliver modest but uncertain savings. These apps, however, provide important non-energy benefits that, while difficult to accurately quantify, suggest that they could deliver meaningful societal value over the longer term. Furthermore, the lack of availability of an app (or apps) to allow consumers to track their consumption in near-real-time acts as an implicit signal to consumers that there is little value in doing so.

The Government of Ontario has published a regulatory proposal for province-wide implementation of the Green Button standard.[16] According to a presentation to the Ontario Energy Association[17], the proposed regulation would require that Ontario LDCs with more than 25,000 customers to implement Green Button within two years of the regulation being enacted. The Green Button "*Connect My Data*" (CMD) standard allows individual utility customers to grant access to their historical hourly data to third parties so that these third parties can provide the utility customers with analytics to help them manage their electricity use.

The implementation of the Green Button CMD removes one significant barrier to the development and distribution of energy-monitoring apps to Ontario consumers. Although necessary, the access to customer data is not a sufficient condition for ensuring the development and deployment of such apps to consumers. While a few energy apps currently exist that conform to the Green Button standard[18], public agencies in concert with app developers and other third parties can facilitate and expedite the further

[15] The total resource cost (TRC) ratio is a benefit/cost ratio typically used for evaluating the cost effectiveness of energy efficiency programs. The TRC measures the net costs of an energy efficiency program based on total costs of the program including both the participants' and the utility costs.

[16] Environmental Registry of Ontario, *Regulatory proposal for province-wide implementation of Green Button,* Proposal posted October 8, 2020

https://ero.ontario.ca/notice/019-2564

[17] Ministry of Energy, Northern Development and Mines, *Proposals for Green Button and Community Net Metering: Presentation to Ontario Energy Association Climate Change and Energy Efficiency Committee,* November 6, 2020

[18] The Ministry presentation cited above referenced nine energy-tracking apps, three of which are explicitly for residential use: The Hazel Project, Stumply, and Ohmconnect. Guidehouse staff attempted to register or download theses apps. The Hazel Project's registration page did not load, Stumply's link to its app on Google Play is non-functional, and Ohmconnect timed out when trying to connect with the staff member's Toronto Hydro account.

development of these apps by working together, to support their availability and the inclusion of certain core features that support energy policy goals.

The regulation the Ministry of Energy, Northern Development and Mines is currently proposing for Green Button would give utilities two years from the time of its enactment to implement Green Button. During this time, there would be opportunity to conduct broad-based discussion and identify core features that energy apps should contain to meet energy policy goals.

Based on the findings of the evaluations of pilots that test app-based treatments, Guidehouse has identified a set of core features whose inclusion in any Green Button-enabled app would support current public policy goals – these are outlined in further below. This is preceded, immediately below, by discussion of how widespread adoption of energy monitoring apps (with the appropriate functionality) could materially support policy goals related to consumer price response and energy efficiency. These discussions are then followed by Guidehouse's recommendations for informational treatments.

<u>Using Apps to Improve Recruitment Cost-Effectiveness and Build Consumer Engagement</u>

The findings that the London Hydro *Trickl* app yielded modest On-Peak savings from volunteer participants, and that app usage in the Oshawa PUC pilot was very strongly correlated with participant price response (both reductions and increases in demand) suggest that app usage is less a *driver* of conservation than it is an *indicator* of who is a highly engaged consumer. Highly engaged consumers will deliver substantial savings when the price signal indicates it is worth it, but may, conversely, relax their on-going (existing) conservation behaviours when the price signal indicates it is *not* worth it (as shown by the Oshawa Information Only treatment group which *increased* consumption in most TOU periods).

The use of Oshawa program participants' app usage data to identify the most engaged price plan participants, and to estimate the impact they delivered separately from the balance of consumers, allowed the pilot evaluator and Guidehouse to gain a much more nuanced understanding of the price plan impacts. It is a valuable contribution to the electricity pricing professional literature.

If an app (or group of apps with similar functionality) were made available to a wider group of consumers, app usage statistics could allow program administrators to target highly engaged consumers for enrolment in other alternative price plans or conservation or demand management (CDM) programs. As these consumers are more engaged, they are more likely to enroll and more likely to respond to the program treatments, reducing the acquisition cost of conservation and demand response.

As noted in Section 5.2.1, mobile apps also provide consumers with a trustworthy and secure communications channel with their LDC, a channel which could, for example, help consumers transition to an alternative TOU price plan, or to a new default TOU rate such as that recommended above. Mobile apps can be a powerful tool for building consumer engagement – for example, as cited in Chapter 5, Oshawa PUC was able to use the Peak app to promote the AffordAbility Fund (Affordability Fund Trust) to participants.

Offering consumers an app that allows consumers to engage with their own behaviour and, if they are interested, understand and alter that behaviour can improve recruitment cost effectiveness and engagement. This means that active engagement by consumers is no longer limited to enthusiasts and can be undertaken even by consumers with a more casual interest in their electricity use. Improved access to information lowers the psychic cost of entry to consumers and makes them more likely to become engaged in the future.

Chapter 5 of this report notes that the Alectra focus group analysis found that an energy monitoring app was an "expectation" of its customers.

The potential effect on consumer engagement of signaling to consumers the value of their engagement by meeting this expectation and ensuring the availability of an energy monitoring app could be considerable. Likewise, the improved ability to monitor and harness consumer engagement via one or more apps could substantially help improve aggregate consumer price response and energy efficiency achievements.

App Features

The features an app should contain will depend on the goals set out for the app. The OEB's goal for non-price tools, as tested in the RPP pilots, is to improve consumer price response.

An app that works to build consumer engagement and improve consumer price response over time should provide consumers with transparency into their usage patterns, direct and intuitive indications of bill impacts (e.g., $/period per day as well what each period's cost contribution is to their average daily billed cost), and the functionality to connect participants with information about new or existing programs or price plans that will help them reduce the costs they impose on the electricity system.

More specifically, app features that would help to achieve enhanced consumer price-responsiveness to OEB price plans could include:

- **Data Sharing (suggested core feature).** The most important feature from a policy and program administration perspective. It is vital than any apps deployed provide price plan and CDM program designers with some individual consumer usage statistics that can be joined with hourly electricity consumption data. This will enable statistical inference to estimate the impacts of price plans and CDM programs delivered to the most engaged consumers. This previously unavailable ability to differentiate between engaged and less-engaged consumers can help improve the designs of price plans and CDM programs and can help policy makers understand how to increase the number of consumers that are engaged.
- **Consumption Data (suggested core feature).** Near real-time (e.g., no more than 1-day delay) hourly consumption information, and the ability to aggregate these values by a variety of time increments. This is a key feature and is the one most likely to interest consumers (e.g., use of this feature by Oshawa PUC participants climbed steadily throughout the pilot – see Figure 98 of the evaluation report). This could also include access to view past and present electricity bills.
- **Cost Data (suggested core feature).** The ability for a consumer to look at their consumption in a given day or given hour and understand the cost of that consumption. Ideally, this should be presented as absolute and relative values (e.g., consumption between 9am and 10am costs $0.75, or 0.8% of your monthly bill). Cost values should include all variable costs, not just commodity costs.
- **Push Notifications (suggested core feature).** A dynamic push notification that alerts consumers when their consumption is higher than usual in a costly period. For example: send a push notification when demand during the On-Peak period is 1.5 times the average value for the given season.
- **Program Cross-Promotion (suggested core feature).** The Oshawa PUC Peak app was used to cross-promote the provincial AffordAbility Fund (Affordability Fund Trust). A feature such as this would enhance consumer awareness of opportunities to save electricity as well as support other provincial programming that encourages conservation and demand management, leading to overall improvements in program recruitment cost-effectiveness.
- **Technical Assistance (suggested secondary feature).** This could include a technical connection to a utility call centre or provincial call centre that provides technical tips for saving energy.
- **Peer Benchmarking (suggested secondary feature).** Information feedback and peer benchmarking (e.g., through home energy reports) have long been demonstrated to yield modest savings. Presentation via an app could reduce delivery costs sufficiently to make such functionality cost-effective.

The first feature above enhances the ability of the regulator and system operator to develop, deploy, and continuously improve the price plans and CDM programs that are offered.

The remaining features noted above all enhance consumers' understanding of, engagement with, and ability to respond to the prices they face.

These features support the OEB's goal of improving consumer response with non-price tools and may also support the goals of other provincial agencies or stakeholders, for example by improving the cost-effectiveness of CDM program delivery. There may be other app features not considered above that could deliver benefits to consumers or the province, in line with the goals of other agencies or stakeholders.

Engagement with other provincial agencies and stakeholders in a formal working group setting could increase the value of any app eventually deployed by considering a broader range of benefits than only price response. This is the basis of Guidehouse's recommendation below regarding the use of a mobile app.

Mobile Applications (Apps)

In summary, Guidehouse recommends that the OEB:

- **Not proceed with Nudge reports.** The Nudge reports tested by Alectra appear highly unlikely to be cost-effective. Until such time as a robust third-party evaluation can demonstrate the cost effectiveness (e.g., TRC > 1) of these, no further action should be taken.

- **Convene a stakeholder working group to develop principles, objectives and guidelines for informational support from apps to enhance customer price responsiveness to OEB price plans.** The working group should be composed of: IESO, Ministry of Energy, Northern Development and Mines, LDCs, app developers, consumer groups and others, as appropriate. Consideration should be given to seeking input from experts in behavioural research.

  These public agencies must enable such a working group to ensure that there is a path forward for the development and deployment of energy-monitoring apps that can support and enhance provincial policy and offer meaningful benefits to consumers. Energy tracking apps have the potential to be an important policy tool for these agencies, but if these agencies cannot – through a working group or some other venue – clearly articulate their policy needs and how these can be addressed by apps, then network and other market effects may lead to an ecosystem of apps unsuited to serving the province's policy goals or the needs of consumers. This remains an infant industry, and as is often the case with infant industries, it, and the public, may benefit from direction and momentum provided by public agencies.

  The working group could be convened by either OEB or IESO or jointly as both have key roles regarding energy efficiency, with OEB responsible for approving any conservation and demand management (CDM) proposed by utilities within their distribution system plans to defer infrastructure and IESO responsible for both provincial CDM and regional planning within which utilities may have a role in providing geo-targeted CDM or demand response to help with system constraints.

  Because of these roles, the OEB and IESO are well positioned to ensure that application development can take these regulatory and planning frameworks into account effectively. Since the recommendations regarding the applications arise from this meta-analysis, the OEB has a more comprehensive understanding of the findings and how to build on them, making OEB best suited to take a leadership role in convening the working group.

The working group should be tasked with:

- ***Specifying a List of App Principles and Objectives****.* This list should include principles or ultimate goals (e.g., "*Educating consumers and improving price response*") as well as objectives or proximate goals, which should be more concrete (e.g., "*X% improvement in the ability of app users to estimate the impact of action Z on their monthly electricity bill by year Y*").
  In developing the list of app principles and objectives, the working group should explicitly address the importance of enabling policy-makers to use consumer app usage data without compromising consumers' privacy.
- ***Defining the App Features that will Deliver on the Principles and Objectives.*** The working group should define which features are most important to meet the principles and objectives, taking into account criteria such as, usability, ability to have consistent messaging and customer experience, ease of implementation, and cost.
- ***Articulating the Major Barriers to Implementation***. The working group should identify and discuss key reasons why energy-monitoring mobile apps have not flourished previously in Ontario, and identify successes in other jurisdictions that could be more effective in Ontario.
- ***Identifying the Appropriate Delivery Model****.* The working group should consider key questions in delivery such as: Should an app (or apps) be procured by a central agency (e.g., the IESO)? Or by LDCs? Others? How can the delivery model help to remove barriers to access and app use? How can the delivery model contribute to app developers offering "freemium" (no cost for some features, payments required to "unlock" others) mobile apps to consumers?
- ***Developing Draft Guidelines for Broader Stakeholder Input***. The guidelines should specify a list of app principles and objectives, define the appropriate ap features and identify the appropriate delivery model. The description of each feature could include, for example, what information should be offered and what functionality should be prioritized.

Opt-Out Technology-Enabled Critical Peak Pricing

The key findings to support Guidehouse's recommendation with respect to an opt-out technology-enabled CPP price plan are summarized below:

- **Critical peak pricing delivers statistically significant demand response.** Critical peak pricing has been demonstrated across all three pilots in which it was employed to deliver statistically significant demand response in the summer months (see Table 2-10).

- **Critical peak pricing response persists over time.** As the 17-month Alectra evaluation report shows, CPP response by the Dynamic treatment group was remarkably consistent from the summer of 2018 to the summer of 2019, despite some decline in price responsiveness in the other price periods. Investments in building CPP capacity appear to continue to deliver returns so long as the price signal remains.

- **CPP should be confined to the summer months.** Demand response at times of system peak delivers significant societal value by reducing the long-term cost of power. As Ontario is a summer peaking jurisdiction, demand response offers little value in the winter months from a provincial perspective.

  All the CPP treatment groups evaluated have clearly demonstrated what is intuitively clear: residential participants' capacity to deliver demand response is concentrated in the summer months. A/C use is, in most homes, the largest truly discretionary load for which there is a single point of control. As the benefits of demand response are vastly greater in the summer than in the winter (when there is no avoided capacity cost benefit), it does not make sense to alienate participants by subjecting them to winter events to which they have only a limited ability to respond.

- **CPP events should be longer than one hour**. As the cost-reflectiveness analysis (Section 4.3.2) demonstrates, CPP events must be longer than one hour. In that analysis, the Seasonal TOU price plan was found to be less cost-reflective in the long-term than the status quo TOU price plan, but the Seasonal TOU with CPP price plan was found to be more cost-reflective than London Hydro's CPP price plan. As London Hydro's CPP price plan is just the status quo price plan with 36 one-hour CPP events, it is clear that the four-hour Oshawa PUC Seasonal TOU with CPP critical peak events were more cost-reflective (in the long run) than the one-hour London Hydro events. As demonstrated in Section 4.3.2, four-hour CPP events are much more cost-reflective than single-hour CPP events.

- **Technology-enabled CPP yields the greatest avoided cost benefits of the plans reviewed**. DR-enabling technology greatly increases demand response as demonstrated by the results from participants enrolled in CPP price plans, with technology increasing DR impacts by approximately 0.4 kW in the London Hydro pilot. This result matches the findings of other technology enabled critical peak pricing programs, as detailed in Section 2.2.4.

- **Deploying and maintaining technology can be costly.** Under the assumptions currently in place none of the technology-enabled price plans are cost-effective from a societal perspective (see Section 4.4). As demonstrated by Alectra's Dynamic price plan (and other utilities outside of Ontario)[19], smart thermostats already in consumers' homes may be enabled to provide automatic demand response.

- **Opt-out recruitment is much faster and less costly than opt-in recruitment**. All the RPP pilots that adopted an opt-out recruitment approach attained their enrolment targets. Of all the opt-in treatment groups, only Oshawa PUC met its recruitment target, and then only through an extremely resource-intensive effort. The per-participant recruitment cost of opt-out programs is much lower than for opt-in programs, improving cost-effectiveness. As shown in Section 5.3, the marketing cost per customer for Alectra's Enhanced TOU (opt-out) was approximately 2% of the marketing cost per customer of the Dynamic price plan.

- **Attrition can be limited by offering first-year bill protection**. First-year bill protection has been demonstrated to be very effective at limiting attrition. The legacy Dynamic participants had the lowest pilot period attrition rate of *any* treatment group subjected to alternative prices (bill protection was cited as one of the most important motivators for enrolment in the 2016 process evaluation of this program). OG&E's Smart Hours (variable and critical peak pricing) program has enrolled 15% of its residential customer base in the program in part by motivating enrollment by offering bill protection for the first 12 months of participation – a risk-free trial.

  Bill protection eliminates the short-term risk to participants of experimenting with the new price plan, and so encourages participation (and discourages dropping out) even amongst risk-averse consumers.

  In the case of Oshawa PUC's Super-Peak opt-out price plan, although attrition was very high, two thirds of those that did drop out did so before June 2018 when Super-Peak prices began to be applied. These participants dropped out because of a *perception* of risk, not because of bill impacts. This attrition might have been significantly reduced had participants had the option of a

[19] Consider for example this bring-your-own-thermostat program in Colorado:
Nexant, Inc., prepared for Xcel Energy, *Xcel Energy Colorado Smart Thermostat Pilot – Evaluation Report*, May 2017
https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/CO-Smart-Thermostat-Pilot-Evaluation.PDF

year of bill protection so that they could better understand their financial exposure under the new price plan.

- **In-person technical support could make the price plan more accessible and improve participant retention.** Retention – and impacts – can be increased over the long term by focusing on encouraging consumers to register their devices in order to allow them to be automatically curtailed by a program administrator, and providing in-person “office hours” style technical support, to help empower potentially marginalized consumers, including in demographics that tend to be less technically adept, and those for whom English is not their first language. Such engagement has been effectively demonstrated by London Hydro to help some consumers cross initial technical hurdles and improve program results.

Given these findings, Guidehouse recommends:

The OEB work with LDCs to deploy an opt-out CPP price plan adder. This would not be a separate price plan, but rather an additional layer that could be applied to any consumer’s existing price plan, analogous to a rate rider.[20] The development of this deployment should consider the following:

- *Deployment Costs.* A precise costing of a CPP price plan adder for provincial deployment is outside of the scope of this analysis. The analysis that is in scope – a review of reported pilot costs and high-level estimates provided by a sample of LDCs in a survey – suggests such costs are highly uncertain, though they could be substantial. LDC estimates of implementation costs for deploying a CPP price plan provided as responses to Guidehouse’s survey (see Section 3.7) ranged from less than $100,000 to more than $1 million. Given the use of CPP in other jurisdictions[21], the value of avoided capacity, and potential scale economies of provincial deployment, it seems likely that the benefits of an opt-out CPP price plan adder would exceed the costs of implementing it, but OEB Staff should conduct additional targeted analysis to confirm this assertion.
- *Eligibility.* The list of consumers to be included in the opt-out price plan should be derived from the transaction records of GreenON, the IESO, and utilities (gas and electric) to target consumers that have received a free, or heavily rebated, smart thermostat. Only those that have received a free, or heavily discounted, thermostat capable of automatic curtailment should be automatically included. The message to consumers should be that the province is asking (but not compelling – opting out is possible) for help reducing costs for all rate-payers from those consumers who are most capable of providing it through equipment partially or wholly funded by tax- and rate-payers. Other consumers that have the requisite thermostats purchased on their own without Ontario government or utility subsidy could opt-in to participate.
- *Target Summer Peak.* Only customers of summer-peaking LDCs (that have received a free or heavily rebated smart thermostat) should be included automatically, though all consumers with the requisite technology should have the to opt in should they so choose.
- *Offer a Reward.* Consider, rather than offering participants a modest discount on the Off-Peak price, offering an annual bill credit. A single more substantial payment is likely to be a greater enticement to consumers than a discount of a fraction of a cent per kWh of Off-Peak consumption. The magnitude of the annual payment can be determined through a comparative analysis of the avoided cost benefits of a projection of forecast consumer price response against the projected costs of deployment (per above). As evaluated impacts and audited costs become available, this value should be updated accordingly, and this incentive should be contingent on a full summer of participation.

[20] Rate riders are typically temporary chargers or credits applied to customer bills, often related to operational costs (or revenue) not included in regulator-approved rates.

[21] Southern California Edison’s CPP-D pricing plan, Green Mountain Power’s Rate 9, Xcel Energy’s Critical Peak Pricing Program, etc.

- *Undertake a Staged Deployment.* As with the deployment of RPP TOU rates in the 2008 – 2012 period, the CPP price plan adder should be rolled out gradually. Begin with a volunteer LDC, and course-correct on-going deployment based on the lessons learned in the initial deployments.
- *Encourage Registration of Smart Thermostats for Automatic Control*. Encourage consumers included in the price plan to register their smart thermostat to allow for automatic curtailment, as was done as part of Alectra's Dynamic price plan pilot. This will substantially increase demand reductions and reduce bills – as noted above in Section 5.2.4, critical peak pricing enhanced with enabling technologies can deliver demand response up to three times that provided when price alone is used. Alectra successfully registered the thermostats of approximately 20% Dynamic price plan participants. Guidehouse believes that this proportion could be significantly increased by reducing barriers for consumers to contact their LDC for help[22], and through a more focused marketing effort.[23] The OEB should consider working with a market research firm to assess the most effective way to persuade enrolled consumers to register their thermostat.
- *Provide Some Limited Bill Protection.* Provide participants with bill protection for the first two summer months of participation. This will reduce short-term attrition due to sticker shock and encourage risk-averse consumers to stick with the price plan adder for at least a month or so to better understand their financial exposure.
- *Allow, and Consider Encouraging, Opt-Ins.* As part of the analysis undertaken to determine the appropriate incentive to offer prospective participants, assess the value of marketing the price plan adder to those not eligible for automatic enrollment. This should be based on the observed recruitment rates of the RPP pilots with CPP components, and potentially with advice from a market research firm on how to most cost-effectively acquire opt-in participants.

Better Understanding the Decarbonization Potential of the Overnight Price Plan

The Overnight price elicited the most substantial purely behavioural impact of any treatments tested, with a 45% increase in demand between midnight and 6am during the summer and a 73% increase in demand in the same time period in the winter. Summer overnight demand increases were partially off-set by On-Peak and Mid-Peak demand reductions of approximately 10% and 8%,respectively - the largest purely behavioural demand reductions delivered by any treatment group in a static price period.[24] Overall, the average annual consumption of participants increased nearly 15% (20% in winter months).

The Overnight price plan analysis uncovered three key issues which must be addressed:

- **The Overnight price plan under-collected revenues. However, it was an under-collection of only 15%. This can be mitigated by setting any future plan with revenue neutral prices based on appropriate load profiles.**

  The under-collection for this group – the difference between the average pilot revenue per kWh and the average RPP supply cost (RPA) – while being the largest deviation (in absolute value) of any price plan[25], was only 15%. This is a not unexpected result. Given that the purpose of the price plans is to shape behaviour through a price signal, it should not be surprising the behaviour change provoked by the price signal results in a reduction in average revenue per kWh (or, conversely a reduction in the consumer's average cost of consumption). The principal implication here is that any deployment on a large scale would need to set revenue neutral prices based on

[22] The focus group analysis procured by Alectra indicated that participants that called the Customer Service Centre with questions: "*did not always receive a satisfactory response*" and noted that there was considerable confusion between the pilot-specific web-site and the more general Alectra customer portal.

[23] The same focus group above noted "*an almost complete lack of awareness of the value"* of the program-provided (or registered) smart thermostats.

[24] i.e., excluding variable and critical

[25] The second-largest deviation (in absolute value) was the over-collection of 3.1% by the Oshawa Super Peak treatment group.

the load profile of consumers *already subject to the price plan* (to account for the change in behaviour).

- **The Overnight price plan did not meet its recruitment target. This is likely to become more readily achievable as the penetration of EVs grows**.

  As noted in Section 2.2.1 this pilot only succeeded in enrolling 320 consumers (64% of the goal) prior to its deadline. Following an extension of that deadline by one month, the pilot was able to achieve 88% of targeted enrolment. While unfortunate for the statistical power of the evaluation, this is not entirely surprising. The IESO's REUS[26] reports that between 2.2% and 2.4% of residential consumer households own or lease an electric vehicle. This substantially reduces the pool of potential volunteers for a price plan that explicitly targets EV owners, though 43% of those participants enrolled in this pilot did own or lease an EV during the pilot period The implications for a wider roll-out of such a price plan depend largely on the assumed growth of EV penetration in the province. Guidehouse Insight's Q4 2019 forecast of EV penetration predicts that by 2030 approximately 700,000 light duty vehicles in Ontario will be EVs.[27] At present there are approximately 13 million registered light duty vehicles in Ontario.[28]

- **By limiting the analysis of price plan impacts to participants' home electricity consumption data, it is likely that the analysis has understated the benefits of this plan.**

  Based on the data in hand, response to the Overnight price yields a negative system benefit. The avoided cost benefit of the peak demand and On-Peak and Mid-Peak energy reductions are less than the incremental system costs of the additional overnight consumption, with a net present value of a lifetime avoided cost benefit of -$14 (see Section 4.4), and a net average increase in consumption of 5% in the summer and 20% in the winter for an average annual increase of nearly 15%.

  Guidehouse has hypothesized that two most probable sources for the net additional Overnight Off-Peak and non-Overnight Off-Peak load are:

  - **Shifting EV Charging Location.** Participants with EVs shifting from paying a per-hourly charge for EV charging (for example, at their workplace) outside of their home, to charging their EV at home overnight.

  - **Behavioural Fuel Switching.** Participants satisfying an increasing share of their overnight thermal load with auxiliary electric space heating equipment instead of natural gas heating equipment. This would be most likely to occur in older homes well-equipped with auxiliary electric baseboard heat (more common in homes with hydronic gas heating systems than forced air systems) where it could make financial sense to reduce the use of central heat in favour of targeted room heating via the auxiliary electric equipment.

  Additional discussion of the reasoning for these hypotheses may be found in Section 2.2.3, in the body of the report.

If either or both of Guidehouse's hypotheses regarding participant price-response (i.e., shifting away from workplace charging and/or behavioural fuel-switching) above are correct, then an examination only of

[26] Cadmus, prepared for the Independent Electricity System Operator, *Ontario Residential End-Use Survey: Final Report*, November 2018
http://www.ieso.ca/homeenergysurvey

[27] Guidehouse Insight, *Market Data: EV Geographic Forecast – North America*, 4Q 2019
https://guidehouseinsights.com/reports/market-data-ev-geographic-forecast-north-america

[28] Statistics Canada, *Table: 23-10-0067-01 (formerly CANSIM 405-0004) Vehicle Registrations, by type of vehicle – Ontario*, accessed September 2020.

participant household electric loads will understate – potentially quite substantially - the price plan's benefits.

In the first case, an analysis only of participant AMI and billing data (and not of non-home charging) will understate system benefits by not quantifying the demand reductions during system peak of a shift from public charging at peak times to overnight charging at home. In the second case, an analysis which does not account for changes in gas consumption (and the avoided energy and carbon cost benefits of such changes) might understate the societal benefits of this price plan by ignoring the potentially material decarbonization of home heating it could be incenting.

There is the potential that this price plan, or one like it, could help to support decarbonization of the home heating and transportation sectors. There is therefore value in gathering additional data and conducting additional analysis to determine if either of the hypotheses above can be rejected.

Given these findings, Guidehouse recommends that the OEB consider:

- **Conduct additional analysis; leverage existing data. Carry out additional analysis of the Overnight Plan data through a survey of the Overnight price plan participants to assess whether the winter behavioural fuel switching hypothesis can be rejected by identifying and assessing the electricity consumption behaviours during the Overnight Plan of EV owners and non-EV owners.**

- **Authorize a new Overnight price plan pilot in one or more utility service territories. This pilot should track the *vehicles'* as well as the dwelling's electricity demand. This would allow for an accurate and complete accounting of the benefits to participants and to the electricity grid of the charging behaviour induced as a result of the Overnight price plan. The pilot would also monitor and measure any changes to electricity consumption that are not due to EV charging during the overnight Off-Peak period. The new pilot would build on the first pilot by providing greater clarity and accuracy regarding the benefits of the Overnight price plan and the behavioural changes motivated by the price plan, and by providing guidance on the components of the Overnight price plan necessary to induce desired participant behaviours.**

Additional detail regarding the specifics of each recommendation may be found in Section 6.4.

1. INTRODUCTION

Since April 2005, the Ontario Energy Board has administered the RPP. The RPP sets the electricity commodity prices for approximately 5.2 million of Ontario's residential and small business consumers.[29] Beginning in May of 2006, as Ontario deployed its advanced metering infrastructure (AMI) network, RPP consumers began to be transitioned from the existing inclining block ("Tiered") price plan to a mandatory three period (On-Peak, Mid-Peak, Off-Peak), two season (summer and winter[30]) TOU price plan.

Since 2012, nearly all RPP consumers have been subject to the TOU price.[31] Prices are set on an annual (previously semi-annual) basis to ensure cost-recovery on a forecast basis.

The OEB's six goals for the development and application of TOU prices, as they are laid out in the OEB's RPP Manual[32] are to:

- Set prices to recover the full cost of RPP supply, on a forecast basis, from the consumers who pay the prices;
- Set the price structure to reflect current and future RPP supply costs;
- Set the price structure to support the achievement of efficient electricity system operation and investment;
- Set both prices and the price structure to give consumers incentives and opportunities to reduce their electricity bills by shifting their time of electricity use and reducing their peak demand;
- Create a price structure that is easily understood by consumers; and,
- Provide fair, stable and predictable commodity prices to consumers.

These objectives reflect updates made in 2016 as part of OEB's in-depth review of the RPP, the RPP Roadmap.[33]

In 2017, the OEB commissioned pilots from a group of Ontario local distribution companies (LDCs) to test the effects of a variety of price and non-price treatments, and to provide the OEB with the information required to continue to evolve the RPP and advance its goals. The interim evaluations of these pilots began to be delivered to the OEB in the spring of 2019.

In July of 2019, the OEB engaged Guidehouse to conduct a review – a meta-analysis – of these documents and the pilots on which they based. The goal of this meta-analysis is for Guidehouse to provide evidence-based advice to the OEB regarding new or modified pricing plans and non-price tools that may be effective for furthering the renewed policy objectives of the RPP.

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[29] Ontario Energy Board, *Yearbook of Electricity Distributors*, 2019
https://www.oeb.ca/utility-performance-and-monitoring/natural-gas-and-electricity-utility-yearbooks

[30] For purposes of pricing, the RPP defines the winter as from November 1st through April 30th and the summer as May 1st through October 31. Unless otherwise explicitly noted in this report, all references to "winter" or "summer" should be understood to refer to these periods.

[31] A very small number of consumers – those to whom the deployment of AMI is infeasible, for example – remain subject to the Tiered pricing, and the OEB continues to set Tiered prices on an annual basis. Per the Final RPP Variance Settlement Factor report up to January 31, 2020 (provided in correspondence with the OEB), approximately 4% of all RPP consumption in the 12-month period through January 2020 was by consumers subject to the Tiered price plan.

[32] Ontario Energy Board, *Regulated Price Plan Manual*, updated February 2016
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

[33] Ontario Energy Board, *Regulated Price Plan Roadmap: Report of the Board*, EB-2014-0319, November 2015
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Roadmap_Report_of_the_Board_20151116.pdf

This chapter of the report is divided into three sections:

1. **Context.** This section provides the reader with historical context for this engagement. It provides a summary of the OEB's continuous monitoring and review of the RPP TOU price plan, leading up to the activities embodied in this report.
2. **How Does the Meta-Analysis Drive Recommendations?.** A high-level description of the work undertaken by Guidehouse and the reasoning that informs the assessment structures adopted.
3. **Structure of this Report.** A summary of the contents of this report – an orientation on the structure and flow of this report.

1.1 Context

Guidehouse's meta-analysis of the four pilots approved by the OEB in 2017 is the latest in a series of activities undertaken by the OEB as part of its commitment to ensuring that the RPP continues to deliver – and evolves to better deliver – on the policy objectives set out for it. This section provides a capsule history of the extensive analytic work conducted by the OEB and other agencies to evaluate the continued progress of the RPP toward meeting its policy objectives.

1.1.1 The Impacts of TOU Pricing in Ontario – a Pocket History

As noted above, Ontario consumers first began to be subject to TOU prices in May of 2006. As early as 2010, evaluation indicated that TOU prices were having a modest but meaningful impact on consumer behaviour – a reduction in On-Peak consumption of approximately 2.8%.[34] In 2013, the OEB published[35] its evaluation of the historical (*ex-post*) impact of the provincial transition to TOU prices followed shortly after by the Independent Electricity System Operator (IESO)'s[36] final report[37] on the same subject. Both reported very similar findings: average reductions in summer On-Peak residential consumption of approximately 3.3% and 2.3%, respectively.

The OEB evaluation of the historical impacts of TOU pricing was part of a wider review of TOU prices commissioned by the OEB at that time. This review resulted in the publication of:

- An evaluation of alternative TOU price plan scenarios[38] based on the historical quantitative analysis summarized above.
- An analysis of how to improve consumer energy literacy and price-response through changes to consumer bills.[39]

[34] Guidehouse Canada, Ltd. (formerly Navigant Consulting, Ltd.) presented to Newmarket Tay Power Distribution, *The Effects of Time-of-Use Rates on Residential Electricity Consumption*, April 2010
http://www.nmhydro.ca/pdf/NMH_TOU_FINAL.PDF

[35] Guidehouse (formerly Navigant) prepared for the Ontario Energy Board, *Time of Use Rates in Ontario Part 1: Impact Analysis*, December 2013
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Navigant_report_TOU_Rates_in_Ontario_Part_1_201312.pdf

[36] Then operating as the Ontario Power Authority (OPA).

[37] The Brattle Group, prepared for the Ontario Power Authority, *Year Two Analysis of Ontario's Full Scale Roll-Out of TOU Rates*, December 2014
http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2013/2013-Evaluation-of-TOU-Rates-Year-Two-Analysis.pdf?la=en

[38] Guidehouse (formerly Navigant) prepared for the Ontario Energy Board, *Time of Use Rates in Ontario Part 2: Alternative Scenario Analysis*, March 2014.
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Navigant_Report_TOU_Rates_in_Ontario_Part2.pdf

[39] BEWorks prepared for the Ontario Energy Board, *Behavioural Economics Review: Anaylzing and Nudging Energy Conservation and Demand Shifting Through Time of Use Compliance,* December 2014
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/BEworks_TOU_Report.pdf

- A set of three reports assessing RPP consumers' awareness of, understanding of, interest in, and self-reported behaviours in response to, Ontario's TOU pricing.[40]
- A review of time-varied pricing in seven other jurisdictions.[41]

1.1.2 Evolving the RPP – the RPP Roadmap

The findings of these reports, along with some additional original research conducted by the OEB and its contractor, were synthesized into the OEB's RPP Roadmap (see citation above) published in 2016. The Roadmap identified some clear challenges for the RPP that the OEB planned to address. Two of the most significant challenges identified by the Roadmap were:

a) The misalignment between the (then existing) RPP objectives and the broader public policy objectives of electricity system planning, specifically the need of the RPP to take a "*long term view when setting and designing prices*"; and,
b) The lack of consumer understanding of the TOU price structure and agency over the magnitude of their electricity bills.

To meet these challenges, the Roadmap:

- Provided a set of renewed RPP objectives that better aligned with broader public policy and longer-term system efficiency concerns;
- Spelled out the need to empower consumers to be better able manage their demand in response to price signals via informational tools and enabling technology; and,
- Announced the intention to undertake a set of price and non-price pilots in collaboration with Ontario LDCs.

It is the evaluations of these (now-completed) pilots that provide the foundational data set for this meta-analysis.

1.1.3 Economic Efficiency and the Global Adjustment (GA) – Considering GA Costs over the Longer Term

In addition to procuring the pilots that inform the analysis that follows, OEB staff conducted an analysis in 2018 and 2019 of the allocation of the Global Adjustment (GA), to address the "*GA misalignment problem*" identified by the Roadmap.[42]

Specifically, this OEB staff paper sought to address inefficiencies in the current allocation of the GA by testing alternative allocations that could "*more effectively induce reductions in long-run system costs by reducing the need for investments to meet peak demands*." The paper concluded that an allocation of GA costs by time period that correlates with provincial demand delivers a more economically efficient

[40] Ipsos Public Affairs for the Ontario Energy Board, *Consumer Perceptions Research*, 2014
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Ipsos_Reid_Consumer_Perceptions_Research_Report.pdf
Ipsos Public Affairs for the Ontario Energy Board, *Business Perceptions Research*, 2014
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Ipsos_Reid_Business_Perceptions_Research_Report.pdf
Ipsos Public Affairs for the Ontario Energy Board, *Time of Use and Electricity Bill Research*, January 2015
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Ipsos_Reid_OEB_Res_and_Business_Survey_Report.pdf
[41] Power Advisory for the Ontario Energy Board, *Jurisdictional Review of Dynamic Pricing of Electricity*, October 2014
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/Power_Advisory_Report_RPP_Jurisdictional_Review.pdf
[42] Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, February 2019
https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

outcome than the existing allocation, in part by better reflecting the longer-term marginal costs of demand in peak periods. The results and outputs of this paper are integral to the RPP pilot meta-analysis, and materially affect its outcomes.

1.1.4 The Distance Between Prices and Bills – Price Signals and Unbundled Rates

Unlike many jurisdictions in which TOU rates are offered, TOU prices in Ontario are not “bundled”. Only the commodity is charged according to the TOU periods. The commodity cost makes up only a portion of the bill, and, in more efficient households may account for as little as half of the total bill. This can mean that even substantial changes in behaviour in response to commodity price signals can result in only quite small changes to the total bill itself.

This is best illustrated with an example.

According to the OEB’s 2018 Yearbook of Electricity Distributors[43], the average Alectra residential consumption is 8,147 kWh per customer, per year. RPP consumers as a whole use 64% of their electricity during Off-Peak hours, 18% in the On-Peak hours and the remaining 18% in the Mid-Peak hours.[44] After accounting for all other charges (including transmission and distribution charges), under the status quo TOU price plan, a customer with this average profile would pay a total of approximately $98 for electricity in an average month, and nearly the identical amount under the Enhanced TOU price plan piloted by Alectra (RPP pilot prices were set to be revenue neutral assuming no changes in behaviour).

Assuming this customer enrolled in Alectra’s Enhanced TOU price plan, if this customer could reduce On-Peak consumption by 30% (a truly dramatic change) without increasing their consumption *in any other period*, this Alectra customer would reduce their bill by just over five dollars per month, or about 5% of their total bill.

Even if this customer happened to use considerably more electricity than average, e.g., consumed two times the energy of the average customer (approximately 16,300 kWh per year), a 30% reduction in On-Peak consumption – a feat that could only be accomplished with considerable effort and planning in most households – would yield a monthly bill reduction of just over 6%, or not quite $11 a month.

It must be borne in mind, however, that when electricity prices are communicated to consumers it is almost always the *commodity price* that is communicated. Marketing for the Enhanced TOU price plan would advertise an On-Peak price of 17.5 cents, a Mid-Peak price of 13.2 cents, and an Off-Peak price of 4.4 cents (the default TOU price plan prices in force at the time were, respectively 13.2, 9.4, and 6.5 cents per kWh).

The magnitude of the ratios between the price periods sends one price signal to consumers. The impact on the total bill of even quite significant changes in behaviour sends a different one.

This disconnection between prices and bills is a reality of the policy environment in which RPP price plans must operate, and it should be borne in mind by the reader when considering the estimated impacts elicited by the different price plans, as well as Guidehouse’s conclusions and recommendations. It should further be remembered that this disconnection has grown since these pilots were in the field: at the time of the pilots, the Ontario Electricity Rebate (OER) was applied to the *prices*, reducing them. Since November of 2019 the OER has been applied as a bill line-item. This means that consumers will have seen prices rise considerably (On-Peak in October of 2019 was 13.4 cents/kWh, in November 2019 it

[43] Ontario Energy Board, *Yearbook of Electricity Distributors 2018*, August 2019 https://www.oeb.ca/oeb/_Documents/RRR/2018_Yearbook_of_Electricity_Distributors.pdf
[44] Ontario Energy Board, *Regulated Price Plan Price Report November 1, 2019 to October 31, 2020*, October 2019 https://www.oeb.ca/sites/default/files/rpp-price-report-20191022.pdf

became 20.8 cents/kWh), but are likely to have noticed almost no change in their total bill as a result since the higher prices were largely offset by the line-item OER credit.

1.2 How Does the Meta-Analysis Drive Recommendations?

The objective of this meta-analysis is to provide the OEB with evidence-based advice on new or modified pricing plans and non-price tools that may be effective for furthering the renewed policy objectives of the RPP.

Guidehouse's recommendations in this report are informed by two parallel streams of analysis: a close review of the findings of the pilot evaluation reports, and the comparison of each of the piloted treatment groups across a common set of metrics. The two are not wholly distinct: the inputs used by Guidehouse to evaluate its metrics are often outputs of the pilot evaluations, and the outcomes of some metrics help to inform and clarify the findings of the evaluation reports.

The first workstream – Guidehouse's review of the evaluation reports – is self-explanatory.

The second workstream merits some additional explanation. The raw inputs of this analysis are complex, and the considerations are multi-dimensional. Combinations and iterations of piloted treatments can sometimes be unclear and the effects difficult to disentangle. The goals that the treatments are ultimately meant to support (the renewed RPP objectives of the RPP Roadmap) can sometimes be in tension with one another and need to be balanced. A strong formal structure, with distinct categories defined mostly by the RPP objectives, provides a robust and transparent framework from which conclusions may be developed.

To enable an analysis of the treatment groups, over and above the synthesis of the most important findings and outputs of the pilot evaluation reports, Guidehouse developed seven distinct evaluation metrics, and ranked each treatment group's performance for each metric. The first six of these metrics align with the renewed RPP objectives. The seventh relates to concerns of practical and technical feasibility. Guidehouse evaluated each treatment group against the following seven metrics:

1. Cost Recovery. How well does the treatment price recover the average RPP supply cost?
2. Cost Reflectiveness. How closely do the hourly changes in treatment price reflect the hourly changes in the supply cost, both short-term and long-term?
3. Cost Minimizing. To what degree will each treatment group, if implemented at the provincial level, reduce overall system costs?
4. Predictability. Which price treatments have price structures that deliver the most predictable prices to consumers?
5. Comprehensibility. How easy are the price treatments for consumers to understand?
6. Opportunity for Bill Savings. What opportunity for bill savings does each price plan offer?
7. Ease of Implementation. What technical hurdles, particularly related to billing systems and customer care, would local distribution companies (LDCs) need to surmount to offer the given price plan to their customers?

Each metric is ranked from 1 (worst) to 5 (best). Ties are possible. Guidehouse has intentionally not rolled up individual metric scores into a total treatment group specific value for three reasons:

- Firstly, the purpose of Guidehouse's analysis is not to pick a "winner". Each pilot offers different lessons learned, and each may include different elements worthy of expansion into a wider offering to a larger population. Ultimately it is the quality of the individual features of each pilot, rather than the pilot as a whole that is of most interest.
- Secondly, such a scoring, by relegating some pilots to a lower rank than others, could unintentionally obscure benefits that elements of such (nominally) poorly performing pilots may

offer, benefits that may be evident only through a nuanced comparison of the metric results *and* the evaluation report findings.

- Thirdly, developing a final overall rank for each pilot would require assigning weights to each metric. The development, and ultimate values, of such weights could – due to their inevitably subjective nature – distract from the final recommendations, even when the evidence underlying those recommendations (from the evaluation reports, and from individual metrics) is often clear and unambiguous.

It should be noted that only the results from the first 12 months of the Alectra Dynamic price plan are used in the evaluation of the metrics. This is to ensure that metric outputs are truly comparable across all price plans (only the Dynamic price plan received the five-month extension).

The detail of Guidehouse's recommendations clearly spells out the evidence that drives them and explicitly identifies areas where uncertainty or ambiguity exist.

1.3 Structure of this Report

To streamline the contents of the final meta-analysis report without unduly sacrificing transparency, Guidehouse has split its reporting across two documents.

The first document is this report. This document introduces the work and places it in its historical context, outlines the approach used to undertake the analysis, summarizes the key findings of the pilot evaluation reports, summarizes the findings of Guidehouse's metric-specific analysis and then synthesizes this information into a set of evidence-based recommendations.

The second document is a set of Output Data Sheets, referred to in aggregate as "the ODS". This second document is the repository for the treatment group-specific detail that underlies the analysis presented in this document. This is not essential information for most reviewers of this report, and comprehension of the recommendations and findings of this report should not depend on a reviewer's familiarity with the ODS.

It is in the ODS that full details of each treatment group (such as were available to Guidehouse) may be found. For example, the ODS contains details about the functionality of a mobile app, the price levels and time periods of a specific price treatment, or the number of participants that enrolled in (or opted out of) a given price treatment, etc. In effect, the ODS compiles all the relevant available information about the treatment groups, into a consistent structure to facilitate the analysis provided in this document.

The remainder of this report is divided into the following chapters:

2. **Pilot and Pilot Evaluation Summary Descriptions.** This chapter provides a high-level description of the four pilots and the ten treatment groups[45] assessed as part of those pilots. This section also summarizes the most important findings reported in each of the evaluations, as identified by the technical consultant for the given pilot, or by Guidehouse in its review of those documents.

3. **Approach.** This chapter describes the analytic approach used by Guidehouse for scoring each of the seven metrics evaluated for all treatment groups.

[45] Note that there is an important distinction between "treatments" and "treatment groups". In this report, a "treatment" refers to a single programmatic intervention: a price plan, an app, a technology, etc. A treatment group is a group of individual consumers exposed to a unique combination of treatments within a given LDC's pilot. Thus, the number of treatments tested as part of this set of pilots will not match the number of treatment groups.

4. **Treatment Scoring (Results).** This chapter summarizes the results of the metric scoring undertaken by Guidehouse, across all the treatment groups and report's on Guidehouse's key findings from this analysis. Additional detailed results of the metric scoring analysis may be found in the ODS.

5. **Synthesis of Findings and Review of Piloted Features.** This chapter summarizes the key features tested by the pilots, reviews the benefits of, and potential barriers to, the adoption of these features, and discusses how the pilot evaluation results suggest such barriers might be overcome. This chapter forms a foundation for the recommendations made in the following chapter by synthesizing the key findings derived from Guidehouse's review of the evaluation reports in Chapter 2 and the key findings derived from Guidehouse's metric rankings in Chapter 4.

6. **Recommendations.** This section makes specific, actionable recommendations for next steps along the RPP Roadmap. Recommendations flow directly from the synthesized findings and feature-specific analysis presented in Chapter 5, and are intended to provide both immediately actionable next steps in the incremental evolution of the RPP, as well as longer term actions to support ongoing improvements in the effectiveness of the RPP at meeting its objectives.

2. PILOT AND PILOT EVALUATION SUMMARY DESCRIPTIONS

As noted in the introduction, Guidehouse's recommendations to the OEB are informed by two workstreams: a careful review of the pilot evaluation reports submitted to the OEB by the proponent LDCs' technical consultants, and a comparative analysis of the performance of different treatment groups across seven metrics that are mostly derived from the RPP objectives.

The outputs of this first workstream are presented in this chapter. This chapter is divided into two main sections, the second of which is itself divided into six sub-sections.

1. **The Pilots – Summary Description.** This section provides a capsule summary of the treatment groups assessed for each LDC as part of this meta-analysis. A more in-depth description of the characteristics of these treatment groups may be found in the ODS.

2. **Key Pilot Findings.** This section is divided into six sub-sections that provide a comparative discussion of evaluation report findings across pilots and treatment groups, by different pilot elements. This section highlights only the most important of the pilot findings and does so through a comparison of findings across the pilots to better illustrate the overall lessons presented. A more detailed summary of the evaluation report findings specific to each treatment group, may be found in the ODS.

2.1 The Pilots – Summary Description

In commissioning its pilots, the OEB sought to test a diverse set of price and non-price treatments. These treatments were selected based on the content of the RPP Roadmap. This section of this chapter provides a high-level introduction to these pilots. Section 2.2, which summarizes the results of the pilot evaluations, provides some additional incidental detail for each of the pilots.

The four LDCs, or groups of LDCs, also referred to in this report as proponent LDCs, that deployed pilots as part of this effort were: Alectra Utilities,[46] CustomerFirst,[47] London Hydro, and Oshawa PUC. Hydro One had applied to deliver a pilot, but withdrew its participation in June of 2018, citing its inability to finalize an implementation plan that would meet the OEB's evaluation requirements without it taking on a level of timeline and deliverable quality risk that it deemed unacceptable.[48] Horizon Utilities also applied as part of the RPP pilot process, but ultimately withdrew its application.

In Table 2-1 below Guidehouse has summarized treatment types and some other key information regarding each of the pilots.

[46] The piloted treatments were all deployed in Alectra's PowerStream service territory, a set of suburban municipalities north of Toronto.

[47] CustomerFirst is an energy solutions company that provides local distribution companies with program management services. CustomerFirst managed the deployment and evaluation of piloted treatments for Greater Sudbury Hydro, Newmarket-Tay Power Distribution, North Bay Hydro Distribution, Norther Ontario Wires, and PUC Services (Sault Ste. Marie). Although not an LDC, CustomerFirst is, for concision, referred to as such in this report.

[48] Frank D'Andrea on behalf of Hydro One Networks, Inc., Letter to Ontario Energy Board, subject line: *EB-2016-0201 – Hydro One Networks Inc. RPP Roadmap Pricing Pilot,* June 22, 2018

http://www.rds.oeb.ca/HPECMWebDrawer/Record/612521/File/document

Table 2-1: Tabular Summary of Piloted Treatment Groups

LDC	Treatment Group	Mobile App	Enhanced TOU Ratios	Alternative TOU Structure	Variable Peak Pricing	Critical Peak Pricing	DR Enabling Technology	Enrolment Type	Achieved Enrollment	Attrition
Alectra	Enhanced TOU		●					Opt-Out	7000	21%
Alectra	Dynamic				●	●	✦	Opt-In	770	20%
Alectra	Overnight			●				Opt-In	440	12%
CustomerFirst	Enhanced TOU		●					Opt-In	529	10%
CustomerFirst	Seasonal TOU			●				Opt-In	562	5%
London Hydro	CPP and CPP/RT	✦				●	●	Opt-In	658	8%
London Hydro	RT-Only	●						Opt-In	1135	2%
Oshawa PUC	Super-Peak			●				Opt-Out	1906	32%
Oshawa PUC	Seasonal TOU with CPP			●		●		Opt-In	508	15%
Oshawa PUC	Information Only	●						Opt-In	512	7%

Source: Guidehouse analysis of pilot evaluation reports

In Table 2-1, the four-pointed stars indicate that the treatment type is not applied (or not applied in the same way) to all participants within the treatment group. Black dots indicate treatments applied to all participants of the treatment group. Variations in treatments within treatment groups are addressed in the summary below and in greater detail in the ODS.

The "Achieved Enrollment" refers to the number of participants enrolled in the treatment group at the outset of the pilot. The attrition rate is the percentage of initially enrolled participants that exited the program prior to its completion, for any reason.

All electricity prices referenced in this report refer only to the commodity price of electricity, unless explicitly noted otherwise.

The key characteristics of each of the piloted treatment groups[49] are provided below. Additional detail regarding the treatments applied to each of these groups may be found in the ODS.[50]

1) **Alectra Utilities.** Alectra deployed three treatment groups, some of which included sub-groups subject to alternative informational treatments, and one of which (Dynamic) included participants enrolled years previously for an earlier iteration of that pilot.

    a) ***Enhanced TOU**. An opt-out pilot***. Participants were allocated to this group by the LDC but could elect to leave the pilot (opt out). Participants were subject to the status quo TOU structure, but with a larger differential (a 4:3:1 ratio of On-Peak: Mid-Peak: Off-Peak compared to the status quo ratio of 2:1.4:1) between higher and lower-priced periods. A random sample of half of the participants were provided with monthly "Nudge" reports to encourage conservation and shifting.

[49] In this report, "treatments" refer to individual elements whose effectiveness is being tested by pilots: a price plan, a technology, or a non-price intervention. "Treatment groups" refers to groups of participants subject to some combination of different treatments.

[50] It should be noted that the status quo RPP TOU prices have changed considerably since the period in which the RPP pilots were in the field (in most cases May 2018 through April 2019).

The prices in place beginning on May 1, 2018 were: On-Peak – 13.2 cents/kWh, Mid-Peak – 9.4 cents/kWh, and Off-Peak – 6.5 cents/kWh.

b) ***Dynamic**. **An opt-in pilot***. Participants volunteered to participate.[51] Participants in this group were subject to a variable peak price (VPP) between 3pm and 9pm on non-holiday weekdays and six critical peak pricing events per season, each lasting four hours. Daily variable peak price periods can be High (~40 cents/kWh, 20% of days), Medium (~20 cents/kWh, 30% of days) or Low (10 cents/kWh, 50% of days). During critical peak price (CPP) events participants were subject to a price of ~50 cents/kWh. Participants were provided day-ahead notification of events. The Dynamic price plan differs from all the other price plans in one important respect: it was extended for an additional five months (through to the end of September 2019) to allow for an assessment of the persistence of CPP and VPP impacts and to determine whether average per-event response would materially differ if participants were subject to nine, instead of six events.

Some participants were supplied with enabling technology (an Energate Foundation thermostat) to automate price response; others were encouraged to register their smart thermostats to enable automatic price response during critical peak events. A random sample of participants were provided with monthly "Nudge" reports to encourage conservation and shifting.

c) ***Overnight**. **An opt-in pilot***. Participants volunteered to participate. Volunteers accepted a higher On-Peak (~18 cents/kWh) price in exchange for a price (2 cents/kWh) in the period from midnight to 6am that is less than one third the status quo TOU Off-Peak rate. Otherwise the price structure matches that of the status quo TOU. This pilot initially targeted recruiting EV owners (43% of participants own or lease EVs), and customers that might benefit from the price plan "*due to shift work, lifestyle, etc.*"). [52]

2) **CustomerFirst** CustomerFirst divided the two treatment groups across its five client LDCs. Greater Sudbury Hydro, North Bay Hydro, and PUC services contributed participants to the Enhanced TOU treatment group, and Newmarket-Tay Power and Northern Ontario Wires contributed participants to the Seasonal TOU treatment group.

a) ***Enhanced TOU***. ***An opt-in pilot***. Participants volunteered to participate. Participants were subject to the status quo TOU structure, but with a larger differential (a 4:3:1 ratio of On-Peak: Mid-Peak: Off-Peak compared to the status quo ratio of 2:1.4:1) between higher and lower-priced periods. Participants received a smart thermostat as an incentive to participate. Half received it prior to the start of the pilot, half following its completion.

b) ***Seasonal TOU***. ***An opt-in pilot***. Participants volunteered to participate. In the periods from December through February and June through August, participants were subject to a 12-hour On-Peak period (7am to 7pm) with a price of 13.5 cents/kWh. In the same months the Off-Peak period (all other hours) was discounted (by 1.1 cents/kWh). In the six remaining months, participants paid 8.1 cents per kWh in all hours, all days of the week. Participants received a smart thermostat as an incentive to participate. Half received this incentive prior to the start of the pilot, half following its completion.

3) London Hydro. London Hydro's pilot included three treatment groups, one provided with real-time information only ("RT-Only") via a mobile app, one subjected to critical peak pricing ("CPP") and one to which both treatments were applied ("CPP/RT"). Due to the outcome of the impact evaluation of

[51] Participants are divided into two distinct groups: new participants (those enrolled specifically for this pilot) and legacy participants (those enrolled in a previous iteration of this pilot, prior to June 2016). Unless otherwise explicitly noted, the analysis in this report refers to the new participant group, the group recruited specifically for the OEB-sponsored pilot period. The second group of legacy participants is referred to in Alectra's evaluation report as the Legacy Dynamic group.

[52] BEWorks [on behalf of Alectra Utilities] prepared for the Ontario Energy Board, *Regulated Price Plan Pilot Evaluation, Measurement, & Verification Plan*, June 2018 (redline).

this pilot[53], the CPP and CPP/RT groups are treated, in this meta-analysis, as a single treatment group. This treatment group (CPP and CPP/RT) is subject to the treatment “Quick-Ramp CPP”.

a) ***RT-Only. An opt-in pilot***. Participants volunteered to participate. Participants were subject to the status quo TOU structure without any changes in price. Participants were provided with a mobile application (an “app”) called “*Trickl*” that allowed them to track their consumption in real-time, and provided goal reporting based on historical electricity consumption.

b) ***CPP and CPP/RT (Quick-Ramp CPP)***. ***An opt-in pilot.*** Participants volunteered to participate. Participants agreed to be subject to 18 one-hour critical peak events in each season, called with fifteen minutes’ notice, over a twelve-month period and receive a 0.5 cent discount to Off-Peak consumption charges. During the critical peak periods, the price was nearly 60 cents per kWh. Participants were equipped with a panel-mounted load switch (connected to a circuit of the participant’s choice) that activates when London Hydro dispatches the critical peak signal. Participants were provided with the *Trickl* app. Participants could control their load switch remotely with this app and received push notifications of critical peak events. CPP/RT participants also had access to the real-time information functionality provided to the RT-only group.

4) Oshawa PUC. Digital engagement is the centerpiece of the Oshawa PUC pilot. All participants were provided access to a mobile app (“*Peak*”) that provided daily consumption summaries, daily consumption benchmarking (against the participant’s own weather normalized historical consumption), competitive peer-group savings benchmarking (“gamification”) and personalized energy saving tips.

a) ***Super-Peak. An opt-out pilot***. Participants were allocated to this group by the LDC and could elect to leave the pilot should they so choose. In June through August participants were subject to a price of approximately 25 cents/kWh from 1pm to 7pm on non-holiday weekdays (the Super-Peak period). In the remaining non-Off-Peak periods participants paid 9.5 cents per kWh. Off-Peak prices were very slightly discounted (0.2 cents/kWh) from status quo TOU.

b) ***Seasonal TOU with CPP. An opt-in pilot*****.** Participants volunteered to participate. In the periods from December through February, and June through August, participants were subject to a 12-hour On-Peak period (7am to 7pm) with a price equivalent to the status quo On-Peak price. In the same months the Off-Peak period (all other hours) was discounted (by 1.2 cents/kWh). In the six remaining months, participants paid 7.9 cents per kWh in all hours, all days of the week. Participants were subject to 10 four-hour critical peak events in summer and 10 in winter. Each event lasts four hours. Participants were notified more than 24 hours in advance and paid approximately 25 cents per kWh during events.

c) ***Information Only***. ***An opt-in pilot*****.** Participants volunteered to participate. Participants were subject to the status quo TOU structure without any changes in price and were provided (as were all participants) with the *Peak* app.

Table 2-2, below summarizes the weekday commodity prices for all the pilots, by season, as well as the status quo TOU prices in force during the pilot period. In all cases, the price on weekends and public holidays is the same as the standard Off-Peak price for the give pilot and treatment group. Note that the time convention used in this case is “hour-ending”, so the price in period 15 is the price between 2pm and 3pm.

[53] The technical consultant found that there was no statistically significant difference between the impacts estimated for the CPP and CPP/RT groups.

Table 2-2: Seasonal Summary of TOU Prices (cents/kWh) by hour ending (prevailing time)

	Month	Season	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
December / January / February	*Status Quo TOU (2018-05-01 to 2019-10-31)*	Winter	6.5	6.5	6.5	6.5	6.5	6.5	6.5	13.2	13.2	13.2	13.2	9.4	9.4	9.4	9.4	9.4	9.4	13.2	13.2	6.5	6.5	6.5	6.5	6.5
	Alectra Enhanced TOU	Winter	4.4	4.4	4.4	4.4	4.4	4.4	4.4	17.6	17.6	17.6	17.6	13.2	13.2	13.2	13.2	13.2	13.2	17.6	17.6	4.4	4.4	4.4	4.4	4.4
	Alectra Dynamic	N/A	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	4.9	4.9	4.9
	Alectra Overnight	Winter	2.0	2.0	2.0	2.0	2.0	6.5	6.5	18.4	18.4	18.4	18.4	9.2	9.2	9.2	9.2	9.2	9.2	18.4	18.4	6.5	6.5	6.5	6.5	6.5
	CustomerFirst Enhanced TOU	Winter	4.4	4.4	4.4	4.4	4.4	4.4	4.4	17.6	17.6	17.6	17.6	13.2	13.2	13.2	13.2	13.2	13.2	17.6	17.6	4.4	4.4	4.4	4.4	4.4
	CustomerFirst Seasonal TOU	Winter	5.3	5.3	5.3	5.3	5.3	5.3	5.3	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	5.3	5.3	5.3	5.3	5.3
	London Hydro CPP and CPP/RT	Winter	5.5	5.5	5.5	5.5	5.5	5.5	5.5	13.2	13.2	13.2	13.2	9.5	9.5	9.5	9.5	9.5	9.5	13.2	13.2	5.5	5.5	5.5	5.5	5.5
	London Hydro RT-Only	Winter	6.4	6.4	6.4	6.4	6.4	6.4	6.4	13.3	13.3	13.3	13.3	9.5	9.5	9.5	9.5	9.5	9.5	13.3	13.3	6.4	6.4	6.4	6.4	6.4
	Oshawa Super-Peak	Winter	6.3	6.3	6.3	6.3	6.3	6.3	6.3	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	6.3	6.3	6.3	6.3	6.3
	Oshawa Seasonal TOU with CPP	Winter	5.4	5.4	5.4	5.4	5.4	5.4	5.4	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	5.4	5.4	5.4	5.4	5.4
	Oshawa Information Only	Winter	6.4	6.4	6.4	6.4	6.4	6.4	6.4	13.3	13.3	13.3	13.3	9.5	9.5	9.5	9.5	9.5	9.5	13.3	13.3	6.4	6.4	6.4	6.4	6.4
November / March / April	*Status Quo TOU (2018-05-01 to 2019-10-31)*	Winter	6.5	6.5	6.5	6.5	6.5	6.5	6.5	13.2	13.2	13.2	13.2	9.4	9.4	9.4	9.4	9.4	9.4	13.2	13.2	6.5	6.5	6.5	6.5	6.5
	Alectra Enhanced TOU	Winter	4.4	4.4	4.4	4.4	4.4	4.4	4.4	17.6	17.6	17.6	17.6	13.2	13.2	13.2	13.2	13.2	13.2	17.6	17.6	4.4	4.4	4.4	4.4	4.4
	Alectra Dynamic	N/A	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	4.9	4.9	4.9
	Alectra Overnight	Winter	2.0	2.0	2.0	2.0	2.0	6.5	6.5	18.4	18.4	18.4	18.4	9.2	9.2	9.2	9.2	9.2	9.2	18.4	18.4	6.5	6.5	6.5	6.5	6.5
	CustomerFirst Enhanced TOU	Winter	4.4	4.4	4.4	4.4	4.4	4.4	4.4	17.6	17.6	17.6	17.6	13.2	13.2	13.2	13.2	13.2	13.2	17.6	17.6	4.4	4.4	4.4	4.4	4.4
	CustomerFirst Seasonal TOU	Shoulder	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
	London Hydro CPP and CPP/RT	Winter	5.5	5.5	5.5	5.5	5.5	5.5	5.5	13.2	13.2	13.2	13.2	9.5	9.5	9.5	9.5	9.5	9.5	13.2	13.2	5.5	5.5	5.5	5.5	5.5
	London Hydro RT-Only	Winter	6.4	6.4	6.4	6.4	6.4	6.4	6.4	13.3	13.3	13.3	13.3	9.5	9.5	9.5	9.5	9.5	9.5	13.3	13.3	6.4	6.4	6.4	6.4	6.4
	Oshawa Super-Peak	Winter	6.3	6.3	6.3	6.3	6.3	6.3	6.3	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	6.3	6.3	6.3	6.3	6.3
	Oshawa Seasonal TOU with CPP	Shoulder	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
	Oshawa Information Only	Winter	6.4	6.4	6.4	6.4	6.4	6.4	6.4	13.3	13.3	13.3	13.3	9.5	9.5	9.5	9.5	9.5	9.5	13.3	13.3	6.4	6.4	6.4	6.4	6.4
May / September / October	*Status Quo TOU (2018-05-01 to 2019-10-31)*	Summer	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.4	9.4	9.4	9.4	13.2	13.2	13.2	13.2	13.2	13.2	9.4	9.4	6.5	6.5	6.5	6.5	6.5
	Alectra Enhanced TOU	Summer	4.4	4.4	4.4	4.4	4.4	4.4	4.4	13.2	13.2	13.2	13.2	17.6	17.6	17.6	17.6	17.6	17.6	13.2	13.2	4.4	4.4	4.4	4.4	4.4
	Alectra Dynamic	N/A	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	4.9	4.9	4.9
	Alectra Overnight	Summer	2.0	2.0	2.0	2.0	2.0	6.5	6.5	9.2	9.2	9.2	9.2	18.4	18.4	18.4	18.4	18.4	18.4	9.2	9.2	6.5	6.5	6.5	6.5	6.5
	CustomerFirst Enhanced TOU	Summer	4.4	4.4	4.4	4.4	4.4	4.4	4.4	13.2	13.2	13.2	13.2	17.6	17.6	17.6	17.6	17.6	17.6	13.2	13.2	4.4	4.4	4.4	4.4	4.4
	CustomerFirst Seasonal TOU	Shoulder	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
	London Hydro CPP and CPP/RT	Summer	5.5	5.5	5.5	5.5	5.5	5.5	5.5	9.5	9.5	9.5	9.5	13.2	13.2	13.2	13.2	13.2	13.2	9.5	9.5	5.5	5.5	5.5	5.5	5.5
	London Hydro RT-Only	Summer	6.4	6.4	6.4	6.4	6.4	6.4	6.4	9.5	9.5	9.5	9.5	13.3	13.3	13.3	13.3	13.3	13.3	9.5	9.5	6.4	6.4	6.4	6.4	6.4
	Oshawa Super-Peak	Winter	6.3	6.3	6.3	6.3	6.3	6.3	6.3	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	6.3	6.3	6.3	6.3	6.3
	Oshawa Seasonal TOU with CPP	Shoulder	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
	Oshawa Information Only	Summer	6.4	6.4	6.4	6.4	6.4	6.4	6.4	9.5	9.5	9.5	9.5	13.3	13.3	13.3	13.3	13.3	13.3	9.5	9.5	6.4	6.4	6.4	6.4	6.4
June / July / August	*Status Quo TOU (2018-05-01 to 2019-10-31)*	Summer	6.5	6.5	6.5	6.5	6.5	6.5	6.5	9.4	9.4	9.4	9.4	13.2	13.2	13.2	13.2	13.2	13.2	9.4	9.4	6.5	6.5	6.5	6.5	6.5
	Alectra Enhanced TOU	Summer	4.4	4.4	4.4	4.4	4.4	4.4	4.4	13.2	13.2	13.2	13.2	17.6	17.6	17.6	17.6	17.6	17.6	13.2	13.2	4.4	4.4	4.4	4.4	4.4
	Alectra Dynamic	N/A	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	10.0 19.9 39.8	4.9	4.9	4.9
	Alectra Overnight	Summer	2.0	2.0	2.0	2.0	2.0	6.5	6.5	9.2	9.2	9.2	9.2	18.4	18.4	18.4	18.4	18.4	18.4	9.2	9.2	6.5	6.5	6.5	6.5	6.5
	CustomerFirst Enhanced TOU	Summer	4.4	4.4	4.4	4.4	4.4	4.4	4.4	13.2	13.2	13.2	13.2	17.6	17.6	17.6	17.6	17.6	17.6	13.2	13.2	4.4	4.4	4.4	4.4	4.4
	CustomerFirst Seasonal TOU	Summer	5.3	5.3	5.3	5.3	5.3	5.3	5.3	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	5.3	5.3	5.3	5.3	5.3
	London Hydro CPP and CPP/RT	Summer	5.5	5.5	5.5	5.5	5.5	5.5	5.5	9.5	9.5	9.5	9.5	13.2	13.2	13.2	13.2	13.2	13.2	9.5	9.5	5.5	5.5	5.5	5.5	5.5
	London Hydro RT-Only	Summer	6.4	6.4	6.4	6.4	6.4	6.4	6.4	9.5	9.5	9.5	9.5	13.3	13.3	13.3	13.3	13.3	13.3	9.5	9.5	6.4	6.4	6.4	6.4	6.4
	Oshawa Super-Peak	Summer	6.3	6.3	6.3	6.3	6.3	6.3	6.3	9.5	9.5	9.5	9.5	9.5	9.5	25.3	25.3	25.3	25.3	25.3	25.3	6.3	6.3	6.3	6.3	6.3
	Oshawa Seasonal TOU with CPP	Summer	5.4	5.4	5.4	5.4	5.4	5.4	5.4	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	5.4	5.4	5.4	5.4	5.4
	Oshawa Information Only	Summer	6.4	6.4	6.4	6.4	6.4	6.4	6.4	9.5	9.5	9.5	9.5	13.3	13.3	13.3	13.3	13.3	13.3	9.5	9.5	6.4	6.4	6.4	6.4	6.4

2.2 Key Pilot Findings

This section of Chapter 2 summarizes some of the key insights offered by the pilot evaluation reports. In some cases, these are insights provided directly by the LDCs and their technical consultants themselves in the evaluation reports; in other cases, they are Guidehouse's interpretation of outputs reported by those contractors. A more detailed review of the key findings, on a treatment group by treatment group basis, may be found in the ODS.

This section is divided into six sub-sections, each dealing with a distinct sub-set of issues or pilot elements:

1. **Recruitment and Attrition.** Briefly describes some of the challenges that the proponent LDCs faced with recruitment and flags some key trends in attrition. Recruitment for opt-in rates is challenging. Only one LDC met its (relatively modest) enrolment targets via opt-in.

Attrition is not necessarily higher for opt-out price plans than for opt-in price plans. Attrition might be reduced through the offer of an initial period of price protection, particularly if bill impacts are "front-loaded".[54]

2. **Enhanced Price Differentials.** Summarizes the key impact findings related to two Enhanced TOU treatment groups. Participants' lack of price response to enhanced TOU ratios may be due in part to a disconnection between observed "menu prices" for electricity prices (the TOU prices) and the total bill cost. This disconnection is likely to worsen given the Ontario Electricity Rebate (OER) discount's migration from the prices themselves to a stand-alone bill line-item[55].
3. **Alternative Price Plan Structures – Static.** Summarizes the key impact findings related to the regularly scheduled TOU periods for the CustomerFirst's Seasonal TOU, Oshawa PUC's Seasonal TOU with CPP, and Alectra's Overnight price plans.
4. **Alternative Price Plan Structures – Dynamic Price Plans, With and Without Enabling Technologies.** Summarizes the key impact findings related to the price treatments and enabling technologies deployed as part of Alectra's Dynamic price plan (new participants), London Hydro's CPP and CPP/RT group, and Oshawa PUC's Seasonal TOU with CPP.
5. **Informational Treatments, Customer Communication and Engagement.** Summarizes the key evaluation findings with respect to Alectra's Nudge reporting, London Hydro's RT treatment, and digital engagement across Oshawa PUC's treatment groups.

2.2.1 Recruitment and Attrition

This sub-section addresses two related components of the pilots: recruitment (and some of the recruitment challenges experienced by the LDCs) and attrition – the percentage of participants that exited the pilots before their completion.

The key findings of Guidehouse's review of the evaluation reports are:

- ***Recruitment for opt-in price plans proved challenging.*** This is, in part, due to evaluation requirements which for some pilots limited advertising activities to support an experimental design or limited the pool of potential participants (e.g., excluding participants in other CDM programs). Recruitment may also have been a challenge because of some risk aversion on the part of customers presented with alternative rates. Only one LDC, Oshawa PUC, met its opt-in enrolment targets.

- ***Attrition is not necessarily higher for opt-out price plans than for opt-in price plans***. Once participant move-outs are accounted for, attrition for the opt-out Enhanced TOU price plan (Alectra) was lower than that of Alectra's voluntary (opt-in) Dynamic price plan. Attrition was highest for the Super-Peak (Oshawa PUC) opt-out group (33%), but this may be at least partly due to a "front-loading" of bill impacts. Specifically, prices were set to over-collect in the summer and under-collect in the winter, and the pilot happened to begin in the summer. It is noteworthy that 65% of those participants that dropped out, did so before June 1, the period when the Super-

[54] This is the case with the Oshawa PUC Super-Peak price plan, which collected a disproportionate share of revenues in the first six months (the summer) of the pilot.

[55] Prior to November 1, 2019, the OER applied to *prices* – e.g., the On-Peak price from May 1 to November 1, 2019, *included* the impact of the OER discount. From November 1, 2019 on, the OER was applied as a line-item credit on customers' bills and the TOU prices were displayed undiscounted. For example, the consumer-facing On-Peak price became 20.8 cents per kWh, up from 13.4 cents per kWh on October 31, 2019.

Peak price came into effect. Nearly all participants that exited the Super-Peak pilot (93%) did so prior to November 1.[56]

- ***Bill protection for the first 12 months of the program might reduce attrition.*** Attrition was very low for the legacy Dynamic participants (who enjoyed years of bill protection)[57] compared to the new Dynamic participants (who had the second-highest attrition rate of any treatment group), likewise attrition was very low for London Hydro's CPP and CPP/RT group, perhaps in part due to the implicit bill protection provided by the participation incentive ($100).

Additional details regarding the analysis that informs these key findings is laid out immediately below.

Recruitment

Recruitment was a challenge for nearly all opt-in pilots, with only Oshawa PUC successfully recruiting the targeted number of participants. The recruitment goals for each pilot and realized recruitment are summarized in Table 2-3, below.

Table 2-3: Treatment Group Recruitment Goals and Achievement

LDC	Treatment Group	Recruitment Goal	Achieved Recruitment	Precentage Goal Achieved
Alectra	Enhanced TOU*	7,000	7,000	100%
Alectra	Dynamic - Participants	1,000	770	77%
Alectra	Overnight	500	440	88%
CustomerFirst	Enhanced TOU	1,992	529	27%
CustomerFirst	Seasonal TOU	1,992	562	28%
London Hydro	CPP and CPP/RT - Participants	600	658	110%
London Hydro	RT-Only - Participants	1,000	1,135	114%
London Hydro	Recruit-and-Deny Control Customers	1,600	474	30%
Oshawa PUC	Super-Peak*	2,000	1,996	95%
Oshawa PUC	Seasonal TOU with CPP	500	508	102%
Oshawa PUC	Information Only	500	512	102%

** Opt-Out recruitment style pilots*

Additional details regarding recruitment are described below:

- **Alectra**, in its evaluation plan, had targeted recruiting 1,000 participants for the Dynamic treatment group, and 500 for its Overnight group. It successfully recruited only 770 Dynamic participants and 440 Overnight participants, of which 74 (Overnight participants) were recruited only by extending the recruitment period into the pilot period, meaning that only 366 had available 12 months of pilot period data to support the analysis.

- **CustomerFirst.** CustomerFirst's application anticipated enrollment of 3,984 participants across both treatment groups. The CustomerFirst evaluation report indicates that only 1,091 customers had enrolled across both treatment groups (529 as part of the Enhanced TOU, and 562 as part of the Seasonal TOU groups).

[56] The "front-loading" of bill impacts means that on average participants would be expected to experience higher bills in the June through October period, and lower bills (on average) in the November through April period.

[57] The Alectra Dynamic price plan evaluated results considered in this analysis for "new" participants, those that enrolled in the pilot funded by the OEB. Prior to this Alectra had, since 2015, been running a pilot with the same design, but funded by the Ministry of Energy and the IESO. This is the "legacy" Dynamic pilot. Alectra's evaluation considered the impacts and attrition of this pilot. All participants in the legacy Dynamic group were provided with complete bill protection between enrollment and the unprotected period which began on March 1, 2018. More information regarding this group may be found in the ODS.

- **London Hydro**. London Hydro's initially planned experimental design was a recruit-and-deny.[58] It targeted the recruitment of 2,000 RT-only applicants, 600 CPP applicants and 600 CPP/RT applicants. Half the applicants in each group would be assigned to a control group, and half to a participant group (i.e., 1,000 RT-Only participants, 300 CPP, and 300 CPP/RT participants). Enrolment was sufficiently below expectations that London Hydro offered an incentive to CPP and CPP/RT participants of $100 (paid mostly at completion). As a result of this, final enrollment was 1,100 RT-only participants, approximately 300 CPP and 300 CPP/RT participants, and approximately 450 recruit-and-deny control customers. Despite the incentive, London Hydro successfully recruited only 70% of its overall target (although London Hydro achieved the targeted number of participants, it only managed to recruit 30% of the targeted number of volunteer controls). In the end, recruitment challenges resulted in a much higher proportion of recruited customers being assigned to the treatment, rather than the control group.

- **Oshawa PUC**. Oshawa PUC did meet its recruitment goals for the opt-in treatments. The evaluation plan targeted recruiting 500 customers for the Information Only treatment group and 500 more for the Seasonal TOU with CPP treatment group. Oshawa PUC successfully enrolled 512 and 508 participants into these two groups, respectively. OEB staff have noted to Guidehouse that in order to achieve the targets, Oshawa PUC had to exert considerable effort – resources were called upon that went well beyond what would be applied for a standard conservation program recruitment.

Part of the recruitment challenges appear to have been a result of evaluation requirements. Alectra and CustomerFirst were constrained to direct communications (no mass-marketing[59]) for recruiting their opt-in participants in order to support eligibility (no participation in other CDM programs - Alectra) and experimental design (a randomized encouragement design – CustomerFirst) requirements. Another impediment was the eligibility requirement that participants had to have a certain amount of consumption history (important for control group validation) in order to participate.

A certain amount of risk-aversion likely played its part. The price of power in Ontario is a political hot-button issue as a result of the relatively steep increase in average annual bills over the past 15 years. High menu prices for electricity may present potential participants with a distorted sense of bill risk: many consumers may not have a clear sense of the disconnection between commodity rates and final bill amounts. For example, commodity costs account for less than 60% of the average London Hydro CPP and CPP/RT participant's bill during the pilot period. Observing the larger price differentials, many potential participants may have been discouraged by "sticker shock".

CustomerFirst's implicit incentive offer – the provision of a smart thermostat for free – does not appear to have been sufficient to achieve targeted enrolment. This group of LDCs had the least successful recruitment of all the pilots. London Hydro's incentive, however, was quite successful at improving recruitment, once it was implemented. This incentive provides a form of implicit bill protection, or "insurance". This incentive does not blunt the treatment price signal, but helped to motivate enrollment after its introduction.

A limited form of bill protection was offered by Alectra to participants. In September of 2017 all opt-out Enhanced TOU participants were enrolled in the price plan, and volunteer (opt-in) participants began to be enrolled in the Dynamic and Overnight price plans. From this point until March 1, 2018 participants were subject to the pilot prices with bill protection: participants that did better under the new price plan

[58] Recruit-and-deny is the practice of encouraging consumers to apply for an opportunity to participate in a pilot and then allocating applicants randomly to a treatment group and a control group. This enables a randomized control trial (a very robust experimental design). This approach is analogous to that used to develop placebo groups for pharmaceutical research.

[59] In addition to creating a barrier to enrollment directly (few customers knew about the pilot), this approach may have indirectly suppressed enrollment due to LDC caution regarding fraudulent email advertising. As the pilot was not publicly advertised, potential participants had no way to quickly and easily confirm that the offer was genuine on the LDC website. Some potential participants unable to do so may have concluded that the email offer was fraudulent and did not respond.

received bill credits; participants that did worse were billed under the status quo TOU prices. Depending on when a volunteer enrolled, their protected period may have been quite short, and no participant had the benefit of bill protection in the June through August period, when their financial exposure was likely to be highest.

Bill protection was identified by the legacy Dynamic participants[60] (in a previous iteration of this pilot) as being a key motivator for enrolling, and in fact one year of bill protection is offered to customers enrolling in Oklahoma Gas and Electric's "Smart Hours" program, which is the program upon which the design of the Dynamic price plan is based.[61]

Attrition

Given the pilot period, offering a full year of bill protection would not have been practical, but some evidence exists within the pilot attrition values regarding the potential for such a practice to limit participant attrition in a wider roll-out of these (or similar) price plans.

Consider Table 2-4, below. This table provides the recruited sample of participants, the sample after drop-outs/opt-outs and move-outs have been deducted,[62] and the calculated attrition rates. Two attrition rates are presented. The first is the total attrition rate and represents the overall percentage change in the size of the sample group. The second measure of attrition is the "Move-Out Attrition". This captures the percentage of participants exiting the pilot for reasons besides a desire to exit the pilot. This second metric is not available for all pilots.

This differentiation is important, because it underscores the fact that although the opt-out Enhanced TOU price plan deployed by Alectra *appears* to have been unpopular, most attrition appears to be being driven by move-outs, rather than drop-outs.

Table 2-4: Participant Attrition by Treatment Group

LDC	Treatment Group	Achieved Recruitment (Eligible)	Sample at Pilot Close	Total Attrition (Including Move-Outs)	Move-Out Attrition (Where Known)
Alectra	Enhanced TOU*	7,000	5,550	21%	12%
Alectra	Dynamic	770	617	20%	4%
Alectra	Overnight	440	389	12%	2%
CustomerFirst	Enhanced TOU	529	477	10%	*Unknown*

[60] In the previous iteration of the Dynamic pilot, participants paid their standard TOU price bill, and then periodically received a bill credit for any difference between this bill and what it would have been had they been paying the piloted prices. Note that this balancing was asymmetric – participants only ever received a credit and were not debited if their bill under the pilot prices was higher than their bill under the status quo TOU prices.

Navigant, on behalf of Alectra Utilities, *Advantage Power Pricing Pilot – Impact and Process Evaluation: Winter 2015/2016 and Summer 2016*, July 2017

https://www.powerstream.ca/attachments/Navigant_Evaluation_Advantage_Power_Pricing_2015-2016.pdf

[61] In a participant's first year of participation, if the amount they are billed exceeds what they would have been billed under their previous tariff; they receive a bill credit for the difference.

Oklahoma Gas And Electric Company, *Standard Pricing Schedule: R-VPP Residential Variable Peak Pricing Code No. 13V*, June 2018

https://www.oge.com/wps/wcm/connect/c41a1720-bb78-4316-b829-a348a29fd1b5/3.50+-+R-VPP+Stamped+Approved.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-c41a1720-bb78-4316-b829-a348a29fd1b5-mhatJaA

[62] Only Alectra's technical consultant provided a distinction between move-outs and drop-outs during the pilot period. Oshawa's technical consultant distinguished between these reasons for pilot attrition for the pre-pilot period, but not for the entirety of the pilot period.

LDC	Treatment Group	Achieved Recruitment (Eligible)	Sample at Pilot Close	Total Attrition (Including Move-Outs)	Move-Out Attrition (Where Known)
CustomerFirst	Seasonal TOU	562	532	5%	*Unknown*
London Hydro	CPP and CPP/RT – Participants	658	606	8%	*Unknown*
London Hydro	RT-Only - Participants–	1,135	1,109	2%	*Unknown*
London Hydro	Recruit-and-Deny Control Customers	474	435	8%	8%
Oshawa PUC	Super-Peak*	1,906[63]	1,271	33%	*Unknown*
Oshawa PUC	Seasonal TOU with CPP	508	431	15%	*Unknown*
Oshawa PUC	Information Only	512	474	7%	*Unknown*

** Opt-Out price plans*

Only Alectra's technical consultant provided a distinction between move-outs and drop-outs during the pilot period. Oshawa PUC's technical consultant distinguished between these reasons for pilot attrition for the pre-pilot period, but not for the entirety of the pilot period.

Since London Hydro's control customers were not subject to any treatments, it may be assumed that all drop-outs (8% of sample) in this case are move-outs. It would also be reasonable to suppose that since there is no cost to participate in the treatment groups that do not include any pricing treatments (i.e., London Hydro RT-Only and Oshawa PUC Information Only), attrition rates for these are entirely due to move-outs. Given this, it is a reasonable assumption that move-out rates for other treatment groups fall between 2% (attrition for London Hydro RT-only) and 13% (documented move-out rate for Alectra's Enhanced TOU). This delivers a mid-point estimated move-out rate of 7.5%.

According to Alectra's evaluation report, across the 12 months between March 1, 2018 and April 30, 2019, approximately 16% of new participants in Alectra's Dynamic price plan opted out of the program. In contrast, in the same period only 6% of the *legacy* (enrolled since before June 1, 2016) Dynamic participants (not shown in the table above) dropped out of that program during the unprotected pilot period (approximately 9% of these participants moved out during this period).

It could be argued that all those that would have dropped out earlier already had (in prior years) so that this is an unfair comparison, but total participation of legacy customers appears to have been remarkably stable in the two years leading up to the pilot period.[64] This suggests that an initial period of bill protection that covers the full summer period where incremental participant costs are likely to be greatest, better allows participants to assess their true exposure under alternative rates, potentially resulting in lower attrition.[65]

Seasonally skewed impacts may have been a driver of attrition for the Oshawa Super-Peak price plan (one of the two opt-out plans). This plan had the highest attrition rate, with 33% of participants dropping out of the pilot (note that the Oshawa evaluation report does not distinguish between participants exiting the program – "drop-outs" and those forced to stop participating due to moving house – "move-outs"). This drop-out rate is likely driven by a combination of "sticker shock" at the new prices (a Super-Peak participant's commodity price would have increased by more than 2.5 times in the 5pm to 7pm period

[63] 90 of the initially enrolled Oshawa PUC participants are electricity retailer customers, ineligible for participation in the pilot, and therefore excluded from this table.

[64] The evaluation report of the summer 2016 iteration of the Dynamic (the group of participants identified in the final Alectra report as the "Legacy Dynamic" participants) pilot lists 1,849 participants, indicating an attrition between that time and the May 2018 pilot period start - at which time there were 1,808 participants enrolled – of only 2.7%.

[65] The OG&E "Smart Hours' program referenced above had about 15% of all residential customers enrolled, after approximately three to four years of complete operation, suggestive of a reasonably positive word-of-mouth effect that would not be expected with an annual attrition rate of 15% or more.

from June through August), or perceived bill increases. Note that this price plan was explicitly designed to over-collect in summer months, so the average participant might have observed increases in their bills during the summer period. Of the participants that dropped out of the pilot, approximately 40% did so prior to, or immediately following the start of the pilot in May, and in total approximately 90% of participants that did drop out had done so by August 2018. These effects may have been exacerbated by the involuntary nature of participation.

Attrition for the other opt-out price plan (Alectra's Enhanced TOU) is high (21%) principally because of the move-out rate (12%). After accounting for the move-out rates the pure opt-out rate for the Enhanced price plan (9%) is lower than that of the Dynamic price plan (16% net of move-outs for Dynamic) and only slightly higher than for the Overnight price plan (10% net of move-outs). This finding – that opt-out recruitment does not necessarily yield higher attrition rates than opt-in recruitment – is consistent with the findings of a major United States Department of Energy (DOE) study on consumer behaviour in response to electricity prices. This study found that retention rates were approximately the same for both opt-in and opt-out TOU and CPP price structures, although demand reductions tend to be lower for opt-out designs.[66]

2.2.2 Enhanced Price Differentials

This sub-section addresses the estimated impacts of the Enhanced TOU price plan treatment groups. Note that this sub-section addresses only the *price*-driven effects. Impacts or savings due to interactions between the price treatment and a non-price treatment are addressed in sub-Section 2.2.5, below.

The key findings of Guidehouse's review of the Alectra evaluation report and the CustomerFirst evaluation report are:

- ***Simply enhancing TOU price ratios – to the level applied for these pilots – is insufficient to motivate any statistically significant reduction in demand.*** CustomerFirst's evaluation had a relatively small sample, so statistically non-significant results in that evaluation may simply be an indication that impacts were too small for the sample size obtained. The statistically non-significant summer impacts for Alectra (sample at start of pilot ~7,000 individuals) suggests that (in this case) this price plan is simply not motivating participants to change their behaviour in the desired fashion and in fact may even result in increased consumption.

- ***Participant lack of demand reductions to enhanced TOU ratios may be due in part to a disconnection between the observed price differentials (the TOU commodity prices) and the total bill cost.*** Given that a very high proportion of most consumers' total bill is the sum of non-commodity charges, the bill impacts of modest behaviour changes may prove to be invisible for consumers against the standard "noise" of month-to-month bill variation. Discouraging results (bill savings) early in the pilot period may have caused participants to lose interest.

The estimated impacts by season and TOU period for the two Enhanced TOU price plans are summarized in Table 2-5 and Table 2-6, below. A positive value indicates an increase in consumption as a result of the pilot. "(N/S)" indicates that the estimate is not statistically significantly different from zero at the 90% confidence level.

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[66] Page vi of

U.S. Department of Energy, Electricity Delivery & Energy Reliability, *American Recovery and Reinvestment Act of 2009: Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies*, Smart Grid Investment Program, November 2016

https://www.energy.gov/sites/prod/files/2016/12/f34/CBS_Final_Program_Impact_Report_Draft_20161101_0.pdf

Table 2-5: Estimated Conservation Impacts – Enhanced Price Plans

Season	Alectra - Enhanced Only (No Nudge)	CustomerFirst – Enhanced
Summer	+ 0.38% (N/S)	+ 2% (N/S)
Winter	+ 0.97% (N/S)	-1.45% (N/S)
Overall (Annual)	+ 0.71% (N/S)	+ 0.28 (N/S)

Table 2-6: Estimated Impacts by Price Period – Enhanced Price Plans

Season	TOU Period	Alectra - Enhanced Only (No Nudge)	CustomerFirst - Enhanced
Summer	On-Peak	- 0.17% (N/S)	- 0.83% (N/S)
	Mid-Peak	- 0.09% (N/S)	+ 0.79% (N/S)
	Off-Peak	+ 0.6% (N/S)	+ 3.12 % (N/S)
Winter	On-Peak	+ 0.53% (N/S)	- 3.61% (N/S)
	Mid-Peak	+ 0.47% (N/S)	- 2.91% (N/S)
	Off-Peak	+ 1.2% (N/S)	-0.44% (N/S)

A potential stumbling block in terms of response may be that in fact the overall bill impact of behaviour changes is much lower than the commodity price differentials might suggest. As noted above, commodity costs typically only account for approximately half of the overall electricity bill, and there is some indication from the focus group analysis performed by Ipsos Public Affairs for the Alectra pilot[67] that participants felt let down by a perceived differential between their level of effort and their achieved savings. Some participants in these focus group sessions indicated that they were dissatisfied with their bill credit, and further indicated that the effort expended did not seem "*worthwhile as compared to the savings".*

An example may help illustrate how even very aggressive changes in behaviour can have only modest impacts on customer bills. Consider an Alectra residential customer with an average annual consumption of 8,147 kWh per year.[68] Suppose that this individual's consumption is evenly split across the 12 months of the year and that they consume 65% of their electricity in the Off-Peak period and the rest split evenly between the Mid-Peak (17.5%) and the On-Peak (17.5%) periods. If this customer, subject to the piloted Enhanced price plan, reduces their consumption in the On-Peak by 30%, this will deliver bill savings of less than $5 per month, less than 5% that customer's average monthly bill. How much effort in behaviour change is it worth to achieve a monthly benefit that is less than the cost of a specialty coffee?

The gap between communicated prices and their effect on the total bill increased as of the November 2019 price-setting (after all the RPP pilots had completed), with the change in how the OER is applied. Under the new regime, TOU period prices are now presented as an unsubsidized value, and the rebate is applied as a line-item unrelated to commodity costs.

[67] Ipsos Public Affairs for Alectra Utilities, *Alectra Utilities Advantage Power Pricing (APP) Qualitative Research Report*, October 16, 2018

[68] Ontario Energy Board, *Yearbook of Electricity Distributors 2018*, August 2019 https://www.oeb.ca/utility-performance-and-monitoring/natural-gas-and-electricity-utility-yearbooks

For the sake of comparison, Table 2-7 shows the status quo TOU prices in place from May 1, 2018 through April 30, 2019, the Enhanced TOU prices, and finally the November 1, 2019 price-setting for the status quo TOU.

For most consumers, despite the very substantial change in the unit price of electricity as of November 1, 2019, average bills are unlikely to have changed significantly – as noted above, the OER just shifted the subsidy from the price to the total bill. There is a danger that consumers observing this may conclude that there is little value in response and will fail to respond if price differentials are made more dramatic in the future.

Table 2-7: Status Quo Price Structure Price Comparison

Price Plan	TOU period		
	On-Peak	Mid-Peak	Off-Peak
Status Quo TOU, 2018-05-01 through 2019-04-30	13.2	9.4	6.5
Enhanced TOU (Alectra and CustomerFirst)	17.5	9.4	6
Status Quo TOU, as of 2019-11-01	20.8	14.4	10.1

Source: Guidehouse analysis of OEB status quo and pilot price plans

It is possible that the very large jump in the apparent price – when not matched by a comparable change in monthly bills – may make it even more difficult for policy makers to use prices to motivate changes in behaviour going forward. Given the findings above, it may be that an Enhanced TOU price plan can only deliver results when differentials are pushed even higher than they were for these Enhanced price plan pilots. The On-Peak, Mid-Peak, Off-Peak price ratios for the Enhanced price plans were: 2.9:1.6:1.

2.2.3 Alternative Price Plan Structures – Static Price Plans

This sub-section addresses the estimated impacts of the alternative price plan “static” price treatments – those that were regularly scheduled and known well in advance (i.e., not critical peak or variable peak pricing) but have a different schedule from the status quo TOU price plan.

Note that this sub-section focuses on the price-driven effects and addresses the non-price driven interactions only where they are vital context for understanding the pilot outcomes. A more focused discussion of savings due to interactions between the price treatment and a non-price treatment (and non-price treatments alone) is addressed in sub-Section 2.2.5, below.

The RPP pilots deployed four different static price structures: Alectra’s Overnight, CustomerFirst’s Seasonal TOU, Oshawa’s Super-Peak, and Oshawa’s Seasonal TOU with CPP.[69]

A summary of the conservation and TOU period impacts for each of the treatment groups addressed in this section is presented in Table 2-8 and Table 2-9, below. A positive value indicates an increase in consumption as a result of the pilot. “(N/S)” indicates that the estimate is not statistically significantly different from zero at the 90% confidence level. The acronym “DEP” stands for “digitally engaged participant” [70]. Approximately 19% of Oshawa Super Peak participants were digitally engaged, and approximately 79% of Oshawa PUC Seasonal TOU with CPP participants were digitally engaged.

[69] The CPP element of this price structure is addressed in the next sub-section.

[70] Section 1.2 of the Oshawa evaluation report defines this term in the following manner: “*Non-Digitally Engaged Participants are those who never connected to the Peak app or registered to receive email or SMS notifications*”. This indicates that digitally engaged participants are those that engaged with the “Peak” app at least once or else registered to receive email or SMS notifications.

In the table below “Summer” is the period from June through August, “Summer Shoulder” is the period that includes May, September, and October, “Winter” is the period from December through February, and “Winter Shoulder” is the period that includes November, March, and April.

Table 2-8: Estimated Conservation Impacts – Static Alternative Price Plans

Season	Alectra - Overnight	CustomerFirst - Seasonal TOU	Oshawa PUC - Seasonal TOU with CPP			Oshawa - Super-Peak		
			Average	DEP	Non-DEP	Average	DEP	Non-DEP
Summer	+ 5.26%	+ 3.94% (N/S)	- 1.54%	- 2.91%	+ 3.66%	+ 0.19% (N/S)	-3.71%	+ 1.17%
Summer Shoulder	+ 5.26%	+ 0.55%	- 0.42% (N/S)	- 1.98%	+ 5.47%	+0.13% (N/S)	- 1.75%	+ 0.59%
Winter	+ 19.57%	+ 0.09%	- 1.33% (N/S)	- 2.05 %	+ 1.1% (N/S)	+ 1.98%	+ 2.78%	+ 1.79%
Winter Shoulder	+ 19.57%	+ 0.55%	+ 1.13% (N/S)	- 0.58% (N/S)	+ 2.99% (N/S)	+ 2.15%	+ 0.97 % (N/S)	+2.43%
Overall (Annual)	+ 14.81%	+ 1.28% (N/S)	- 0.63%	- 1.68%	+ 3.14%	+ 1.13%	- 0.45%	+ 1.51%

Table 2-9: Estimated Impacts by Price Period – Static Alternative Price Plans

	TOU Period	Alectra – Overnight	CustomerFirst - Seasonal TOU	Oshawa PUC - Seasonal TOU with CPP			Oshawa - Super-Peak		
				Average	DEP	Non-DEP	Average	DEP	Non-DEP
Summer	Super-Peak	N/A	N/A	N/A	N/A	N/A	- 2.23%	- 9.46%	- 0.42% (N/S)
	On-Peak	- 9.64%	+ 5.15% (N/S)	-4.11%	- 6.51%	+ 4.96%	- 1.8%	- 5.93%	- 0.77% (N/S)
	Mid-Peak	- 8.11%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Off-Peak (Weekday)	+ 4.85%	+ 0.03% (N/S)	+ 0.73% (N/S)	+ 0.33% (N/S)	+ 2.28% (N/S)	+ 2.02%	- 0.35% (N/S)	+ 2.63%
	Off-Peak (Weekend)	+ 4.85%	+ 0.03% (N/S)	- 0.86%	- 2.4%	+ 5.11%	+ 0.93%	- 2.17%	+ 1.72%
	Overnight Off-Peak	+ 45.04%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Summer Shoulder	On-Peak	- 9.6%	N/A	N/A	N/A	N/A	- 1.86%	- 4.48%	+ 1.24%
	Mid-Peak	- 8.11%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Off-Peak (Weekday)	+ 4.85%	N/A	N/A	N/A	N/A	+ 1.48%	+ 0.21% (N/S)	+ 1.80%
	Off-Peak (Weekend)	+ 4.85%	N/A	N/A	N/A	N/A	+ 0.91%	- 0.83% (N/S)	+ 1.34%
	Overnight Off-Peak	+ 45.04%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Winter	On-Peak	+ 1.46% (N/S)	- 0.06% (N/S)	- 0.81% (N/S)	- 1.87%	+ 2.75%	+ 2.83%	+ 2.74%	+ 2.85%
	Mid-Peak	+ 0.66% (N/S)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Off-Peak (Weekday)	+ 16.2%	+ 0.18% (N/S)	- 0.82% (N/S)	- 1.58%	+ 1.84% (N/S)	+ 2.02%	+ 4.11%	+ 1.52%
	Off-Peak (Weekend)	+ 16.2%	+ 0.18% (N/S)	- 2.28%	- 3.04%	+ 0.34% (N/S)	+1.13%	+ 1.61%	+ 1.01%
	Overnight Off-Peak	+ 73.34%	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Winter Shoulder	On-Peak	+ 0.15 (N/S)	N/A	N/A	N/A	N/A	+ 2.72%	- 0.61% (N/S)	+ 3.52%
	Mid-Peak	+ 0.66% (N/S)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Off-Peak (Weekday)	+ 16.2%	N/A	N/A	N/A	N/A	+ 1.90%	+ 2.68%	+ 1.71%
	Off-Peak (Weekend)	+ 16.2%	N/A	N/A	N/A	N/A	+ 1.79%	+ 0.88%	+ 2.01%
	Overnight Off-Peak	+ 73.34%	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The key findings of Guidehouse’s review of the three evaluation reports, with respect to the static price treatments, are:

- **Alectra’s Overnight**
    - ***Magnitude of impact.*** Of all the price plans tested, this one elicited the most significant – by far – purely behavioural response: an average increase in demand between midnight

and 6 a.m. of 45% to almost 75% (summer, winter). This is partially offset in the summer months by modest statistically significant decreases in demand during the On-Peak and Mid-Peak periods (~10%).

- ***Source of shift.*** The magnitude of the response has led Guidehouse to hypothesize that these impacts are likely to be from one or the other (or both) sources: a transition from charging EVs away from the home[71], to charging EVs at home, overnight; the shifting of cooling loads to the overnight hours; and, participants supplementing some overnight natural gas space heating with auxiliary electric space heating. As noted earlier, 43% of Overnight treatment group participant households owned or leased an EV.
- ***Not all benefits may be accounted for.*** The evidence suggests that it is possible that in winter participants may be shifting from using natural gas heating to auxiliary electric heating in the overnight hours. To the degree that this behaviour, and a shift in the location of EV charging, may be taking place, the benefits of this price plan will be undervalued, absent additional data and analysis.

- **CustomerFirst and Oshawa Seasonal TOU**
  - ***Seasonal TOU conservation was delivered only by Oshawa PUC's digitally engaged participants.*** Digitally engaged Oshawa PUC Seasonal TOU participants are reported, in Oshawa's evaluation report, to have delivered a statistically significant conservation impact in the summer (June through August) and winter (December through February). Non-digitally engaged participants deliver a statistically significant *increase* in annual consumption, driven by increased consumption in the summer months. CustomerFirst Seasonal TOU participants did not deliver any statistically significant impacts.
  - ***Digitally engaged Oshawa PUC participants responded to the combined effect of the price plan and the app more by conserving than shifting.*** Digitally engaged participants delivered statistically significant reductions in *all* non-shoulder TOU periods except for summer Off-Peak weekdays (a statistically non-significant increase in consumption). The second largest non-shoulder TOU period impact is the reduction, by 3.04%, of winter (December through February) weekend Off-Peak consumption. Participants do not appear to be responding primarily with shifting behaviour, but with conservation behaviour.

- **Oshawa Super-Peak**
  - ***Super-Peak period impacts were delivered entirely by digitally engaged participants.*** The estimated average energy savings value during the summer Super-Peak period reported by the evaluation was a reduction of 2.23%. This is delivered entirely by the most enthusiastic participants, the 19% of participants that were digitally engaged, who deliver a 9.46% reduction in this period. The average savings estimated during this period for non-digitally engaged participants was not statistically significant.
  - ***Digitally engaged participants tend to respond targeted price period increases with a seasonal conservation response.*** Digitally engaged participants deliver statistically significant energy reductions in most summer (June through August) and summer shoulder (May, September, October) TOU periods, including lower-priced weekend Off-

[71] Recent research indicates that on average 28% of personal vehicle EV charging is conducted at public chargers, and that this share has been rising sharply over time as more public charging infrastructure becomes available.

FleetCarma, *Charge the North – Final Report*, July 2019

Share of EV charging by location included in full report. A short summary of the report may be found online here: https://www.fleetcarma.com/charge-the-north-summary/

Peak periods. Conversely, in the winter (December through February), digitally engaged participants *increase* their consumption in nearly every period.

- ***Opt-out RPP consumers that were not digitally engaged appear to be more responsive to the Super-Peak price plan discounts than to its premiums.*** A substantial increase in the price during Super-Peak period resulted in only a statistically non-significant reduction in consumption during that period for non-digitally engaged participants. In contrast, this group increased their consumption nearly in all other periods, in some cases relatively substantially, despite only modest changes in price (e.g., an increase in summer Off-Peak weekday consumption of 2.63% despite a drop in price in this period of only 0.2 cents per kWh).[72]

Additional details regarding the analysis that inform the key findings above are laid out immediately below:

Alectra's Overnight

Of all the price plans evaluated as part of this set of pilots, none have exhibited as much of a behavioural impact as the Overnight price plan. The estimated increase in demand between midnight and 6 a.m. of between 45% and nearly 75% (summer, winter) is, in absolute terms, many times greater than the impact estimated for any other static price period plans.

In the summer months, the overnight increase is partially compensated for by decreases in On-Peak and Mid-Peak demand (approximately 9.6 % and 8.1%, respectively). Overall, consumption increased substantially for this treatment group – by 5% in the summer and almost 20% in the winter. So, while summer impacts seem to indicate some net new loads, the overall winter impacts indicate the addition of considerable net new load.

This result raises the question: what are the new loads that participants were adding between the hours of midnight and 6 a.m., when most consumers will be asleep?

Guidehouse hypothesizes that these impacts were the result of two main participant behaviours:

- **EV Charging Location Changes.** If EV participants, prior to enrollment, used a public charging station, the price plan may have motivated them to begin charging their car at home, overnight. This price plan was expressly targeted to EV drivers (the evaluation report indicates that 43% of participants own or lease an EV), so it is reasonable to expect that a material proportion of participants may have engaged in this behaviour. Further, recent Canadian research of EV charging behaviours indicates that on average 28% of personal vehicle charging is conducted away from the home.[73]

- **Shifting of Space Conditioning Loads and Fuels.** There are relatively few end-uses that can be time-shifted without inconvenience. No matter how drastic rate differentials are, immediate-use end-uses (watching television, doing laundry, ironing clothes, etc.) cannot realistically be shifted to the midnight to 6 a.m. period in any meaningful way. The thermal envelope of the home, however, does allow for some shifting of space conditioning. Thermostats can be programmed, and the building envelope will preserve the desired temperature for some time after set-point adjustment.

    - *Summer.* The increased overnight consumption and offsetting (but smaller in absolute terms) demand reduction during On-Peak and Mid-Peak hours suggests that it is possible

[72] In contrast, the Super-Peak price is an increase of between 90% (between 1pm and 5pm) and nearly 170% (between 5pm and 7pm) and elicited no statistically significant reduction in consumption from non-digitally-engaged participants during this TOU period.
[73] FleetCarma, *Charge the North*, July 2019

that participants may be pre-cooling the house overnight to reduce charges incurred during more expensive time periods, or at least reducing A/C use during On-Peak and Mid-Peak hours.

- *Winter.* The same principle holds in the winter as in the summer. The price should motivate a shift of space-heating to the overnight period. Most Alectra customers have access to natural gas connections, and most use natural gas as their primary space-heating fuel. Under the pilot pricing, *it may appear to consumers to be less expensive to use electricity than natural gas for heating in the overnight period*. At 2 cents per kWh, the commodity cost of electricity is approximately $5.50/GJ.

  Given a total effective cost per meter-cube of gas of approximately 31 cents per m^3, or approximately $8 per GJ,[74] it may have appeared, because of the very low “sticker price” for electricity, to some consumers that they could reduce overall household costs by increasing their use of auxiliary electric space heat and reducing their natural gas thermostat’s set-point overnight.

CustomerFirst and Oshawa Seasonal TOU

Although the focus of this sub-section is the impact of the static alternative price plan structures, it is impossible not to address the interactions between price plans and the enabling information (provided by the *Peak* app) reported in Oshawa PUC’s evaluation report.

The Oshawa PUC evaluation reports estimated impacts separately for digitally engaged (79%) participants and non-digitally engaged (21%) participants, as well as on average for the group as a whole. The evaluation report indicates that non-digitally engaged participants *increased* their annual electricity consumption by more than 3%. This is consistent with the finding of the CustomerFirst evaluation, that reports an average (though not statistically significant) increase in annual consumption of approximately 1.3%.

In contrast, digitally engaged Oshawa PUC Seasonal TOU participants deliver a statistically significant 1.68% annual conservation impact, though no statistically significant conservation is delivered in the winter shoulder season.

The Oshawa PUC evaluation reports that digitally engaged participants delivered statistically significant reductions in all summer and winter (non-shoulder) TOU price periods, except for summer weekday Off-Peak periods, in which participants very modestly increased their consumption (0.33% summer, not statistically significant). This suggests that Oshawa PUC participants that used the app (the digitally engaged participants) focused price response efforts on conservation, rather than shifting. It is possible that in this case the driver for energy conservation as practiced by the digitally engaged Oshawa PUC participants was neither the app (see Section 2.2.5 below which identifies that digitally engaged participants who were part of the Information Only group *increased* consumption), nor the price plan, but the *combination* of both treatments.

This could either be a causal effect (the app, when used in combination with a novel price plan, helps drive conservation) or a spurious correlation; participants that are receptive to, and enthusiastic for,

[74] Note that this comparison is deliberately flawed (it compares a *commodity* cost for electricity to the *total* variable cost for gas) to reflect how consumers “see” prices. Electricity pricing communications are focused on unit prices, whereas natural gas bills focus more on overall amounts and weather effects.

In fact, even after the very deep discount of the Overnight rate, once non-commodity variable costs in place at the time are accounted for, the unit energy cost to consumers in this example is slightly higher for electricity than it is for natural gas, during the midnight to 6am period.

informational apps, are more enthusiastic participants in the voluntary price plan and therefore more likely to respond to this new set of price signals.[75]

It seems reasonable (particularly in light of the London Hydro RT-Only results – see below) to suppose that it may be some combination of the two factors: digitally engaged participants would have saved more than non-digitally engaged participants even if there had been no app, but the app may have helped to deliver incremental savings over and above what the most enthusiastic participants would have delivered without it.

Super-Peak

The Oshawa Super-Peak price plan was an opt-out price plan with participant and control assignment carried out randomly. This substantially reduces the likelihood of any selection bias.[76] One result of this design is that a far lower proportion of participants were digitally engaged. Just 20% of Oshawa PUC Super-Peak participants were digitally engaged (have downloaded and used the Peak app), compared with nearly 80% of Oshawa PUC participants in the Seasonal TOU with CPP treatment group or the 85% of participants in Oshawa's Information Only treatment group.

The combined response to the price plan and Peak app for this treatment group aligns with what was observed for the Seasonal TOU with CPP treatment group: in months of the year where digitally engaged participants delivered statistically significant savings, they tended to do so in all TOU periods. Their response is characterized by conservation, rather than shifting. In the summer (June through August), the digitally engaged participants decrease their consumption in nearly all periods[77], even in those periods where the price had fallen.

Unlike the Oshawa PUC Seasonal TOU with CPP treatment group, however, digitally engaged participants increase their consumption in all but one period during the winter (December through February) and winter shoulder (November, March, April). The exception is the statistically non-significant decrease in winter shoulder On-Peak consumption of 0.61%.

As with the Oshawa PUC Seasonal TOU with CPP treatment group, digitally engaged participants deliver a statistically significant conservation impact during the summer period and summer shoulder periods. Consistent with the Oshawa PUC seasonal TOU with CPP treatment group, non-digitally engaged participants increased their consumption overall in all seasons. Unlike in the Seasonal TOU treatment group (where only summer and summer shoulder consumption increases were statistically significant), however, non-digitally engaged participants in the Oshawa Super-Peak treatment group increased their consumption by a statistically significant amount in all winter and summer months.

One key difference between the estimated responses of the non-digitally engaged participants of the Oshawa PUC Seasonal TOU with CPP treatment group and the participants in the opt-out Super-Peak treatment group is that the non-digitally engaged Super-Peak participants did not increase their consumption during the summer (June through August) Super-Peak and On-Peak – the estimated

[75] This is a good illustration of the importance of a randomized control trial. Under an RCT, selection bias could be ruled out and therefore a stronger case could be made that the relationship is causal. In this case the control group was developed through matching non-participants to participants so selection bias may be present. Given that Oshawa's Seasonal TOU price plan was an opt-in pilot, the expectation would be that volunteers would, in general, be more enthusiastic than those that have not volunteered (the controls).

Enthusiasm to effect changes in behaviour is likely to be correlated with digital engagement, which has been demonstrated to be correlated with savings. Since we cannot identify (and control for) which control group customers are most enthusiastic (i.e., who would have been digitally engaged, had they been presented the opportunity), we cannot also identify to what degree digitally engaged consumers' impacts are a result of their digital engagement, compared to what degree digital engagement and savings are both outcomes of unobservable variables (i.e., participant enthusiasm).

[76] Since participants could opt out some selection bias may be present, although it is likely to be less acute than under the opt-in recruitment designs.

[77] The estimated reduction in Off-Peak weekday consumption is not statistically significant.

impacts (though not statistically significant) are of a reduction in consumption by this group during these periods. The non-digitally engaged participants in the Seasonal TOU with CPP treatment group, recall, were estimated to have *increased* their consumption in all periods, including those in which the price had gone up.

These results suggest three things. Firstly, enthusiastic participants that become digitally engaged[78] tend to respond to targeted increases in price in a given period with behaviours that focus on conservation, rather than shifting consumption (as demonstrated by across-the-board summer consumption reductions). Secondly, the same enthusiastic (digitally engaged) participants respond to daytime discounts of prices by increasing consumption in all periods (as demonstrated by the winter response of digitally engaged participants). Thirdly, and finally, the less enthusiastic RPP consumers (non-digitally engaged participants) will tend to respond more to discounts (by increasing consumption) than premiums (by reducing it), as demonstrated by the estimated summer impacts for the non-digitally engaged participants.

2.2.4 Alternative Price Plan Structures – Dynamic Price Plans, With and Without Enabling Technologies.

This sub-section addresses the estimated impacts of the dynamic price treatments – those that included some irregularly scheduled pricing periods: either variable or critical peak pricing. Four pilots included dynamic price structures: Alectra's Dynamic, London Hydro's CPP and CPP/RT, and Oshawa's Seasonal TOU with CPP. Two of these three treatment groups' impacts were (at least partly) dependent[79] on enabling technologies that automatically curtailed participant loads in response to LDC price signals.

A summary of the CPP event period demand response (DR) impacts are shown in Table 2-10, below. A positive value indicates an increase in consumption as a result of the pilot. "(N/S)" indicates that the estimate is not statistically significantly different from zero at the 90% confidence level. The acronym "DEP" stands for "digitally engaged participant".

For London Hydro, the "Connected" column provides an estimate of the impact for participants whose enabling technology[80] was connected (functional) at the time of the event, the "Disconnected" column provides an estimate of the impact for participants whose enabling technology was not connected (not functional) at the time of the event, and the "Average" column provides the estimate on average across all participants.

As noted above, the Alectra Dynamic price plan pilot was extended by five months to cover a second summer, the summer of 2019. Table 2-10 below shows estimated CPP event impacts. The first column in the table related to the Alectra price plan ("Alectra – Dynamic (12 Months)") summarizes the CPP impacts in the first twelve months, while the second Alectra column ("Alectra – Dynamic (17 Months") summarizes

[78] As noted above, caution should be used in attributing causation to digital engagement. It is possible that digital engagement may be a symptom rather than an outcome; enthusiastic participants tend to save more, and enthusiastic participants are also more likely to become digitally engaged.

[79] All London Hydro CPP and CPP/RT participants were provided with a panel-mounted switch, dispatched automatically during events. Per Table 80 of the Alectra evaluation report, during the summer months, 160 of the 770 enrolled participants (approximately 20%) were equipped with a registered thermostat capable of automatic curtailment during Critical Peak Pricing events.

[80] London Hydro participants were provided with a panel-mounted load switch, installed by London Hydro's electrical contractor on the circuit of the participant's choice. Evidence from the estimated impacts presented in the evaluation report suggests that a very high proportion of switches were installed on circuits that controlled central A/C units.

the CPP impacts in the five-month, summer 2019, pilot extension.[81] The impacts presented in the table are simple averages across the 6-event and 9-event group.[82]

Table 2-10: Estimated CPP Event Impacts

Season	Impact Type	Unit	Alectra – Dynamic (12 Month)	Alectra – Dynamic (17 Month)	Oshawa PUC - Seasonal TOU with CPP			London Hydro - CPP and CPP/RT		
					Average	DEP	Non-DEP	Average	Connected	Disconnected
Summer	Average	kW	- 0.353	-0.3562	- 0.354	- 0.193	- 0.233	-0.051	- 0.671	- 0.756
		%	- 25.84%	Not provided	- 17.24%	- 10.53%	- 12.84%	- 2.64%	- 34.41%	- 38.93%
	Max DR	kW	- 0.407	-0.4725	- 0.407	- 0.284	- 0.331	- 0.17	- 1.001	- 1.126
		%	- 29.74%	-23%	- 24.06%	- 14.13%	- 16.59%	- 7.27% (N/S)	- 40.81%	- 46.75%
	Min DR	kW	- 0.282	-0.063 (N/S)	- 0.282	- 0.121	- 0.136	+ 0.158	- 0.395	- 0.434
		%	- 19.73%	-6.06% (N/S)	- 13.9%	- 7.77%	- 8.88%	+ 9.67%	- 26.08%	- 28.77%
Winter	Average	kW	- 0.172	N/A	- 0.168	- 0.07	- 0.065	-0.088	- 0.134	- 0.158
		%	- 13.89%	N/A	- 12.95%	-4.38%	- 4.2%	- 4.95%	- 10.24%	- 12.02%
	Max DR	kW	- 0.29	N/A	- 0.319	- 0.131	- 0.153	- 0.208	- 0.233	- 0.261
		%	- 18.60%	N/A	- 20.34%	- 8.67%	- 10.23%	- 9.76%	- 17.3%	- 18.81%
	Min DR	kW	- 0.104	N/A	- 0.094	+ 0.011 (N/S)	+ 0.011 (N/S)	+ 0.011 (N/S)	- 0.016 (N/S)	- 0.05 (N/S)
		%	-14.15%	N/A	- 8.09%	+ 0.72% (N/S)	+ 0.74% (N/S)	+ 0.67% (N/S)	- 1.27% (N/S)	- 3.96% (N/S)

A tabular summary of the relevant components of the three CPP price plans is provided in Table 2-11. Key pieces of information to bear in mind when considering impacts:

- London Hydro's CPP was the highest-priced, with the shortest notification period, lasted the shortest length of time, and every participant was provided with a load switch that completely shut down whichever circuit it was attached to. Evidence from the evaluation report suggests that many, if not most, were attached to participants' central A/C circuit.

- Alectra's CPP had the second highest price, and the second shortest notification period. Approximately 20% of participants had communicating or "smart" thermostats capable of automatic curtailment – devices registered by participants with Alectra. Registered thermostats were automatically controlled by Alectra during all CPP events to support participant response and enhance demand response.

- Oshawa PUC participants were subject to the least aggressive CPP price and were not provided with any enabling technology beyond the information provided by the Peak app, although notification was provided day-ahead.

[81] For the second summer of this pilot, participants were randomly allocated to one of two groups. One group was subject to six CPP events, the other to nine. The object of this exercise was to assess whether event frequency would affect the magnitude of response. The results of the analysis indicate that the addition of three additional CPP events did not materially affect the response of participants to subsequent CPP events.

[82] The average impact is the average of the impacts estimated for the six events to which the 6-event group was subject and the nine events to which the 9-event group was subject. The maximum and minimum impacts are averages across the two groups on the days on which the highest and lowest impact events occurred (the highest and lowest impact events are both within the six events that both groups were subject to).

Table 2-11: Summary of CPP Characteristics

Price Plan Characteristic	Alectra - Dynamic	Oshawa PUC - Seasonal TOU with CPP	London Hydro - CPP and CPP/RT
CPP Price (cents/kWh)	49.8	26.3	59.5
First Notification of Event	Minimum 2 hours' notice	2pm, day prior	15 minutes' notice
Event Length	4 hours	4 hours	1 hour
# Events Per RPP Season	6[83]	10	18
Enabling Technology	Thermostat automatic set-point adjustment (registered devices only).	None	Panel-mounted load switch. Smart plug.

Given the different parameters for CPP events (length, price, frequency), a few examples may be helpful to understand the potential financial exposure of participants (and thus their response). If a participant has an average demand of 2 kW during CPP events, and does nothing to change their behaviour during events they will pay: $24 (Alectra), $21 (Oshawa PUC), and $21 (London Hydro) per season, or $4 (Alectra), $2 (Oshawa), and $1.20 (London Hydro) per event.

The key findings of Guidehouse's review of the three evaluation reports, with respect to the dynamic price treatments, are:

- **Critical peak pricing works reliably, delivering material demand response across all pilots.**
  - In the summer months (where reductions in peak demand deliver a considerable societal benefit in terms of the avoided cost of capacity) all pilots deliver statistically significant demand response impacts.
  - The magnitude of demand response is correlated across pilots with the aggressiveness of the pricing, and with the degree to which enabling technologies are available to participants: where all participants were equipped with (program-managed) enabling technology (London Hydro) impacts were highest, where participants were not equipped with enabling technology (Oshawa PUC) impacts were lowest.

- **Automated response substantially increases event impacts.**
  - London Hydro's CPP and CPP/RT treatment group of technology-equipped participants delivered an average of 0.67 kW (34% of baseline load) of demand response during summer critical peak events.
  - For any given event, the enabling technology that automatically curtails demand for London Hydro's CPP and CPP/RT treatment group was disconnected for approximately 20% of participants (summer and winter), depriving these participants of automatic response. Despite this, these participants delivered an average DR impact during events of 0.3 kW, an average reduction of approximately 15%.
  - Alectra's Dynamic participants (a fifth of whom were equipped with an enabling technology that automates response) delivered an average of 0.35 kW (17% of baseline load) of demand response during critical peak events.
  - Oshawa PUC's Seasonal TOU with CPP treatment participants were equipped only with the Peak app and had no access to automatic curtailment. These participants delivered an average demand response impact of 0.193 kW (10.53%) during critical peak events.

[83] In the summer of 2019 half of the Dynamic participants were subject to nine, rather than six, CPP events.

- **Event-based pricing is more successful in the summer when participants have more discretionary load.**
  - London Hydro's CPP and CPP/RT participants delivered much less demand response during winter events (0.13 kW, or 10.2%, on average, across events) than in the summer, and impacts were uncorrelated with outdoor temperature. The estimated impacts for five out of the 18 winter events are not statistically significant.
  - Alectra's Dynamic participants delivered an average impact of 0.17 kW (13%) during winter events, half the summer value.
  - Oshawa PUC's Seasonal TOU with CPP participants delivered an average impact of 0.069 kW (4.38%) during winter events, less than half the summer value.[84]

- **Critical peak pricing response appears to persist so long as the price signal persists.**
  - The average impact of critical peak demand response for Alectra's Dynamic group increases somewhat in summer 2019 compared to summer 2018 (though it is unclear whether this difference is statistically significant or not).
  - This is particularly noteworthy in that it appears as though response to High priced days decreased substantially from one summer to the next. The average impact of a High priced day in the summer of 2018 was a demand reduction of 0.26 kW (~13%) whereas in the summer of 2019 the impact was a demand reduction of only approximately 0.135 kW (~8%).
  - It is unclear from the 17-month Alectra evaluation that reports these impacts whether this is a weather effect (e.g., High days substantially cooler in 2019 than in 2018) or an optimization behaviour effect (e.g., participants understanding the greater value of CPP as opposed to High price day response and shift focus accordingly). This is because event impacts are presented in the evaluation report without the corresponding average event or day-type (e.g. High, Medium, Low) temperature so the drivers behind the impacts are difficult to assess.
  - Regardless of why they persist, the observation that impacts do persist as long as the price signal does, aligns with the findings of other evaluations of critical peak pricing rate options in other jurisdictions (e.g., OG&E's Smart Hours).

The analysis above notes that the availability of automation technologies can substantially improve the magnitude of participant response to critical peak pricing. This is identified explicitly in the London Hydro evaluation, which estimated that the CPP-period demand response impact of participants whose technology was functional at the time of the event was more than two and a half times the impact when the technology was not functional.

This – the enhancement of critical peak pricing response by enabling technologies – is an effect that is also substantially supported by intuition and the evaluation literature. Critical peak pricing with enabling technology works for much the same reason direct load control works – automatically curtailing peaky loads delivers demand response. The OG&E Smart Hours program reported in 2017 that critical peak period impacts delivered by participants equipped with enabling technology (VPP Plus) were more than triple those of participants not so equipped (VPP rate-only).[85] The 2017 evaluation of Alectra's legacy APP program impacts in program year 2016 reported that participants equipped with an Energate thermostat (automatic curtailment) delivered nearly three times as much DR during critical peak pricing events as those without automatic curtailment, and that participants equipped with the re-purposed

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[84] Both estimated impacts for Oshawa PUC and Alectra's pilot price plans were statistically significant.

[85] See Table ES-1-5, pdf page 365/601 of

Applied Energy Group prepared for Oklahoma Gas and Electric, *2016 Evaluation of OG&E's SmartHours Program in Oklahoma*, May 2017.

https://www.occeweb.com/pu/EnergyEfficiency/2016OGE_DemandProgramsAnnualReport.pdf

NB: AEG report is embedded as part of a larger document, OG&E's Demand Programs Annual Report.

peaksaverPLUS® thermostats (running on Eaton's Yukon system) delivered *more* than three times as much DR as those without automatic curtailment.

Based on:

- A comparison of summer critical peak events across pilots:
  - Alectra's Dynamic group, with 20% penetration of enabling technology delivers an average 17% reduction below baseline;
  - London Hydro's CPP and CPP/RT groups, with 100% penetration of enabling technology delivers an average 34% reduction below baseline;
  - Oshawa PUC's Seasonal TOU with CPP, with no penetration of enabling technology delivers an average 10% reduction below baseline;
- The general consensus in the evaluation literature that technology-enabled (in particular HVAC control enabled) critical peak pricing delivers substantially higher impacts than rate-only critical peak pricing; and,
- The fact that Alectra has confirmed that testing and ongoing monitoring of the technology revealed no significant issues in control functionality;

Guidehouse believes it highly likely that the control technology deployed for the pilots delivered a material incremental demand response impact during critical peak events.[86]

2.2.5 Informational Treatments, Customer Communication and Engagement

This sub-section addresses the informational treatments and customer engagement applied as part of the pilots. Specifically, in this sub-section the following are addressed: the Nudge reports issued by Alectra, the Trickl and Peak apps deployed by London Hydro and Oshawa PUC (respectively), and the open house customer engagement undertaken by London Hydro.

The key findings of Guidehouse's review of the three evaluation reports are:

- **Nudge reports deliver modest statistically significant savings in some TOU periods, but no conservation overall.** Despite not delivering any statistically significant seasonal (or annual) consumption reductions, Nudge reports were estimated to deliver savings of approximately 1% in both summer and winter On-Peak periods. Nudge reports were also reported to result in a significant improvement in comprehension scores over time for participants.
- **Some evidence exists that mobile applications can deliver savings.** The London Hydro RT-only participants deliver estimated savings during the summer On-Peak period of 2.4%. Because this pilot is designed as a randomized control trial (RCT)[87], this impact can confidently be attributed to the Trickl app itself and the educational components of that treatment group. However, because both controls and participants in this pilot are volunteers, this impact should only be extrapolated to wider populations with caution.

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[86] The evaluation report for Alectra's pilot includes an estimate of the incremental impact of thermostat curtailment on participant demand response during CPP and variable peak price event periods. This output was not a requirement specified in its evaluation plan and therefore incremental to the evaluator's scope of work. Due to the evolving demands of the evaluation, an attempt was made to estimate the incremental effect of this automatic curtailment outside the main evaluation framework. Given the limitations imposed by circumstances, Guidehouse believes that the overall estimates of impacts (undifferentiated by technology) provide the most accurate implicit estimate of the effects of thermostat curtailment.

[87] Randomized control trials (RCTs) are generally regarded as the most robust approach for evaluating treatment impacts. RCTs ensure against selection bias in repeated sampling. A classic example of an RCT is a drug trial in which half of the participants are provided with a placebo (and become the control group) and half are provided with the drug being tested (the treatment).

- **Educating and informing consumers about their electricity use and costs without also changing their price plan can lead to increased consumption.** Oshawa PUC's Information Only treatment group increased its consumption in nearly every period except for On-Peak hours in June, July and August. Digitally engaged consumers increased their consumption by more than non-digitally engaged participants in the summer (where the non-digitally engaged impact was not statistically significant), in the winter shoulder period, and across the year as a whole. This contrasts with the results reported for Oshawa PUC's Seasonal TOU with CPP and Super-Peak treatment groups, where digitally engaged participants delivered more conservation than non-digitally engaged participants.
- **Digital engagement, as evidenced through mobile application use, is an identifying feature of consumers' responsiveness to new price signals, not necessarily a driver of it.** Digitally engaged Oshawa PUC participants exposed to alternative price plans delivered more conservation than non-digitally engaged participants (see Sections 2.2.3 and 2.2.4, above). However, when not exposed to an alternative price plan (i.e., the Information Only treatment group), digitally engaged participants *increased* their consumption more than non-digitally engaged participants. This suggests that, in this case, app use is an indicator of highly engaged (price responsive) consumers more than it is a direct driver of savings.
- **Open houses can improve program accessibility and may contribute to increased energy savings.** London Hydro's series of open-houses – effectively drop-in "office hours" for pilot participants – were a success in terms of improving accessibility to the program (25% of participants attending required help with very basic app or technology functionality) and appear to have delivered quantifiable improvements in energy savings (although some component of these may be driven by selection issues).

A tabular summary of the impacts of the Nudge reports and apps deployed by season, the year as a whole, and by TOU period are presented in Table 2-12 and Table 2-13 below.

Table 2-12: Estimated Conservation Impacts – Informational Treatments

Season	Alectra Nudge - Enhanced TOU	Alectra Nudge - Dynamic	London Hydro - RT-Only	Oshawa PUC - Information Only		
				Average	DEP	Non-DEP
Summer	- 0.29% (N/S)	+ 0.21% (N/S)	+ 0.21% (N/S)	+ 3.52%	+ 4.45%	-0.14% (N/S)
Summer Shoulder	- 0.29% (N/S)	+ 0.21% (N/S)	+ 0.21% (N/S)	+ 3.71%	+ 3.87%	+ 3.08%
Winter	- 0.64% (N/S)	- 0.28% (N/S)	- 0.28% (N/S)	+ 3.56%	+ 2.86%	+ 6.52%
Winter Shoulder	- 0.64% (N/S)	- 0.28% (N/S)	- 0.28% (N/S)	+ 4.82%	+ 5.08%	+ 3.77%
Overall (Annual)	- 0.4% (N/S)	- 0.01% (N/S)	- 0.01% (N/S)	+ 3.86%	+ 4.04%	+ 3.12%

Table 2-13: Estimated Impacts by Price Period – Informational Treatments

	TOU Period	Alectra Nudge - Enhanced TOU	London Hydro Trickl App - RT-Only	Oshawa PUC Peak App - Information Only		
				Average	DEP	Non-DEP
Summer	On-Peak	- 1.11%	- 2.36% (N/S)	- 0.68% (N/S)	- 0.7% (N/S)	- 0.57% (N/S)
Summer	Mid-Peak	- 0.46% (N/S)	- 0.42% (N/S)	+ 0.69% (N/S)	+ 1.52% (N/S)	- 2.54% (N/S)
Summer	Off-Peak (Weekday)	- 0.1% (N/S)	+ 1.62% (N/S)	+ 6.85%	+ 8.32%	+ 1.04% (N/S)
Summer	Off-Peak (Weekend)	- 0.1% (N/S)	+ 0.53% (N/S)	+ 4.4%	+ 5.42%	+ 0.31% (N/S)
Summer Shoulder	On-Peak	- 1.11%	- 2.36% (N/S)	+ 2.43%	+ 2.13%	+ 3.62%
Summer Shoulder	Mid-Peak	- 0.46% (N/S)	- 0.42% (N/S)	+ 2.44%	+ 2.54%	+ 2% (N/S)
Summer Shoulder	Off-Peak (Weekday)	- 0.1% (N/S)	+ 1.62% (N/S)	+ 5.28%	+ 5.28%	+ 5.26%
Summer Shoulder	Off-Peak (Weekend)	- 0.1% (N/S)	+ 0.53% (N/S)	+ 3.53%	+ 4.07%	+ 1.32% (N/S)
Winter	On-Peak	- 0.83%	- 1.28% (N/S)	+ 3.17%	+ 2.4%	+ 6.41%
Winter	Mid-Peak	-1.6%	- 0.87% (N/S)	+ 2.87%	+ 1.72%	+ 7.86%
Winter	Off-Peak (Weekday)	- 0.32% (N/S)	- 0.54% (N/S)	+ 4.55%	+ 3.95%	+ 7.09%
Winter	Off-Peak (Weekend)	- 0.32% (N/S)	+ 0.77% (N/S)	+ 3.16%	+ 2.62%	+ 5.47%
Winter Shoulder	On-Peak	- 0.83%	- 1.28% (N/S)	+ 4.92%	+ 5.12%	+ 4.15%
Winter Shoulder	Mid-Peak	-1.6%	- 0.87% (N/S)	+ 4.26%	+ 4.11%	+ 4.88%
Winter Shoulder	Off-Peak (Weekday)	- 0.32% (N/S)	- 0.54% (N/S)	+ 4.95%	+ 5.19%	+ 4.02%
Winter Shoulder	Off-Peak (Weekend)	- 0.32% (N/S)	+ 0.77% (N/S)	+ 4.9%	+ 5.44%	+ 2.72%

** Indicates that Nudge report impact differs for participants subject to price plan and those that are not.*

Nudge report impacts by variable price period for the Alectra Dynamic rate are not shown. All impacts are non-significant and the variable nature of the price periods makes the results of limited usefulness for comparison purposes.

Nudge Reports

The professional evaluation literature has demonstrated that behavioural "nudges" can have meaningful, if modest, impacts on participant consumption behaviours. Evaluations of large-scale deployments of home energy reports (HERs), typically report annual estimated energy savings of 1 – 3%.[88]

For participants in the Enhanced TOU treatment group and the matched controls provided with the Nudge report, the report delivered statistically significant savings only in the On-Peak (winter and summer) and Mid-Peak (winter only) periods. Overall, the reports did not result in any statistically significant seasonal conservation, and the statistically significant impacts that were estimated were very small – approximately a 1% reduction during the On-Peak period and a nearly 2% reduction during the RPP winter Mid-Peak period. These results were reasonably consistent with the estimated impacts of the London Hydro informational treatment (the Trickl app) – this too delivered no seasonal savings, and very modest On-Peak savings.[89] This is markedly different from the impacts of the Oshawa Peak app on the Information Only group in which consumption increased (see below for additional discussion of these differences).

Nudge reports deliver no statistically significant conservation impacts when such impacts are estimated for the Dynamic treatment group. This result is unsurprising given the sample size and the estimated magnitude of the impact from this treatment demonstrated by the Enhanced TOU treatment group. Evaluations of HERs typically include thousands – if not tens of thousands – of participants and controls.

[88] See, for example
Sussman, R. and Chikumbo, M. *Behavior Change Programs: Status and Impact*, October 2016
https://aceee.org/sites/default/files/publications/researchreports/b1601.pdf

[89] Though not statistically significant, the technical consultant for London Hydro has noted that the On-Peak impact of the RT-Only group is very close to statistical significance and makes the argument that this represents a true – though highly uncertain – impact from the treatment.

Mobile Applications

The London Hydro evaluation reports that the RT-only treatment group (subject to status quo TOU rates, provided with the Trickl app), results in a 2.36% reduction in summer On-Peak consumption, an impact that appears to be strongly correlated with weather (implying that A/C adjustments are responsible for much of the impact). The evaluation report notes that this value is not statistically significant at the 90% confidence level but *is* statistically significant at the 89.4% confidence level (i.e., is just outside the range of what is conventionally referred to as "statistically significant"). Guidehouse interprets this to mean that, though highly uncertain, the Trickl app is influencing participants to reduce their demand during the On-Peak period.

The London Hydro evaluation also reports that there is no statistically significant incremental impact due to the app on the consumption or demand response behaviour of the CPP and CPP/RT participant groups.

While the London Hydro app seems to have been moderately successful at motivating participant behaviour changes, the estimated impacts delivered by Oshawa PUC participants that were both exposed to an alternative price plan and actively used the Peak app were significant. As noted in Section 2.2.3, the results of the Oshawa PUC evaluation report indicate that all On-Peak and Super-Peak savings[90] (in the Seasonal TOU with CPP and Super-Peak treatment groups, respectively) are derived from the digitally engaged participants that downloaded and used the Peak app at least once. In some cases, these impacts were quite material (e.g., the 9.46% reduction in demand during the Super-Peak period by digitally engaged participants).

While these results are encouraging, the results of the digitally engaged participants in the Oshawa PUC Information Only treatment group suggest that these may be the result of some selection bias. That is, it is possible that it is not in fact participants' digital engagement with the Peak app that is driving impacts, but rather that the most enthusiastic participants that are most invested in responding to the new price plans also happen to be the kind of individuals most likely to become digitally engaged.

Consider the results of the Information Only treatment group. Not only is there no evidence of conservation impact as there is from digitally engaged participants in the Super-Peak or Seasonal TOU with CPP treatment groups, but in fact just the opposite. The Information Only participants *increase* their demand in all periods of the day. The only periods in which consumption does not increase by a statistically significant amount for this group are the summer (June, July, August) On-Peak and Mid-Peak periods. Impacts in the other 14 seasonal TOU periods are statistically significant increases in consumption. Absent the incremental price signal of an alternative price plan, the digitally engaged (and presumably also the most generally engaged) participants increase their consumption.

Based on the above, Guidehouse believes it is likely that digital engagement is more a *characteristic* of participants that deliver higher impacts than a *cause* of it. The two components are not entirely separable, of course – participants that use the app seem likely to be a sub-group of participants that will tend to deliver higher impacts, but it is also possible that the impacts that these more enthusiastic participants deliver may themselves be enhanced through the use of the app.

This possibility – that in addition to identifying enthusiastic participants an app can also encourage conservation behaviours – can be demonstrated by the fact that London Hydro's RT-only participants delivered On-Peak savings. Selection bias here is no issue as, unlike Oshawa's Seasonal TOU or

[90] Non-digitally engaged participants in the Seasonal TOU with CPP treatment group actually delivered a statistically significant *increase* in On-Peak consumption, and non-digitally engaged participants in the Super-Peak treatment group delivered a Super-Peak period consumption reduction that is not statistically significant.

Information Only control groups, the London Hydro control group is generated as part of a randomized control trial.[91]

As such, one of the key benefits of deploying an app like Peak or Trickl may be in allowing program administrators to identify high engagement consumers that may be the best candidates for voluntary alternative price plans (or other interventions).

This highlights an important point: much of the value of an electricity-focused mobile app may come from sources *besides* the avoided cost benefits of energy savings. Confining consideration of the value of a mobile app to quantifiable energy shifting or conservation impacts is likely to understate the benefits it may offer.

It is beyond the scope of this meta-analysis to comprehensively catalogue or attempt to quantify the value of the other benefits offered, but some worth considering are:

- the demonstrated ability of, for example, the Peak app to cross-promote energy efficiency programs;
- to provide consumers with a trustworthy and secure communications channel from their LDC;[92] and,
- the ability to collect customer data (e.g., via the customer profile) to better target marketing efforts.

In summary, informational mobile apps may sometimes deliver modest savings, but *their most significant value may be as a tool for identifying highly engaged consumers* to target for the marketing of alternative price plans or other utility programs.

Open Houses

One feature of London Hydro's customer engagement strategies was the holding of "open houses" throughout the pilot period. There were six open-house periods. Each open-house period lasted a week. During this period, a member of London Hydro's program team was available between 8am and 6pm to be consulted by pilot participants on a "walk-in" basis (no appointment required).

London Hydro's technical consultant has, in the evaluation report, noted that open-house attendance was correlated with improved energy savings, and that while these estimates might be partly a result of selection bias, there was likely also a causal effect.

One of the key pieces of evidence for the conclusion that open house attendance increased impacts was the finding that of those participants that attended the open house, more than 25% (25 individual participants) attended for help with very basic "table stakes" issues: how to log in to the web portal, how to download the Trickl app, and other very basic IT-related tasks. Over a third (37 individual participants) attended to better understand the price plan and the program as a whole, and half (46 individual participants) attended to seek help with technical difficulties relating to their enabling technology.[93]

Many participants, or would-be participants, may be unfamiliar or uncomfortable with some technology aspects of these pilots. Such participants may find call centre support unhelpful and frustrating,

[91] While the Super-Peak control group is also a randomized control group, selection bias in the digitally engaged participants' results is still possible: they are being compared against *all* control customers, not just those that would have (had they been enrolled) elected to become digitally engaged.

[92] That is, to avoid problems of fraudulent "phishing" emails and phone calls, the latter of which have become sufficiently sophisticated to present a legitimate number or name on incoming call displays.

[93] Percentages need not sum to 100% as in some cases participants attended for multiple reasons.

particularly if English is not their first language.[94] The engagement value to these types of customers of being able to consult one-on-one in-person is material, and the analysis seems to support the assertion that *making support more accessible to otherwise potentially marginalized customers can yield quantifiable improvements in program outcomes*.

Costs for this specific element of London Hydro's engagement strategy were not available (differentiated from other engagement costs), and so the cost-effectiveness of this pilot element is unclear. Altogether only 46 RT-Only (about 4%) and 47 CPP and CPP/RT (about 7%) participants attended these sessions.

[94] Note that this is informed speculation. Guidehouse has no information regarding the demographics of open-house attendees, but would observe that the kinds of basic technical issues that many participants sought aid with tend to be more common in older demographics. TheGuidehouse team has no information regarding the distribution of participants' mother tongue but has based the second assertion on their own experiences in communicating about technical matters over the telephone in a second language.

3. APPROACH

As noted in the introduction, Guidehouse's recommendations to the OEB are informed by two workstreams: a careful review of the RPP pilot evaluation reports submitted to the OEB by the proponent LDCs' technical consultants, and a comparative analysis of the performance of different treatment groups across seven metrics, metrics that are mostly derived from the RPP objectives.

Guidehouse's approach to developing the outputs of this second workstream are presented in this chapter. This chapter is divided into seven sections, the first six of which define Guidehouse's approach for developing values for the six evaluation metrics that correspond to the six RPP objectives, and the seventh corresponding to the "Ease of Implementation" metric. The seven sections of this chapter are:

1. **Cost Recovery.** A description of the approach used to determine how well each of the treatment groups recover the revenue necessary to cover the average RPP supply cost.
2. **Cost Reflectiveness.** A description of the approach used to determine to what degree the price series of each price treatment best reflects the mix of short-term supply costs and the long-term supply costs.
3. **Cost Minimizing.** A description of the approach used to determine to what degree each treatment group – if implemented at a provincial level – would be likely to reduce overall system costs. Put another way, Guidehouse's approach to comparing treatment group estimated future cost-effectiveness.
4. **Predictability.** A description of the approach used to determine which price treatments have price structures that deliver the most predictable prices (and, implicitly, costs) to consumers.
5. **Comprehensibility.** A description of Guidehouse's approach to evaluating self-reported understanding of price plans through proxy comprehension survey data and inherent qualities of each price plan (e.g., number, seasonal consistency, and timing of price periods).
6. **Opportunity for Bill Savings.** A description of the approach used to assess the opportunity each price plan offers for bill savings, based on the actual billing impacts reported in the LDC evaluations, and the theoretical opportunity to reduce bill impacts given an assumed own-price elasticity of demand.
7. **Ease of Implementation.** A description of the approach used by Guidehouse to assess the technical hurdles, particularly related to billing systems and customer care, that LDCs would need to surmount to offer a given price treatment to all customers.

Note that Guidehouse has deliberately avoided aggregating the metric-specific scores into an overall score for each treatment group, as to do so would reduce the usefulness of the analysis.

This is for a variety of reasons:

- Firstly, the purpose of Guidehouse's analysis is not to pick a "winner". It was never the OEB's expectation that Guidehouse would select one pilot treatment group to be recommended above all others. Each pilot offers different lessons learned, and each may include different elements worthy of expansion into a wider offering to a larger population.
- Secondly, such a scoring, by relegating some pilots to a lower rank than others, could unintentionally obscure benefits that elements of such (nominally) poorly performing pilots may offer, benefits that may be evident only through a nuanced comparison of the metric results *and* the evaluation report findings.

- Thirdly, developing a final overall rank for each pilot would require assigning weights to each metric. The development, and ultimate values, of such weights could – due to their inevitably subjective nature – distract from the final recommendations, even when the evidence underlying those recommendations (from the evaluation reports, and from individual metrics) is often clear and unambiguous.

Finally, it should be noted that only the results from the first 12 months of the Alectra Dynamic price plan are used in the evaluation of the metrics below. This is to ensure that metric outputs are truly comparable across all price plans (only the Dynamic price plan received the five-month extension).

3.1 Cost Recovery

The RPP Manual[95] identifies the first objective of the RPP as being to set prices to recover the full forecast cost of RPP supply from RPP consumers.

Guidehouse assessed the degree to which each price (and non-price) treatment recovered average RPP supply cost by assessing the revenue adequacy data provided by each of the pilot proponent LDCs against the forecast average RPP supply cost (RPA).[96]

This section is divided into three sub-sections:

- **Revenue Adequacy Data.** Defines the data used to drive the analysis.
- **Cost Recovery Success Definition.** Identifies the ranking criterion for this metric.
- **Identifying the Driver of Over- or Under-Collection.** Indicates how the data are used to develop a value for the metric ranking.

3.1.1 Revenue Adequacy Data

The technical contractor for each LDC included in its evaluation report a revenue adequacy table that provides the average revenue generated per kWh consumed by participants and controls under the pilot price (participants in price-related treatments only) and what it would have been had these customers all been billed under status quo TOU prices.

Note that the average revenue per kWh under TOU prices value is *not* the counterfactual revenue (i.e., the revenue had no pilot existed). Rather, this is the application of the counterfactual prices (the status quo TOU prices) to *actual* pilot-period consumption. So, this value reflects what the average revenue would have been for participants subject to the status quo TOU price assuming their behaviour *continued to reflect their response to the treatment prices imposed by the pilot*.

Table 3-1, below provides an example revenue adequacy table of the type used in the Cost Recovery analysis. This example is drawn from the London Hydro CPP price treatment.

[95] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

[96] This acronym does not quite match the underlying definition but is the accepted RPP nomenclature. See for example the document cited below, the *Regulated Price Plan Prices and the Global Adjustment Modifier* report: "*the average supply cost for RPP consumers (RPA)…"*

Table 3-1: Example Revenue Adequacy Table

Customer Group	Average Revenue per kWh		% Difference from RPA	
	Pilot Price Plan	Status Quo TOU	Pilot Price Plan	Status Quo TOU
CPP	$0.0802	$0.0810	-2.2%	-1.3%
Control	N/A	$0.0816	N/A	-0.5%

Source: Guidehouse analysis

This example is referred to in the explanatory text below.

3.1.2 Cost Recovery Success Definition

The success of each pilot treatment group's cost recovery was assessed by comparing the average revenue recovered from each group (total revenue under actual prices[97] divided by total consumption) with the average RPP supply cost as forecast for price-setting purposes and adjusted to reflect the Ontario Fair Hydro Plan (OFHP).

The total average Ontario RPP supply cost forecast for the pilot period (May 1, 2018, through April 30, 2019) was $0.12637/kWh.[98] After making the adjustments for the OFHP the average commodity price falls to $0.082/kWh.[99] This is referred to as the average supply cost (reflecting the OFHP adjustment) for RPP customers, or the RPA.

Using these values (revenue adequacy outputs for participants and controls, the RPA), Guidehouse:

- Assessed the degree to which the pilot price was over- or under-collecting revenue;
- Approximately determined the driving factor of the over- or under-collection; and,
- Identified to what degree the over- or under-collection would need to be considered as part of a price-setting process if the price treatment were being considered for a wider roll-out.

This last point, identifying to what degree over- or under-collection would need to be considered as part of a price setting process if the price treatment were being considered for a wider roll out, depends largely on *what* is driving the over- or under-collection.

3.1.3 Identifying the Driver of Over- or Under-Collection

The *total* over- or under-collection is the percentage difference between the average revenue per kWh actually collected from pilot participants and the RPA. This value may be found in the second column from the left of the table included in the Cost Recovery section of each treatment group's ODS.

In the example in Table 3-1 this value is -2.2%. This indicates that, in total, the CPP treatment under-collected revenues by 2.2%.

[97] "Actual" prices are the prices paid by participants during the pilot period. These are the pilot prices in the case of price-related treatment groups, and status quo TOU rates in the case of non-price treatments and control groups.

[98] Table 3 of:

Ontario Energy Board, *Supply Cost Report (Formerly the Regulated Price Plan Report): May 1, 2018 to April 30, 2019*, April 2018
https://www.oeb.ca/sites/default/files/RPP-Supply-Cost-Report-20180501-20190430-correction.pdf

[99] Table 1 of:

Ontario Energy Board, *Regulated Price Plan Prices and the Global Adjustment Modifier for the Period May 1, 2018 to April 30, 2019*, April 2018
https://www.oeb.ca/sites/default/files/RPP-GA-Modifier-Report-20180419.pdf

Guidehouse has used the revenue adequacy data to identify three elements of over- or under-collection for each price plan. The description of these elements below relies on the example above for clarity, but these elements are applied to all price plans. In reviewing the approach below, and the detailed analysis in the ODS, it must be borne in mind that in many cases over- or under-collection values tend to be relatively small, and without additional data (i.e., the standard error associated with the RPA and with the average revenues provided in the evaluation reports) it is impossible to test these values for statistical significance – it is possible that in some cases the differences between actual average revenue collected per kWh and the RPA are not statistically significant.

The three elements of over- or under-collection identified are:

> **Jurisdictional** over- or under-collection relates to over- or under-collection that simply reflects the fact that the utility may be over- or under-collecting from the sample in question even under status quo TOU prices, and even without any change in behaviour (as a result of the treatment).
>
> This is the percentage difference between the control group's average revenue per kWh and the RPA.[100]
>
> This element of over- or under-collection must be netted out of the total when considering how successful the pilot treatment is in cost-recovery, as this is the volume that would be over- or under-collected from the sample absent any treatment. In the example in Table 3-1 this jurisdictional over-collection is -0.5% - that is, the ratio of higher-cost TOU period consumption to lower-cost TOU period consumption is lower for London Hydro customers than it is for the provincial average RPP consumer.
>
> **Behavioural** over- or under-collection relates to the over- or under-collection that is a result of participant response to the treatment. This is calculated as the average revenue per kWh of the participant group when status quo TOU prices are applied less the jurisdictional over- or under-collection.
>
> The average revenue per kWh of the participant group when status quo TOU prices are applied is the value in the right-most column of the table included in the Cost Recovery section of each treatment group's ODS. In the example in Table 3-1, this value is -1.3%. This value is calculated as actually observed consumption times status quo prices divided by total consumption. Recall that *actual observed* consumption, not counterfactual consumption is what is used here.
>
> What net behavioural over- or under-collection (in the example in Table 3-1 this is the under-collection of -1.5% minus the -0.5% jurisdictional under-collection) captures is what proportion of the over- or under-collection is the result of a behaviour change. In this case the net behavioural under-collection is -1%. This indicates that participants in London Hydro's CPP treatment group reduced their ratio of status quo higher-cost TOU period consumption to status quo lower-cost TOU period consumption. In this case, this is likely due to the 5% reduction in On-Peak consumption estimated by the technical consultant.
>
> If this value is high in absolute terms, and close to the total over- or under-collection, *this indicates that maintaining the standard price-setting assumption that prices must be revenue-neutral assuming no change in behaviour will result in poor cost recovery*.
>
> If the main contributor to over- or under-collection is behaviour then it may be prudent for a wider roll-out of the treatment to include explicit consideration of behaviour changes in the price-setting algorithm. The greater the expected adoption the less tolerance there can be for behavioural over- or under-collection.

[100] The embedded assumption here is that the control group is a suitable counterfactual for the participant group.

For example: if total over-collection is 5% and is driven primarily by behavioural changes, but adoption is expected to be modest (e.g., for a price plan where eligibility requires EV ownership), then the cost of maintaining the price-setting assumption of no change in behaviour (in terms of implicit cross-subsidization of the participants by the broader group of rate-payers) is very small.

If, on the other hand, adoption is expected to be very high (e.g., a wide-deployment opt-out rate), then even a very small behavioural over-collection can have a significant impact.

Rate-Structural over- or under-collection is the net impact on total over- or under-collection after accounting for the jurisdictional and behavioural effects. Rate-structural over- or under-collection is the component of over- or under-collection that is purely the result of the change in rate structure – the windfall gain or loss effect.

This effect derives from a discrepancy between the participant sample's baseline consumption profile and the profile used in the price-setting process. In a world of perfect information and rational economic agents it should be expected that every alternative opt-in rate treatment, where prices are set using a provincial average profile, will result in some rate-structural *under*-collection.

A rational economic agent would compare the offered rate to their historical consumption patterns and be able to determine if opting into that rate would deliver windfall gains and, if it did, would opt-in. Of course, perfect information is not available, and consumers are not always rational economic agents. In many cases rate-structural over- or under-collection may be analogous to the jurisdictional over- or under-collection: it just happens that participants in the jurisdiction where the rate is being piloted happen to have a materially different load profile from that used in the price-setting process.

Where rate-structural over- or under-collection is expected to be material (in absolute terms) given anticipated adoption, the price-setting process should explicitly consider the status quo load profile of likely participants and use this, rather than the provincial average, for price-setting purposes.

In assessing a score for this metric all three elements are considered. The more material the over- or under- collection is likely to be in a wider-scale deployment (i.e., some consideration of the level of adoption is made), the lower the score.

3.2 Cost Reflectiveness

The RPP Manual[101] identifies the second objective of the RPP as being to set the price structure such that it reflects current and future RPP supply costs.

Guidehouse has assessed the degree to which each of the piloted treatment price plans (and the status quo TOU price plan) reflect:

- **Short-term Costs.** The existing embedded system supply costs as they are approximately charged to the electricity system in each hour; and,
- **Long-term Costs.** The existing embedded system supply costs as they would be incurred by an electricity system targeting a more economically efficient outcome compared to the status quo.

Guidehouse scored short- and long-term costs separately. In both cases, Guidehouse assessed the cost-reflectiveness of each price plan by comparing the hourly series of historical price plan commodity prices against the relevant (short-term or long-term) hourly series of system costs. This comparison excluded

[101] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

weekend days.[102] The statistic of interest calculated for each price plan was the root mean squared error (RMSE), and price plans were ranked in cost-reflectiveness based on this value. Rankings were bucketed into five final relative rankings with a ranking of "5" denoting the most cost-reflective price treatment, and a ranking of "1" denoting the least cost-reflective, as described in Table 3-2.

Table 3-2. Description of Scores for Cost Reflectiveness

Score	Description
5	Most cost-reflective, i.e., lowest RMSE between commodity prices and system costs
4	2nd or 3rd most cost-reflective of system costs
3	4th or 5th most cost-reflective of system costs
2	6th or 7th most cost-reflective of system costs
1	Least cost-reflective, i.e., highest RMSE between commodity prices and system costs

Source: Guidehouse analysis of pilot evaluation reports and data

The short-term cost in this analysis is very similar to the "supply-shaped" price as identified by the OEB Staff Research Paper that identified alternative approaches for the recovery of Global Adjustment (GA) costs.[103] This paper found that the short-term cost was less economically efficient than the long-term cost series, which was developed in order to "*more effectively induce reductions in long-run system costs by reducing the need for investments to meet peak demands*." Therefore, in the context of assessing the current pilot treatments, long-term cost reflectiveness is the more important metric.

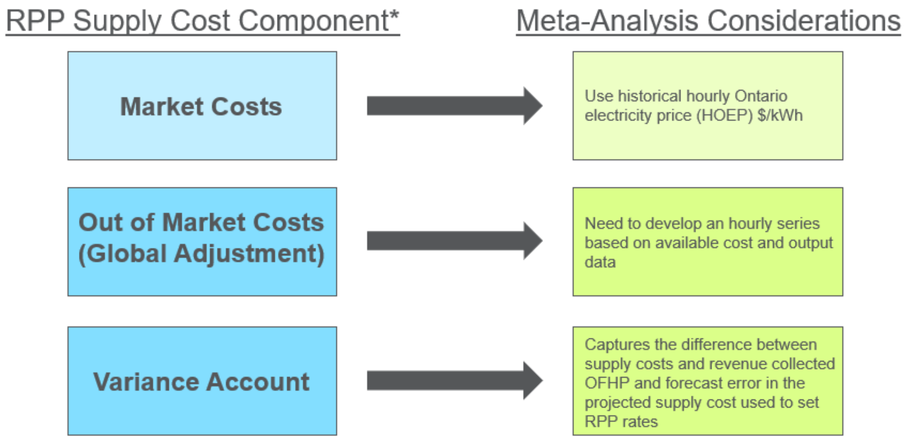
3.2.1 Short-Term Cost Reflectiveness

The key input for short-term cost reflectiveness is the development of an hourly embedded system cost series. Embedded system costs, as approximately charged to the system on an hourly basis, can be divided into three categories: hourly Ontario energy price (HOEP), global adjustment (GA) costs, and variances from prior under- or over-collection of costs in previous periods. These are illustrated in Figure 1., along with Guidehouse's approach for developing an hourly series of these costs.

[102] Based on discussions with OEB, weekends were excluded from the current analysis to focus on TOU periods defined on weekdays. In general, the results of this analysis are not sensitive to the exclusion of weekends.

[103] Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, EB-2016-0201, February 2019 https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

Figure 1. RPP Supply Cost Components

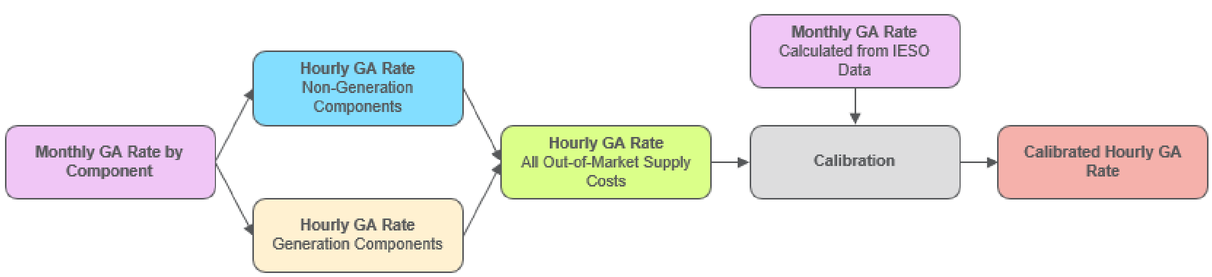


Source: Guidehouse analysis

As HOEP is already reported as an hourly series, no analysis was required to transform the series into the desired format. GA costs are calculated and reported as monthly historic values and are available broken down by component.[104] These components are: conservation; hydro; non-Ontario Power Generation (OPG) nuclear and natural gas; other programs – IEI[105] and storage; wind; solar; biomass, landfill and byproduct, and OPG regulated nuclear/hydro; non-utility generation; and regulated nuclear and hydro.

The development of an hourly series of system costs involved allocating each of these components that contribute to monthly GA into an hourly series reflecting when the activity (principally generator output) for which the system is being charged occurs. The method used to allocate GA charges varied by component. In general, GA charges may be divided into two components: costs associated with generation, and other costs associated with non-generation. The method used to calculate the GA rate is shown in Figure 2.

Figure 2. Methodology for Calculating GA Rate



Source: Guidehouse analysis

To develop the hourly GA series, Guidehouse applied the following six-step process:

[104] IESO, *GA by Components*. http://www.ieso.ca/-/media/Files/IESO/Power-Data/price-overview/GA-by-Components.xlsx?la=en. Accessed 2019-08-08.

[105] IESO, Industrial Electricity Incentive Program. http://www.ieso.ca/en/Sector-Participants/Energy-Procurement-Programs-and-Contracts/Industrial-Electricity-Incentive-Program

1. **Generator Mapping.** Mapped all generators in Ontario connected to the IESO controlled grid[106] to a component (i.e., hydro, non-OPG nuclear, natural gas, wind, solar, biomass, landfill and byproduct, and OPG regulated nuclear/hydro) of the GA generation costs published by the IESO on a monthly basis.[107]

2. **GA Component Average Rate.** Divided the total monthly GA cost by generation component[108] by the total monthly output of each generation component (calculated above). This results in a monthly GA rate ($/kWh of output) by generation component.

3. **Uncalibrated Hourly Series of Generation Supply Charges.**

    a. **Generation Connected to the IESO Controlled Grid.** Applied the rate calculated in step 2 to hourly generation output data from the Generator Output and Capability Report. This transforms the monthly rate into an hourly series ($/kWh) of GA costs for generation.

    b. **Non-Utility Generation.** Allocated hourly proportional to Ontario generation output.

4. **Uncalibrated Hourly Series of Other Supply Charges.** Allocated other monthly components of GA into an hourly series based on the allocation approach below:

    a. Costs associated with Conservation and Financing Charges were allocated hourly proportional to Ontario market demand.

    b. Costs associated with IEI and storage were allocated to the peak hour of each month, based on Ontario market demand.

5. **Uncalibrated Hourly Series of Supply Charges.** Combined the series of generation components of GA (step 3 and 4) with the series of other components of GA (step 4) to get an hourly GA rate ($/kWh).

6. **Calibration of Hourly Supply Charges.** The calculated hourly series is calibrated with the published monthly GA values from the IESO, shown below in Figure 3.

[106] IESO, *Generator Output and Capability Report.* http://reports-qa.ieso.ca/public/GenOutputCapabilityMonth/ Accessed 2019-08-08.

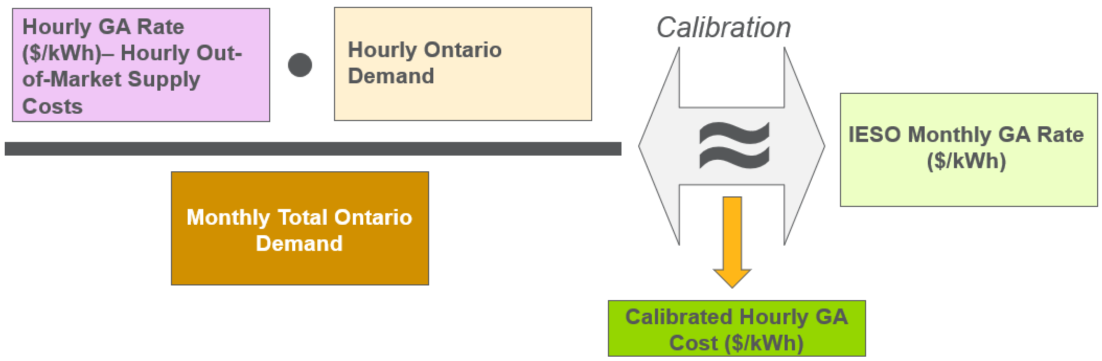
[107] Independent Electricity System Operator, *Data Directory – Price – Global Adjustment Report – GA by Components*, accessed January 2020

http://www.ieso.ca/en/Power-Data/Data-Directory

Direct file download: http://www.ieso.ca/-/media/Files/IESO/Power-Data/price-overview/GA-by-Components.xlsx?la=en

[108] These costs include embedded generation (e.g., embedded solar), which is not explicitly mapped in step 1. While not explicitly accounted for in the calculation, Guidehouse expects that these costs would be shaped appropriately by IESO connected generation. For example, embedded solar generation costs would be shaped by overall solar output.

Figure 3. Calibration of Hourly GA Series



Source: Guidehouse analysis

The result of this process is a series which expresses GA as an hourly rate throughout the treatment evaluation period. To arrive at the final embedded system cost series, HOEP is added to the GA rate.

3.2.2 Long-Term Cost Reflectiveness

The long-term hourly cost series is a cost series in which total existing system costs are mapped to each hour of the period of analysis in such a way as to reflect a more economically efficient hourly allocation of costs relative to the status quo, when considering how GA costs will accrue over the longer term.

This series, developed by OEB staff, is the sum of HOEP and an hourly allocation of the GA. It is based on extensive analysis[109] conducted in order to explore how the recovery of the GA from Class B customers[110] could be made more equitable and reflective of the costs consumers impose on the system as well as the value they derive from their consumption. The results of this analysis revealed that, out of the options that were considered, a demand-shaped allocation of the GA provided the most economically efficient allocation of the costs examined in that analysis. This is the series that best reflected both the costs imposed on the electricity system by consumers and the implied value consumers derive from their consumption.

This demand-shaped series of GA costs, when combined with HOEP, provides a valuable contrast to the supply-driven allocation outlined in Section 3.2.1. As mentioned previously, the OEB Staff Research Paper found that this allocation provides a more economically efficient allocation of costs than the short-term series. The long-term cost series are incurred by consumer demand over the medium and longer-term, while the short-term series effectively only captures the shape of short-term system costs.

This manner of considering the GA system costs is aligned with Bonbright's principles[111] of rate-setting: "*cost of service is itself affected by the values that individuals place thereon and hence by the demands that they make… increments in the output of service during peak periods impose additional capital*

[109] Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, February 2019

https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

[110] Per the OEB staff paper: "*To a close approximation, Class B consumers are those with peak electricity demand less than 1000 kW while those with demand of 1000 kW or more are considered Class A. Class B consumers can be further divided by those participating in the RPP (all residential consumers and general service customers with a peak demand less than 50 kW) and those who are not. These classifications determine how GA costs are recovered from individual consumers".*

[111] Bonbright, James C., *Principles of Public Utility Rates*, 1961

http://media.terry.uga.edu/documents/exec_ed/bonbright/principles_of_public_utility_rates.pdf

Chapter 5

outlays… [creating cost differentials that] *would not exist except for differences in the consumer demand for service at different periods of time."*

3.3 Cost Minimizing

The RPP Manual[112] identifies the third objective of the RPP as being to set a price structure such that it supports the achievement of efficient electricity system investment. Put another way, this objective's goal is reducing costs ("cost minimizing") to the electricity system and consumers by improving the overall cost-effectiveness of the system.

To assess this metric, Guidehouse estimated the cost-effectiveness of each pilot treatment. Guidehouse assumed full deployment (i.e., province-wide) of each pilot treatment independently between November 2021 and October 2035. Each treatment group was analyzed independently of all other pilots; interactions between treatment groups are not considered (e.g., market sizing for one price plan is unaffected by the market sizing for another price plan).

This section is divided into six sub-sections, outlining different components of the cost minimizing analysis:

1. **Pilot Impacts.** Identifies how Guidehouse derived the unit impacts for each treatment group.
2. **Pilot Costs.** Describes how Guidehouse categorized cost data provided by the proponent LDCs and scaled values to reflect assumptions of a wider deployment of each treatment. In general, proponents provided overall pilot costs, which were used to estimate costs on a per-treatment basis.
3. **Market Sizing.** Describes the estimation of the maximum potential market size for each treatment.
4. **System Benefits.** Describes the estimation of total system benefits over the entire analysis period.
5. **Treatment Costs.** Describes the estimation of treatment costs for each treatment group over the entire analysis period.
6. **Cost Effectiveness Scoring.** Describes the determination of cost-effectiveness for each treatment.

3.3.1 Pilot Impacts

Guidehouse reviewed and processed the estimated impacts for each pilot treatment to reshape these data into a standardized format for comparing all treatments. For each treatment, Guidehouse derived an hourly series of average per-participant impacts from evaluation reports and the data provided by the technical consultants that responsible for the reports. Importantly, where the technical consultants reported impact estimates that were not statistically significant, Guidehouse has assumed zero impact.[113]

[112] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016
https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

[113] There is one exception to this rule, in the case of the London Hydro RT-Only treatment group. The On-Peak impact for this group, though not statistically significant at the 90% confidence level, is very nearly significant and has been presented by the technical consultant as a true, though highly uncertain, estimate of that treatment group's impact.

The result for this analysis is a standard hourly series of impacts that was used downstream in the scaling assessment and ultimately cost-effectiveness determination.

3.3.2 Pilot Costs

Guidehouse received from the proponent LDCs an accounting of costs associated with the components of each pilot. These cost components include both fixed (e.g., personnel and management costs, etc.) and variable (e.g., truck rolls, equipment purchase, etc.) costs of pilot deployment. Guidehouse allocated each cost component into one of three categories. Each category may include different types of costs, e.g., fixed one-time costs, fixed annual costs, variable per participant cost, variable per participant/year costs, etc. The three categories of costs are:

1. *Overhead* – costs associated with activities such program design, administration, evaluation, etc.

2. *Technology* – costs associated with technology requirements – both customer-facing and internal process – such as billing system updates, load switches, installation, control systems, maintenance, etc.

3. *Communications* – costs associated with communications with customers, such as marketing, recruitment, retention/engagement activities, etc.

Guidehouse reviewed these cost data to determine to what degree these costs might change if pilot treatments were to be deployed province-wide. This included identifying:

1. *Pilot Costs.* Costs that were purely pilot-related and would not be incurred as part of the full deployment.

2. *One-Time Fixed Costs.* Costs that would be incurred once at the time of pilot deployment, and those that would be recur annually over the life of the program.

3. *Economies of Scale.* Costs that may be reduced when implemented more widely due to economies of scale.

In general, proponent LDCs reported overall pilot costs for implementing all treatment groups together (e.g., London Hydro reported total costs for all three treatment groups: RT-Only, CPP, and CPP/RT). For this analysis, Guidehouse estimated the cost associated with implementing each treatment group individually. Where possible, overall pilot costs were broken down by treatment group. For example, marketing or technology costs were included only for applicable treatment groups.

Other costs are treated as fixed, regardless of the number of treatment groups implemented. For example, in the case of London Hydro, this LDC only reported a single cost for mobile application development across all treatments. For the purposes of cost-effectiveness testing, this was applied to each treatment separately. That is, for a full CPP/RT deployment the full cost of app was development, and likewise for a full RT-only deployment the full cost of app development was assumed.

3.3.3 Market Sizing

To determine system benefits and costs associated with the full deployment of each treatment group's combination of treatments, Guidehouse estimated a terminal year market share for each treatment group. This process involved:

- Identifying the most relevant participant characteristics of the treatment group.

- Determining, based on available data, what proportion of the province shares these characteristics. This is the maximum market share.

- Applying adjustments to account for attrition (opt-out treatment groups) or on-going recruitment (opt-in treatment groups) to arrive at an “achievable” market share.

This is a relatively high-level process intended to provide directionally accurate estimates. It is no substitute for the precision of a dedicated potential study. Outputs based on this process must be considered with this in mind.

Guidehouse used pilot survey results and report findings to identify: (1) trends in revealed participant characteristics that may be correlated with participant response; and (2) targeted participant characteristics. For example, energy impact findings for London Hydro’s treatments suggest that a large portion of energy savings are driven by participant A/C response. Pilot surveys revealed that those enrolled in London Hydro’s treatments tend to live in single-family homes that have central A/C. These characteristics can then be used in the next step, to identify the maximum potential market share.[114] These are *revealed* participant characteristics. Alectra’s Overnight rate targeted EV owners. This is a *targeted* participant characteristic.

Once Guidehouse identified the participant characteristic(s) to be used to scale a treatment, Guidehouse then estimated the number of households with similar characteristics in the entire the province. Guidehouse used a variety of sources for this estimation, including: the Ontario Residential End-Use Survey (REUS);[115] Guidehouse Insight electric vehicle adoption forecasts;[116] and the observed enrolment rate for a long-running dynamic pricing program with a published history of participation rates.[117]

Guidehouse applied an S-shaped market diffusion curve to each treatment to simulate a ramp-up of program enrolment over time.[118] Treatment attrition results from the evaluation of each treatment were applied to the total market size. The result is an estimate of program enrolment from 2021 to 2035 for each treatment group.

For opt-out treatments, Guidehouse assumed the entirety of the eligible population was enrolled in the first year of the program deployment, and applied an annual attrition in each subsequent year, based on the attrition reported in each of the evaluation reports. Program enrolment increases annually based on the incremental growth in eligible households in that year multiplied by the market size (as a percentage of households).

In estimating the achievable market size, each pilot treatment was considered in isolation – no assumptions were applied regarding whether enrollment for one treatment would “cannibalize” enrollment for another.

[114] Only participant characteristics for which provincial level data are known to exist are considered in this process.

[115] Cadmus, 2018. *Ontario Residential End-use Survey*. Prepared for the Independent Electricity System Operator.

[116] Guidehouse Insight. Market Data: EV Geographic Forecast - North America. https://guidehouseinsights.com/reports/market-data-ev-geographic-forecast-north-america

[117] Oklahoma Gas & Electric. *SmartHours.* https://www.occeweb.com/PU/EnergyEfficiency/2016OGE_DemandProgramsAnnualReport.pdf

[118] The S-shaped diffusion curve, and associated parameters, used inGuidehouse’s analysis is drawn Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000, via the 2019 Ontario Achievable Potential Study.

3.3.4 System Benefits

Based on estimated pilot impacts and estimated annual program enrollment, Guidehouse estimated the system benefits delivered by each pilot treatment for the period of 2022 through 2035.[119] The overall system benefit associated with each treatment group is present value of stream of avoided cost benefits over time. Annual avoided cost benefits are the sum of the energy avoided cost and the peak capacity avoided cost benefits. Guidehouse did not consider any non-energy benefits as part of this analysis.

3.3.4.1 Avoided Energy per Participant

Using hourly avoided energy costs and the impact of each treatment on consumption, Guidehouse estimated the avoided energy benefit for each treatment per participant for each year of the analysis period. The IESO provided Guidehouse with avoided energy costs, by season and hour of day from 2019 to 2035.[120] The impact of each treatment on consumption is the hourly series of impacts derived as described in Section 3.3.1.

3.3.4.2 Avoided Capacity per Participant

Using the avoided cost of capacity and estimated impact at the time of system peak demand, Guidehouse estimated the avoided capacity benefit for each treatment on a per participant basis for each year of the analysis period.

Guidehouse assumed a capacity avoided cost of $130,000 per MW-year in 2018 dollars, in 2022 and beyond.[121] This estimate of avoided cost for capacity ensures consistency with previous work conducted by OEB Staff and contractors.[122]

Guidehouse estimated the impact of each treatment group on system peak demand differently for those with and without CPP events. For treatments with critical peak pricing events, Guidehouse assumed that these events would be called such that their impacts accurately target system peak demand (and so result in some future capacity costs being avoided). Some CPP event impacts are “weather-sensitive” meaning dependent on temperature. This sensitivity is reflected in an explicit mathematical relationship between impact and temperature in the regression models used for evaluation. Guidehouse estimated these weather-sensitive CPP event impacts using a consistent peak weather value for all treatments. For this analysis, Guidehouse used the “normal” peak temperature projected by the IESO September 2019 Reliability Outlook for the week ending 2020-07-12 (30.9 degrees Celsius).[123]

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[119] The terminal date for this range was selected based on the temporal range of available electricity avoided costs.

[120] IESO, *Forecast Electricity Avoided Costs*, Provided via Email 2019-09-11
Note that these 2019 avoided costs, developed by the IESO at its 2018 Technical Conference, were the most recently available avoided costs at the time this analysis was conducted. Since that time, the IESO has updated its avoided costs. After reviewing the newer avoided costs, Guidehouse concluded that replacing those used in the analysis with the most updated avoided costs would not change the final ranking of the price plans and so did not update the input values. A discussion of this in more detail may be found in Appendix B. The most important point is that Guidehouse did not use the IESO estimate of avoided capacity cost, but instead used the $130/kW-year ($2018) value used by the OEB, and the vast majority of benefits estimated are due to capacity reductions. This means that changes to avoided energy costs do not have a material impact on the ranking of the price plans for this metric.

[121] This estimate of capacity cost replaced the IESO estimated capacity avoided cost, which is generated such that it provides the avoided cost of capacity between 1pm and 7pm on non-holiday weekdays in June, July, and August.

[122] OEB, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*. EB-2016-0201. https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf. From that paper “*The estimate is an intermediate value, inflated to 2022 dollars, sourced from the IESO’s assessment of the need for the East-West Tie expansion (ref 32). Specifically, the value used is intermediate between approximate clearing prices in the IESO Demand Response auction ($80,000/MW-yr, nominal $) and the estimated cost of building new capacity ($180,000/MW-yr nominal $).*”

[123] IESO, *Reliability Outlook*. http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Reliability-Outlook

Treatments without critical peak pricing events do not specifically target peak demand hours; nevertheless, each treatment may still induce behavioral changes that have an impact on peak demand. In these cases, for cost effectiveness calculations, Guidehouse applied the average summer coincident peak impact as it is reported in evaluation reports.

3.3.4.3 Total System Benefits

The per participant avoided costs of energy and capacity in each year were multiplied by the program enrolment, determined as described in Section 3.3.3. The result is a series of annual system benefits for each treatment. Guidehouse made no assumption about price response increasing or decreasing with time. Specifically, per participant impacts were not scaled downwards or upwards to account for changes in behaviour over time and all impacts were assumed to persist over the entire analysis period.

3.3.5 Treatment Costs

Based on an analysis of pilot costs and projected annual program enrollment, Guidehouse estimated the costs associated with each pilot treatment group for the analysis period of 2022 through 2035. From the analysis described in Section 3.3.2, Guidehouse estimated, for each pilot treatment:

1. Per-LDC costs – both one-time and recurring;
2. Per participant enrollment costs – incurred in the year of enrollment; and,
3. Recurring per participant costs.

Using this information, Guidehouse developed a series of costs for the entire analysis period, assuming full deployment across all LDCs with enrollment levels as described in Section 3.3.3. Certain pilot costs were removed or adjusted based on LDC feedback and Guidehouse’s review. These costs either would not be expected to be relevant to a province-wide deployment (e.g., pilot-related costs) or would be expected to decrease due to economies of scale (e.g., bulk equipment purchases).

3.3.6 Cost Effectiveness Scoring

Guidehouse used the total resource cost test (TRC) to evaluate cost effectiveness for each treatment. This is calculated by dividing the net present value (in 2018 dollars) of the time series of total system benefits by the net present value of the time series of total treatment group costs (determined as described in Sections 3.3.4 and 3.3.5). Guidehouse applied a social discount rate of 4%.[124]

Table 3-3. Description of Scores for Cost Minimizing

Score	Description
5	Benefit/cost ratio greater than zero. High benefit/cost ratio relative to other treatments assessed
4	Benefit/cost ratio greater than zero. Medium benefit/cost ratio relative to other treatments assessed

[124] Value consistent with:

Navigant, prepared for the Independent Electricity System Operator and the Ontario Energy Board, *2019 Integrated Ontario Electricity and Natural Gas Achievable Potential Study*, September, 2019

http://www.ieso.ca/Sector-Participants/Energy-Efficiency/Energy-Efficiency-Resources-and-Reports

Score	Description
3	Benefit/cost ratio greater than zero. Low benefit/cost ratio relative to other treatments assessed.
2	No benefits statistically different from zero.
1	Benefit/cost ratio less than zero.

Source: Guidehouse analysis of pilot evaluation reports and data

3.4 Predictability

The RPP Manual[125] identifies the sixth objective of the RPP as being to set prices that are predictable (such that participants know from one day to the next what the price of power will be).

Guidehouse used the complexity of price changes required for each treatment as an indicator of how predictable prices would be for consumers. The principal differentiator for this metric is whether or not a given price plan has some sort of irregularly scheduled price period which cannot be known with certainty ahead of time, based on the LDC-provided price schedule.

Specifically, price plans that employ critical peak prices are less predictable than those that do not, and those that combine multiple irregularly scheduled price types are less predictable than those that include only a single irregularly schedule price (i.e., the combination of the variable peak price and critical peak price is less predictable than the critical peak price alone). Also considered are the number of price periods, the number of changes to these price periods throughout a 12-month period, and the number and frequency of critical or variable peak events. Guidehouse scored each pilot treatment as described in Table 3-4.

Table 3-4. Description of Scores for Predictable Metric

Score	Description
5	Treatment involves the least number of price periods in a day, so customers experience fewer price changes over a season.
4	Treatment involves price periods and seasonal changes consistent with current customer expectations.
3	Treatment involves additional price periods in each day, which customers must be aware of. Due to the additional number of periods, Customers experience more frequent price changes.
2	Treatment involves CPP events, which are inherently dependent on system conditions and less predictable. Events do not occur every day during the season but may occur roughly monthly at least throughout the year.
1	Treatment involves Variable Peak Pricing, where peak pricing is determined according to system conditions. This treatment is the least predictable, as the prices experienced by customers is determined daily.

Source: Guidehouse analysis of pilot evaluation reports

[125] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

3.5 Comprehensibility

The RPP Manual[126] identifies the fifth objective of the RPP as being to apply a price structure that is easily understood – comprehensible – to consumers.

To assess the comprehensibility of the pilot treatments, Guidehouse sought to identify how well participants understood the new price (or price structure) to which they were subject. Did participants demonstrate an understanding of the price structure and how to respond to prices effectively? How does this compare to an average RPP consumer's understanding of the status quo TOU price structure?

A very comprehensible price plan tends to: have fewer price periods that are consistent and follows a pre-determined regular schedule, and tends to be populated by participants that demonstrate a good understanding of how TOU pricing works or what they can do to save on electricity costs. Price plans are likely to be comprehensible if they feature educational materials that are clear, unambiguous, and explicitly seek to inform participants about how the price plan is reflected on their bill.

In an ideal scenario, the data used to assess the pilots' comprehensibility would capture both participants' perceived comprehension (i.e. how well the participant *thinks* they understand the price periods and other price plan components) and their revealed comprehension (i.e. how well the participant is able to *demonstrate* that they know when the price periods start and end, what the differences in the prices are, if there are seasonal differences, and if/when there are CPP events). However, no such survey data were collected as part of the survey work that accompanied these pilots. Guidehouse has therefore compiled three inputs as proxies for comprehensibility.

The criteria used to assess comprehensibility are described below. These factors indicate the theoretical comprehensibility of the price plans based on their design and the participants' revealed comprehension of them. Comprehensibility was assessed based on the following criteria:

1. **Number of price periods**: This criterion measures the theoretical comprehensibility of the pilot treatments, based on the assumption that price plans with more periods are more complicated and therefore less comprehensible than those with fewer periods. CPP periods were not counted as a price period in this metric but are instead captured in criterion 2.

2. **Consistent and regular timing**: This criterion measures the theoretical comprehensibility of the pilot treatments, based on the assumption that unpredictable or irregular price plans are more complicated and therefore less comprehensible than those with consistent and regular timing. Pilot treatments with prices that change on certain days or hours, or with a larger number of seasons were considered less comprehensible than those with consistent prices and received a lower score. For example, price treatments with CPP or more than two seasons received a lower score due to the non-consistent and irregular timing of CPP periods.

3. **Self-reported comprehension**: This criterion measures the revealed comprehensibility of the pilot treatment, based on self-reported data. While each proponent LDC fielded participant surveys, the questions were not identical across all surveys (Table 3-5). Not all surveys asked directly about the participant comprehension of price plans themselves, so it was necessary to use questions that indirectly captured participant comprehension as proxies to identify respondent understanding of the price plan to which they were subject.

   For example, Alectra asked about how easy it was to remember the new price plan structure. CustomerFirst asked participants about plans to change their electricity consumption patterns (in response to the pilot pricing plan). Since London Hydro's price plans were similar to status quo

[126] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

TOU, but with a few hours of CPP, the question on testing the general understanding of how TOU works was deemed reasonable to use for proxy comprehension of price plans. Similarly, for Oshawa, participants with a good understanding of the difference between flat (seasonal) pricing and TOU pricing were assumed likely to understand the new price plans. The survey questions used as proxies for participants' comprehension of the pilot price plans are shown in Table 3-5.

In assessing the objective characteristics of a price plan that contribute to its comprehensibility (e.g., number of periods), Guidehouse has not assumed any "baseline" of comprehension due to the existing status quo TOU price plan. Guidehouse recognizes, however, that this RPP pilot does not exist in a vacuum; these participants, like all RPP consumers in the province, have been subject to the status quo TOU price plan for many years. It would be reasonable to assume that if this assessment were to measure comprehensibility *in comparison to* the status quo (i.e., if comprehensibility were ranked in terms of deviation from the default status quo TOU price plan), the final ranking might differ.

Table 3-5 Comprehension Survey Questions by Proponent LDC

Pilot Proponent	Comprehension Survey Question
Alectra	[On a scale from 1: "Strongly Disagree" to 7: "Strongly Agree,"] How much do you disagree or agree with the following statement? Remembering the new pricing plan structure was easy
CustomerFirst	Do you plan to change your electricity consumption patterns as a result of your participation in the TOU pilot? [Yes / No]
London Hydro	Using less electricity during the day will save you more money than reducing the same amount of electricity during evening or overnight [True / False]
Oshawa	[On a scale from "Strongly Agree" to "Strongly Disagree,"] Please indicate how much you agree with each of the following statement. I have a good understanding of the difference between flat pricing and time-of-use pricing

Table 3-6. displays the criteria, weighting and scoring framework used to evaluate the pilot treatments' comprehensibility. The weighted average of the three-point score was calculated and scaled appropriately to yield an overall metric ranking on a scale of 1 to 5.

Table 3-6. Comprehensibility Criteria and Scoring Framework

Criteria	Weight	Criteria Score		
		3	2	1
Number of Price Periods Per Season	20%	< 3 periods	3 periods	> 3 periods
Consistent and Regular Timing	40%	Yes	N/A	No
Self-Reported Comprehension	40%	≥ 70% of participants	50 - 70% of participants	< 50% of participants

Source: Guidehouse analysis

Outside of the quantitative scoring framework, Guidehouse qualitatively reviewed pilot design and implementation elements that could facilitate participants' ease of understanding the pricing plan and what actions they could take to save under the new plan. Guidehouse made these qualitative assessments based on in-depth interviews with pilot implementation staff and a review of program outreach materials and sample bills. These elements assessed included the availability of varied and easily accessible customer support channels, clear and simple visual depictions of the price plan for easy reference, and clear electricity bills that highlight the pilot prices and participants' usage by period, and are discussed in more detail as follows:

Customer support channels: customers are more likely to comprehend a pilot treatment if there are multiple channels for them to learn about, reference, or seek help from, in understanding the price design.

Visual depiction of price design: pilot treatments were evaluated based on the effectiveness of the visuals used (such as brochure, app, or web portal). Prior work on RPP pricing presentment[127] shows that TOU price depictions showing price periods in a linear graph are more comprehensible than those shown in a circular "dial" format.

Sample bills: pilot treatments that updated the customer bills to clearly highlight the pilot prices and participant usage by period would be more comprehensible than those that do not.

3.6 Opportunity for Bill Savings

The RPP Manual[128] identifies the fourth objective of the RPP as being to deliver a price structure and set prices such that consumers have an incentive and opportunity to reduce their electricity bills by changing their consumption behaviour.

Guidehouse assessed the opportunity offered by each price treatment to deliver bill savings in two ways:

- Reviewed the *realized* bill savings provided by the evaluation reports completed by the pilot proponent LDCs' technical consultants.

[127] BEWorks, 2014. *Behavioural Economics Review: Analyzing and Nudging Energy Conservation and Demand Shifting Through Time of Use Compliance*. Prepared for the Ontario Energy Board.
[128] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

- Estimated the *potential* bill savings opportunity (i.e., potential savings given the changes in price of each treatment) using an own-price elasticity developed by OEB Staff.[129]

The evaluation for each pilot reports bill impacts for each treatment as the percentage of monthly bill reduced, as well as the absolute bill reduction in dollars. These values are realized bill savings for customers. Guidehouse compared the percentage of average bill savings in both the summer and winter seasons, and rated each treatment based on the overall average bill savings realized by on average, by consumers.

Guidehouse estimated potential bill savings opportunity as follows:

1. Estimate the counterfactual consumption for each price treatment group (i.e., what customers would have consumed in absence of treatment)

2. Calculate, on a price-period period basis, the percentage change in price between status quo and treatment, considering both commodity and variable non-commodity charges.[130]

3. Apply the own-price elasticity value (-0.075) to determine the price-elasticity-adjusted consumption. This is the notional change in behaviour that would be expected from the given price treatment, conditional on the assumed own-price elasticity.

4. Calculate potential bill savings opportunity as the difference between:

    a. **Status Quo Bill.** The amount charged using counterfactual consumption and status quo pricing (what would consumers have paid under the status quo TOU price plan, absent any changes in behaviour), and

    b. **Alternative Price Plan Bill, Given Assumed Elasticity.** The amount charged using the price-elasticity-adjusted consumption and treatment pricing (what would consumers have paid under the given price plan, assuming they had responded as per the elasticity shown above).

Based on this analysis, Guidehouse assigned each pilot treatment group a rank of between 1 and 5, for both the realized and estimated bill savings. The description of scores for realized bill savings are shown in Table 3-7.

Table 3-7. Description of Scores for Opportunities for Bill Savings - Realized

Score	Description
5	Highest realized bill savings; bill savings greater than 8%.
4	Moderate realized bill savings; bill savings between 4% and 8%.
3	Low realized bill savings; bill savings between 1% and 4%.
2	Minimal realized bill savings; no bill savings to bill savings of 1%.
1	Negative realized bill savings.

Source: Guidehouse analysis of pilot evaluation reports

[129] Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, February 2019
https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

[130] Ontario Energy Board, *Electricity Distribution Rates*. Accessed January 2020
https://www.oeb.ca/industry/applications-oeb/electricity-distribution-rates

The description of scores for estimated bill savings are shown in Table 3-10.

Table 3-8. Description of Scores for Opportunities for Bill Savings - Estimated

Score	Description
5	Highest potential bill savings; monthly bill savings greater than $5.
4	Moderate potential bill savings; monthly bill savings between $3 and $5.
3	Low potential bill savings; monthly bill savings between $1 and $3.
2	Minimal potential bill savings; no bill savings to bill savings up to $1.
1	Negative potential bill savings.

Source: Guidehouse analysis of pilot evaluation reports

The final score for the opportunity for bill savings metric is an average of the above scores; Guidehouse developed these scores by analyzing and grouping treatments with similar ranges of realized bill savings ranges, as well as ranges of potential savings opportunity.

Table 3-9. Description of Scores for Opportunities for Bill Savings

Score	Description
5	High realized and potential bill savings, compared to other treatments.
4	Moderate realized bill savings compared to other treatments but high potential bill savings opportunity.
3	Low bill savings compared to other treatments but moderate / high potential bill savings opportunity.
2	None or minimal bill savings compared to other treatments and/or minimal potential bill savings opportunity.
1	Negative realized bill savings and minimal potential bill savings opportunity.

Source: Guidehouse analysis of pilot evaluation reports

3.7 Ease of Implementation

The ease of implementation metric differs from the other six metrics, all of which are drawn from the six renewed objectives of the RPP described in the RPP Roadmap. The scoring of this metric is intended to provide an assessment of the practicality of LDC implementation of the piloted treatment groups on a provincial scale.

To evaluate treatments against the ease of implementation metric, Guidehouse assessed the capability for OEB-regulated LDCs to implement each pilot treatment from the perspective of existing processes, billing system capability, and tools infrastructure. Guidehouse also considered treatment groups' approach to recruitment (i.e., opt-in or opt-out); required hardware installation and maintenance efforts; and approach to customer engagement.[131]

The goals of this analysis were to:

[131]Guidehouse has, in its analysis, noted cases in which a piloted price plan might require a change in regulation (i.e., the O. Reg. 95/05 requirement that the Off-Peak period begin no later than 7pm on non-holiday weekdays); an in-depth review of the potential regulatory or legal barriers for implementation is beyond scope of this meta-analysis.

- Develop high-level approximate cost and time estimates for upgrading existing billing systems, tools, and processes to implement the types of price structure piloted.
- Qualitatively identify major technical obstacles and challenges to implementing new price structures faced by LDCs.
- Qualitatively rank the level of implementation challenges related to recruitment, enabling technologies, and customer engagement faced by LDCs based on how treatments were implemented as pilots.

Guidehouse’s approach involved a survey of a variety of LDCs (size and service territory), in order to understand the range of perspectives throughout Ontario. The survey collected information about LDCs’:

- Current capabilities related to price plan system maintenance and billing;
- Customer care required to support price plan changes; and,
- The general state of operational readiness for implementation and adoption of the proposed price plans.

Guidehouse received responses from 16 LDCs, representing 79% of residential consumers in Ontario. Based on survey responses, Guidehouse developed an implementation cost and time estimate, as well as insights into perceived obstacles and challenges for three pricing elements:

- Implementation of critical peak price (CPP) events
    - Involves calling events to target system peak demand, where the price is raised to encourage curtail electricity use.
    - Examples: the London Hydro, Oshawa, Alectra CPP price treatments.
- Implementation of variable peak pricing
    - Involves a variable peak price that depends on system conditions.
    - Examples: Alectra Dynamic price plan.
- Switch to a new TOU structure
    - Involves modifying the existing TOU structure with different prices or period definitions.
    - Examples: Alectra and CustomerFirst Enhanced TOU price treatments.

Guidehouse subsequently combined the analysis of these three elements for each pilot treatment group, as appropriate. For example, the Alectra Dynamic treatment would require a billing system that is capable of handling both the variable peak pricing and the CPP events.

Guidehouse also interviewed a third-party utility data services provider to complement the analysis of survey results with the perspective of a solution provider. This company provides business operation support systems to entities such as utilities and retail energy suppliers. The purpose of this discussion was to get another cost estimate, as well as to understand the potential cost savings associated with a centralized solution that could be leveraged by multiple LDCs. The third-party utility data services provider interviewed for this metric currently offers utilities a rate engine that is designed to “*cost effectively enhance and upgrade legacy utility-billing systems*”, in addition to market settlement software services, analytics, and cloud-based financial services. This firm’s offerings include a platform intended to enable and implement complex consumer tariffs without requiring major customer information system (CIS)/customer relationship management (CRM), and meter data management (MDM) system upgrades.

This firm's experience in providing the customers of a major US coastal municipal utility with a bill scenario analysis tool to help smooth their transition to a TOU rate, allowed them to provide valuable outside perspective in considering questions of implementation.

To assess implementation challenges related to recruitment, enabling technologies, and customer engagement, Guidehouse reviewed pilot reports and drew from interviews with pilot proponent LDCs. With respect to recruiting, the primary differentiator between treatments was whether they were opt-in or opt-out. Since pilot proponents experienced challenges recruiting participants for opt-in treatments, a province-wide deployment would be expected to face similar challenges. Some of the treatments used an enabling technology that required hardware installation, such as a smart thermostat or panel-mounted load switch. These technologies require a substantial effort for proponents in order to ensure that they function correctly. Finally, different treatments used different approaches for customer engagement to promote success of the pilots. These approaches represent varying levels of effort (e.g., bill inserts, breakfast events, call centres) for implementation. These aspects of each treatment were considered in the final ease of implementation score. Guidehouse scored each treatment from 1 to 5 as described in Table 3-10.

Table 3-10. Description of Scores for Ease of Implementation

Score	Description
5	Treatment requires no, or minimal, changes to existing systems. Treatment is based on opt-out recruitment. Treatment does not require any hardware installation. Less customer engagement required by pilot proponent LDCs than other treatments.
4	Treatment may require alternative price differentials and/or TOU period definitions. Treatment is an opt-in treatment, which may pose recruitment challenges. Treatment does not require the installation of any hardware. Less customer engagement required by pilot proponent LDCs than other treatments.
3	Treatment may require alternative price differentials and/or TOU period definitions. Treatment is an opt-in treatment, which may pose recruitment challenges. Treatment also involves hardware installation, which represents a substantial implementation effort to ensure hardware functions correctly. Less customer engagement required by pilot proponent LDCs than other treatments.
2	Treatment requires changes to both prices and period definitions and the implementation of CPP events. Some period definitions may require some regulatory updates to ensure compliance. Treatment is an opt-in treatment, which may pose recruitment challenges. Treatment also may involve hardware installation, which represents a substantial implementation effort to ensure hardware functions correctly. More customer engagement required by pilot proponent LDCs than other treatments.
1	Treatment requires changes to both prices and period definitions, as well as the implementation of CPP events and a variable peak pricing period. Some period definitions may require some regulatory updates to ensure compliance. Treatment is an opt-in treatment, which may pose recruitment challenges. Treatment also may involve hardware installation, which represents a substantial implementation effort to ensure hardware functions correctly. More customer engagement required by pilot proponent LDCs than other treatments.

Source: Guidehouse analysis of pilot evaluation reports

4. TREATMENT SCORING (RESULTS)

This chapter summarizes the results of Guidehouse's scoring of each of the seven metrics, as described in Chapter 3. The first section of this chapter provides a scoring summary and highlights Guidehouse's key findings from this analysis. Each subsequent section summarizes the scores of each treatment in each scoring metric and discusses some of the key drivers of scoring results. The results of this scoring provide insights into the lessons that can be learned from the results of each pilot, especially regarding how different types of treatments fare better or worse among the various RPP objectives.

Additional details regarding the scoring of each metric can be found in the relevant section in the ODS.

This chapter is divided into the following eight sections:

1. **Scoring Summary.** A brief summary of how the treatment group scored across the metrics, and the key findings that may be derived from the metric scores.

2. **Cost Recovery.** The results of Guidehouse's assessment of the degree to which individual treatment groups over- or under-collected revenue, compared to the average RPP supply cost.

3. **Cost Reflectiveness.** The results of Guidehouse's comparison of the piloted price treatments against the short-term system costs and the long-term costs of demand.

4. **Cost Minimizing.** The results of Guidehouse's assessment of the benefits and costs of each treatment group, assuming deployment on a provincial scale.

5. **Predictability.** The results of Guidehouse's assessment of the predictability of a treatment's prices within any given price-setting period.

6. **Comprehensibility.** The results of Guidehouse's review of pilot survey data, as well as objective factors indicating the theoretical comprehensibility of the prices based on their design.

7. **Opportunity for Bill Savings.** The results of Guidehouse's review of the bill savings reported in the pilot evaluations.

8. **Ease of Implementation.** The results of Guidehouse's analysis of the technical challenges to LDCs of implementing the piloted treatment groups, specifically billing system and customer care challenges.

4.1 Scoring Summary

As noted in the introduction, Guidehouse's recommendations to the OEB are informed by two workstreams: a careful review of the pilot evaluation reports submitted to the OEB by the proponent LDC's technical consultants, and a comparative analysis of the performance of different treatment groups across seven metrics, metrics that are mostly derived from the RPP objectives. This section provides a summary of some of Guidehouse's key findings, derived from the metric-level analysis.

Table 4-1 lists the scores for each treatment across all metrics. As noted in Section 1.2 and the introduction to Chapter 3, Guidehouse has deliberately avoided aggregating the metric-specific scores into an overall score for each treatment group; to do so would reduce the usefulness of the analysis. This summary is provided only to allow readers a quick reference when reviewing the key findings of the metric evaluation workstream shown below.

Table 4-1. Summary of Scoring for Each Treatment

Treatment Group	Cost Recovery	Long-Term Cost Reflectiveness	Cost Minimizing	Predictability	Comprehensibility	Opportunity for Bill Savings	Ease of Implementation
Alectra Enhanced TOU	4	3	2	4	4	1	5
Alectra Dynamic	2	5	4	1	2	5	1
Alectra Overnight	1	3	1	3	4	5	4
CustomerFirst Enhanced TOU	5	3	1	4	4	2	3
CustomerFirst Seasonal TOU	5	1	1	5	4	1	3
London Hydro CPP and CPP/RT	3	2	5	2	3	4	2
London Hydro RT-Only	**	**	2	4	5	2	4
Oshawa Super-Peak	3	4	3	3	5	3	5
Oshawa Seasonal TOU with CPP	5	4	3	2	3	4	2
Oshawa Information-Only	**	**	1	4	5	1	4

Note: Scores are colour coded from Red (1) to Green (5).
** Not applicable, as these are information only treatments that do not involve a price structure change.
Source: Guidehouse analysis

The key findings of Guidehouse's metric-specific review of the ten different treatment groups are:

- **The current approach to price-setting means that price plans that delivered meaningful opportunities for bill savings tend to perform below average for cost recovery.** The current approach to price-setting is to set prices to be revenue neutral, *assuming no change in behaviour.* This means, by construction, that *any price plan that delivers meaningful bill savings to consumers will also under-recover the average RPP supply cost*. Any such under-recovery should not be concerning until such point as the forecast participant population grows to the point where it results in an implicit (meaningful) subsidy across consumer groups, at which point price-setting should explicitly account for behavioural change.

- **Price plans that are most cost reflective in the short-term tend to be the least cost reflective when considered from a longer-term perspective.** The status quo TOU price plan is most reflective of charged (short-term) costs – the supply costs paid by the electricity system on a monthly basis. In contrast, price plans specifically designed to reduce the need in the future for additional generating capacity (i.e., price plans that include critical peak pricing events) are most reflective of the economically efficient demand-based cost series developed by OEB staff.

- **Price plans that use enabling technology to drive peak demand reductions deliver the greatest system benefits, although such benefits tend to be overwhelmed by implementation costs.** Equipment costs are significant, but so are recruitment, customer care, communications, and IT costs. Even under assumptions of significant economies of scale, initial estimates of full deployment costs are sufficiently high, and the avoided cost of energy consumption sufficiently low, that none of the treatment groups achieve a TRC of more than 1.

- **Price plans that deliver greatest system benefit are also likely to be those that are most difficult to deploy and least predictable for consumers.** The avoided costs used in this analysis heavily favour price plans that target periods of system coincident peak demand (i.e. a CPP price structure). By their very nature, this type of price plan is technically complex for LDCs to deploy, requires considerable incremental customer care, and results in prices that are much less predictable to consumers than a regularly scheduled TOU price plan.

- **No price plan performs well across all metrics.** The RPP objectives around which Guidehouse's metrics are based contain elements that are inherently in tension with one another: any rate that provides participants with the opportunity to achieve meaningful bill savings and under which participants *do* achieve bill savings will fail to recover the average supply cost. It is therefore inevitable that no price plan will perform well across all metrics. This illustrates the point that future price plan designs must carefully consider the trade-offs inherent in the nature of the RPP's objectives.

4.2 Cost Recovery

The RPP Manual[132] identifies the first objective of the RPP as being to set prices to recover the full forecast cost of RPP supply from RPP consumers.

Guidehouse assessed the degree to which each price (and non-price) treatment recovered average RPP supply cost by assessing the revenue adequacy data provided by each of the pilot proponent LDCs against the RPP average supply cost (RPA).

Table 4-2. lists the cost recovery score for each treatment, ranked from best to worst. The scores were determined as described in Section 3.1, based on assessment of the three categories of over- or under-collection: jurisdictional, behavioural, and rate-structural.

The ranking – "5" for the price plan that best recovers revenue, and "1" for the price plan which most over- or under-collects was developed based on a qualitative analysis of the revenue adequacy outputs. This analysis assesses the degree of over- or under-collection as well as the likelihood that – at full deployment – the given participant group would become large enough that the over- or under-collection could lead to material variances between total RPP costs and revenues. Overall, the less likely the given price plan is to lead to over- or under-collection of the RPP as a whole at scale, the higher the rank.

Rank is also affected by the degree to which over- or under-collection is driven by behaviour versus to what degree it is driven by rate-structural aspects. As modified behaviour is the goal of these pilots, rate-structural over- or under-collection is regarded as more detrimental to the quality of the price plan than behavioural over- or under-collection.

Table 4-2. Cost Recovery Results by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
CustomerFirst Seasonal TOU	5	No over- or under-collection. Under pilot prices the average revenue is equal to the RPA.
CustomerFirst Enhanced TOU	5	Virtually no under- or over-collection relative to the RPA. Deviation in revenue collection is likely statistical noise.
Oshawa Seasonal TOU with CPP	5	Virtually no under- or over-collection relative to the RPA. Deviation in revenue collection is likely statistical noise.
Alectra Enhanced TOU	4	Some very small under-collection relative to the RPA. Deviation in revenue collection is likely statistical noise given that no statistically significant impacts were estimated.

[132] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

Treatment Group	Score	Summary of Key Drivers of Score
London Hydro CPP and CPP/RT	3	Rates very slightly under-recover the RPA – less than 3% difference.
Oshawa Super-Peak	3	This rate over-collects by 3.1% due to the structure of the rate itself and the relatively modest behavioural response.
Alectra Dynamic	2	This rate under-collects by 4.1%. It seems likely that this under-collection is due to the substantial estimated participant behaviour changes.
Alectra Overnight	1	On average the rate under-collects RPA by 15%. The combined effect of the increased consumption in the lowest priced periods and the substantial drop in the price of the lowest price periods means that revenues collected by this price plan are much lower than the RPA.
London Hydro RT-Only	**	Participants were subject to status quo TOU rates.
Oshawa Information Only	**	Participants were subject to status quo TOU rates.

** Not applicable, as these are information only treatments that do not involve a price structure change.

Source: Guidehouse analysis of pilot evaluation reports

Four of the price plans almost perfectly recover the RPA (average supply cost for RPP consumers). In three cases this is due principally to the fact that these price plans yielded no statistically significant impact on demand. The Alectra Overnight price plan performs the worst by far, under-collecting average revenue per kWh by approximately 15%. This is due to the fact that pilot prices are set to be revenue neutral, assuming no change in participant behaviour, and it is in the Overnight price plan that behaviour changed the most, with Overnight Off-Peak consumption increasing by nearly 75%. Given the substantial discount offered during this period (less than one-third of the status quo Off-Peak price), and the increase in consumption, it is no surprise that this deviation exists. Overall, Guidehouse does not believe that this under-collection is a significant cause for concern or should be a major impediment to the Overnight price plan being considered for wider implementation.

This is for two reasons. Firstly, so long as the population of eligible participants for the Overnight price plan remains small, under-collection should not result in any meaningful cross-subsidy from other consumers. Secondly, the under-collection is an artefact of the price-setting process which assumes participants make no changes to their behaviour when confronted with the new price. Under-collection in a wider deployment could be significantly reduced by setting prices based on an assumption, drawn from the evaluation report, of behaviour change. This assumption should be periodically updated based on on-going evaluation activities related to any wider deployment of the Overnight price plan.

4.3 Cost Reflectiveness

As noted in Chapter 3, Guidehouse has considered both the short-term and the long-term cost reflectiveness of each of the price plans.

4.3.1 Short-Term Cost Reflectiveness

Table 4-3. lists the short-term cost reflectiveness score for each treatment, ranked from best to worst. The scores were determined as described in Section 3.2.1. Rankings were bucketed into five final relative rankings with a ranking of “5” denoting the most cost-reflective price treatment, and a ranking of “1” denoting the least cost-reflective.

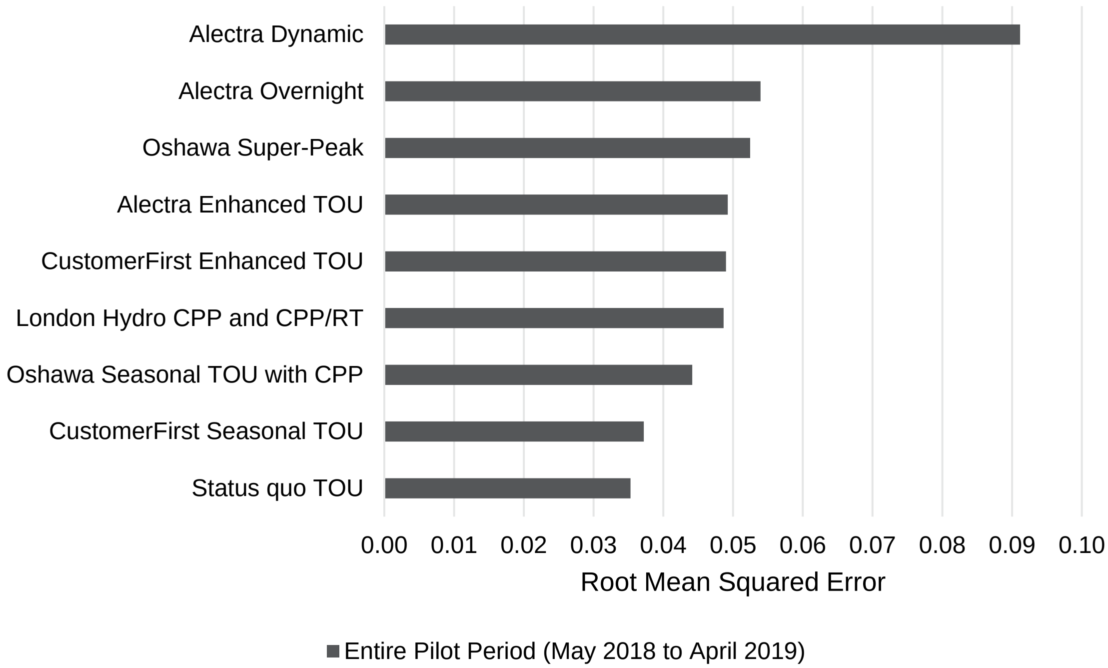
Table 4-3. Short-Term Cost Reflectiveness Scores by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
CustomerFirst Seasonal TOU	5	This rate treatment is the most reflective short-term cost reflective series.
Oshawa Seasonal TOU with CPP	4	This rate treatment is the 2nd most reflective short-term cost-reflective series.
London Hydro CPP and CPP/RT	4	This rate treatment is the 3rd most reflective short-term cost-reflective series.
CustomerFirst Enhanced TOU	3	This rate treatment is the 4th most reflective short-term cost reflective series.
Alectra Enhanced TOU	3	This rate treatment is the 4th most reflective short-term cost-reflective series.
Oshawa Super-Peak	2	This rate treatment is the 6th most reflective short-term cost-reflective series.
Alectra Overnight	2	This rate treatment is the 7th most reflective short-term cost-reflective series.
Alectra Dynamic	1	This rate treatment is the least reflective short-term cost-reflective series.
London Hydro RT-Only	N/A	No price treatment.
Oshawa Information Only	N/A	No price treatment.

Source: Guidehouse analysis of pilot evaluation reports

Figure 4 shows the results of the short-term cost reflectiveness analysis, ranked from lowest (most reflective) to highest (least reflective) RMSE. Recall that the lower the RMSE, which measures the deviation between the vector of prices for the given price plan and the vector of short-term system costs, the more cost-reflective the price plan.

Figure 4 Short-Term Cost Reflectiveness (RMSE) Results by Treatment Group



Source: Guidehouse analysis of pilot evaluation reports

Status quo pricing was more reflective of short-term costs than any other treatment, with an RMSE of 0.035. The existing TOU price plan structure was first developed in 2005 and received a very minor adjustment in 2011.[133] This price plan was designed primarily to reflect short-term costs at a time when the long-term and short-term costs were in much closer alignment. In 2005, the year the status quo price plan structure was finalized, the annual Global Adjustment was *negative* (i.e., a credit), with total system costs being driven by the HOEP. In 2018, in contrast, the total GA was over 900 million dollars per month and market costs (HOEP) accounted for approximately 20% of total system costs. These results are discussed further in comparison with long-term results below.

4.3.2 Long-Term Cost Reflectiveness

Table 4-3. lists the long-term cost reflectiveness score for each treatment, ranked from best to worst. The scores were determined as described in Section 3.2.1. Rankings were bucketed into five final relative rankings with a ranking of “5” denoting the most cost-reflective price treatment, and a ranking of “1” denoting the least cost-reflective.

Table 4-4. Long-Term Cost Reflectiveness Results by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
Alectra Dynamic	5	This rate treatment is the most reflective long-term cost reflective series.
Oshawa Seasonal TOU with CPP	4	This rate treatment is the 2nd most reflective long-term cost reflective series.

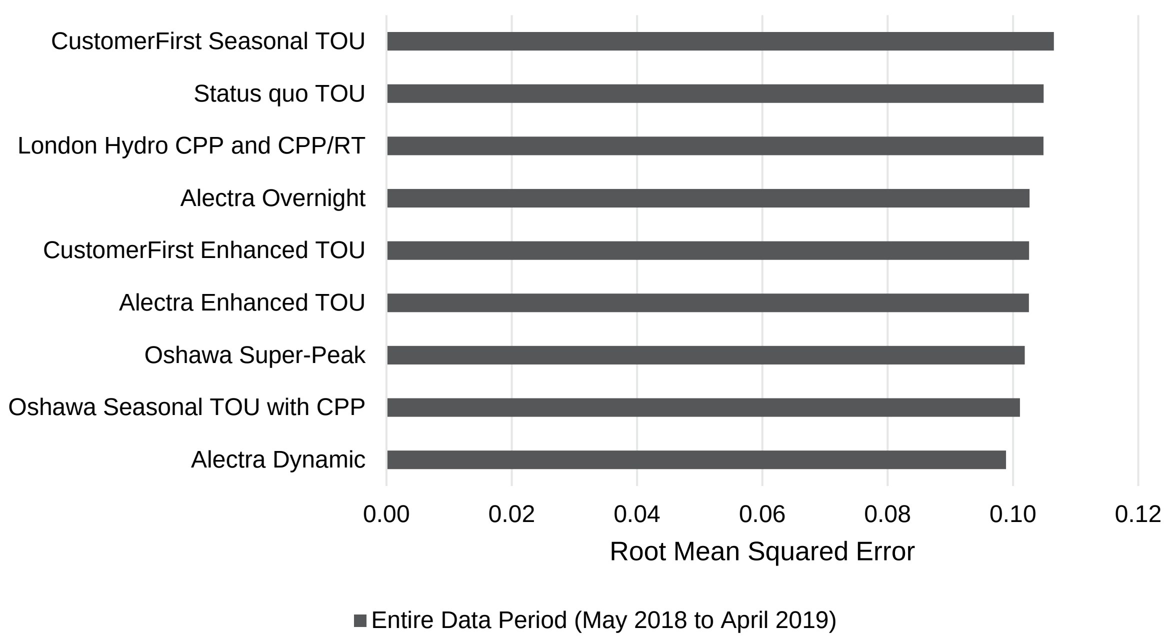
[133] Prior to May 1, 2011, the evening Off-Peak period began at 9pm. On and after that date, the Off-Peak period began (and currently begins) at 7pm.

Oshawa Super-Peak	4	This rate treatment is the 3rd most reflective long-term cost-reflective series.
Alectra Enhanced TOU	3	This rate treatment is the 4th most reflective long-term cost-reflective series. Equivalent to the CustomerFirst Enhanced TOU price structure.
CustomerFirst Enhanced TOU	3	This rate treatment is the 4th most reflective long-term cost reflective series. Equivalent to the Alectra Enhanced TOU price structure.
Alectra Overnight	3	This rate treatment is the 6th most reflective long-term cost-reflective series.
London Hydro CPP and CPP/RT	2	This rate treatment is the 7th most reflective long-term cost-reflective series.
CustomerFirst Seasonal TOU	1	This rate treatment is the least reflective long-term cost-reflective series.
London Hydro RT-Only	N/A	No price treatment.
Oshawa Information Only	N/A	No price treatment.

Source: Guidehouse analysis of pilot evaluation reports

Figure 5 shows the results of the long-term cost reflectiveness analysis, ranked from lowest (most reflective) to highest (least reflective) RMSE.

Figure 5. Long-Term Cost Reflectiveness (RMSE) Results by Treatment Group



Source: Guidehouse analysis of pilot evaluation reports

Contrary to the short-term analysis, the status quo price plan during the pilot period was, compared with the other price plans, *not* as reflective of long-term costs. In general, treatments which were designed to better reflect system conditions (such as those with CPP components) were more reflective of long-term costs. For example, the Oshawa Seasonal TOU with CPP treatment was the most reflective. These results are discussed further in comparison with short-term results in the section below.

4.3.3 Cost Reflectiveness Discussion

Figure 6 and Figure 7 show an example of the comparison of the status quo TOU prices for a characteristic summer week, June 25, 2018 through June 29, 2018. The status quo pricing reflects short-term costs well on weekdays but deviates significantly from long-term costs in the evening, reflecting the manner in which the provincial peak has migrated since the initial design of the TOU price plan.

Figure 6. Comparison of Status Quo Price and Short-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

Figure 7. Comparison of Status Quo Price and Long-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

The results above set the trend for Guidehouse's findings when comparing the other price plans: structures that more closely resemble status quo pricing and include a pricing mechanism that responds to peak demand (e.g. CPP events) were the most long-term cost reflective.

The highest scoring treatment group overall was the Oshawa Seasonal TOU with CPP treatment. Figure 8 and Figure 9 show a comparison of treatment prices to both short-term and long-term costs for June 25 through June 29, 2018. The treatment reflected short-term costs well, like the status quo TOU price plan, but the addition of a CPP event on June 29, 2018 enables the price to better reflect the increase in long-term cost (driven by peak demand) on this day.

Figure 8. Comparison of Oshawa Seasonal Price and Short-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

Figure 9. Comparison of Oshawa Seasonal Price and Long-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

The Alectra Dynamic treatment was very reflective of long-term costs. The design of this price structure was explicitly driven[134] by the need to address *future* system costs. As a result, it reflects short-term costs less well.

[134] Guidehouse (formerly Navigant Consulting, Inc.) on behalf of PowerStream, *Energate-Powerstream Dynamic Pricing Pilot Overview*, June 2014

An example of this is illustrated in Figure 10, which compares prices with short-term costs – prices are less than costs in the first two days of the week, and substantially more than costs later in the week. In contrast, Figure 11 shows just how well the Dynamic price plan reflected the longer-term system costs.

Figure 10. Comparison of Alectra Dynamic Price and Short-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

Figure 11. Comparison of Alectra Dynamic Price and Long-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

Finally, these results demonstrate a phenomenon previously identified in the OEB's RPP Roadmap document: Ontario demand tends to peak as a plateau – not a spike – with the implied result that long-term system costs tend to be highest in sustained periods of a few hours, rather than spiking for only an hour at a time.

Consider the ranking for the London Hydro CPP and CPP/RT treatment group. The price treatment to which this group is subject is (in most hours) virtually identical to status quo pricing. This makes this price treatment one of the most reflective short-term cost-reflective series (see Figure 12 below). The addition of CPP events should lead to better reflectiveness of long-term costs; however, as illustrated in Figure 13, the length of the CPP event on June 29 is only a single hour, and so does not capture the full extent of the increase in long-term costs over the day's peak period.

Figure 12. Comparison of London Hydro CPP/RT Price and Short-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

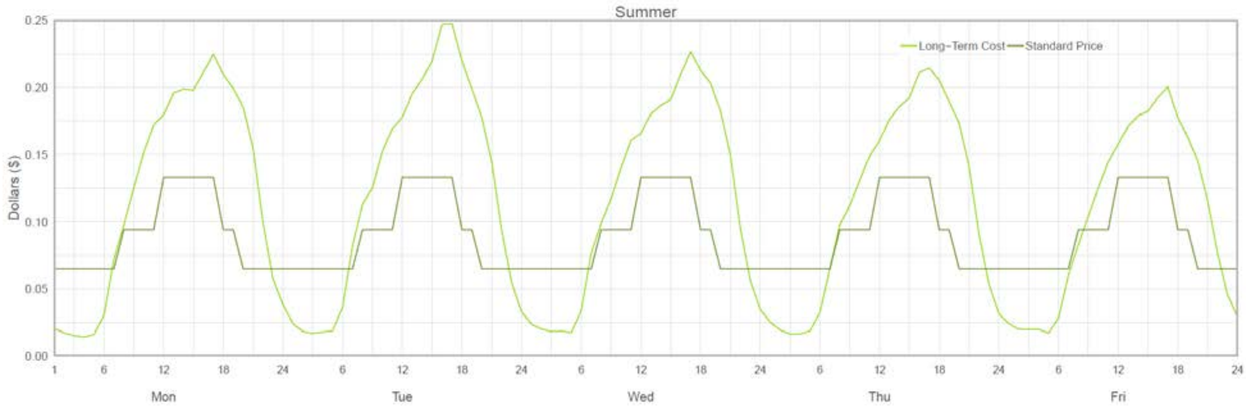
Figure 13. Comparison of London Hydro CPP/RT Price and Long-Term Costs – June 25 through June 29, 2018

Source: Guidehouse analysis

4.3.4 Implications for Design of TOU Price Structure

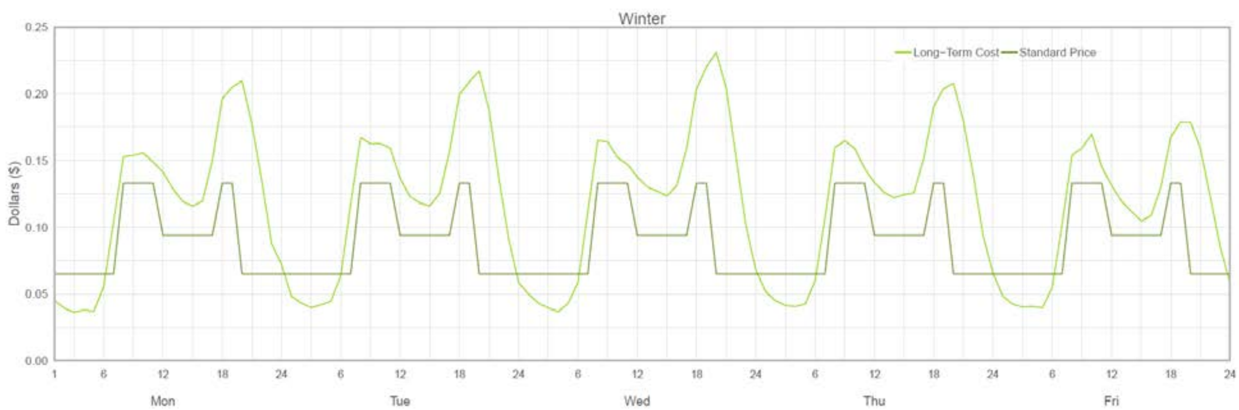
A comparison of hourly prices with the long-term costs provides some guidance regarding design changes that could improve the existing status quo TOU with respect to how well it reflects long-term system costs. Figure 14 and Figure 15 compare hourly average long-term system costs by weekday for summer and winter, respectively. The two key discrepancies between these series are: (1) the actual long-term system peak period extends beyond the end of the status quo On- and Mid-peak periods, which end at 7 p.m.; and (2) the magnitude of peak long-term prices is consistently greater than that of the status quo TOU price.

Figure 14. Comparison of Average Long-Term System Cost and Status Quo TOU Pricing - Summer



Source: Guidehouse analysis

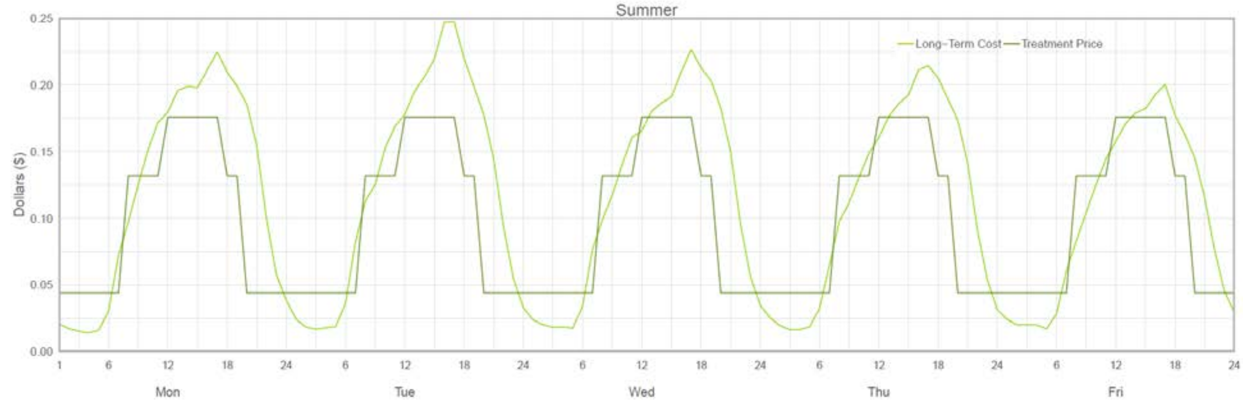
Figure 15. Comparison of Average Long-Term System Cost and Status Quo TOU Pricing – Winter



Source: Guidehouse analysis

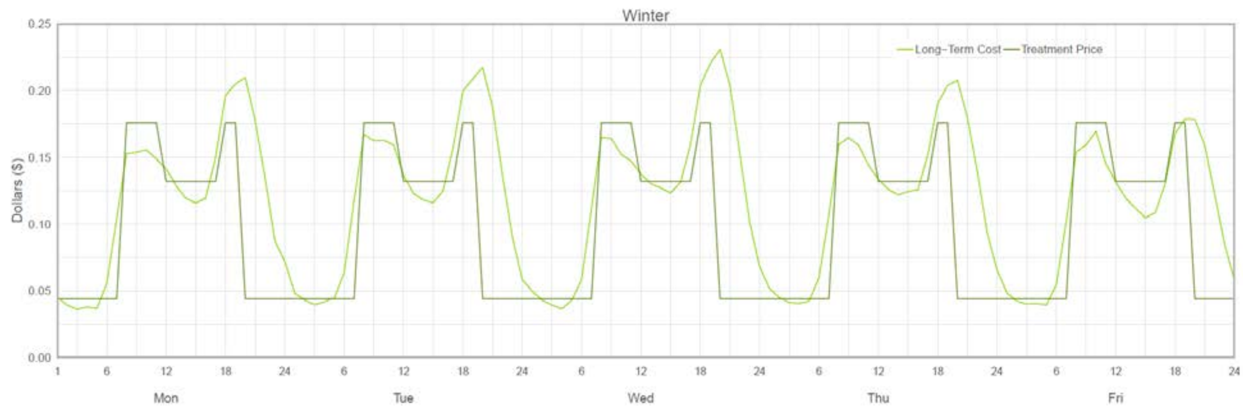
Some pilot treatments better reflected long-term costs with their price structure in terms of the magnitude of their on/off peak price ratios. For example, Figure 16 and Figure 17 compare average hourly long-term system costs for summer and winter for each weekday with the CustomerFirst / Alectra Enhanced TOU price structure treatment. This price plan's prices, though closer to average long-term costs than the status quo TOU price plan, are still too low during peak periods, and too high over night. Additionally, the evening Off-Peak period begins earlier than the long-term cost series would suggest that it should, at 7 p.m.

Figure 16. Comparison of Long-Term System Cost and CustomerFirst/Alectra Enhanced Treatment Price - Summer



Source: Guidehouse analysis

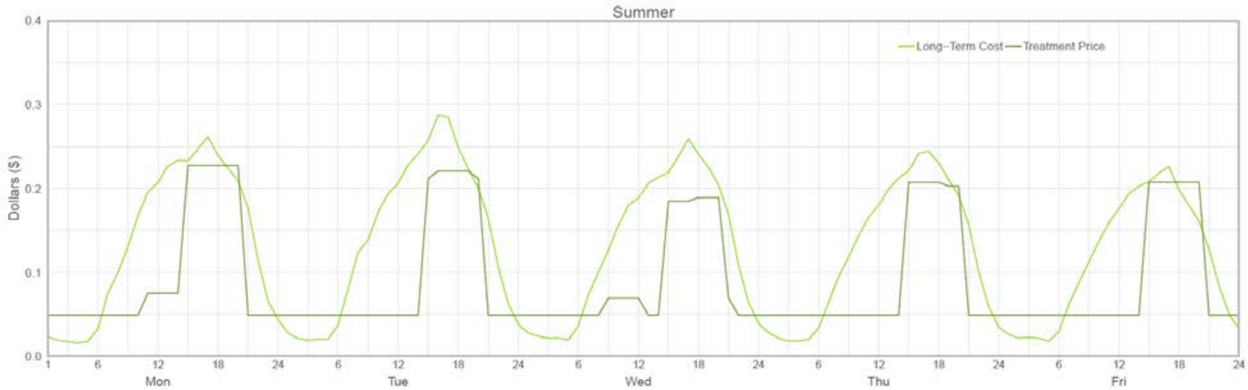
Figure 17. Comparison of Long-Term System Cost and CustomerFirst/Alectra Enhanced Treatment Price - Winter



Source: Guidehouse analysis

Unlike the status quo or Enhanced TOU price plans, the Alectra Dynamic price plan's highest priced periods last until 9 p.m. This is one reason this price plan is the most reflective of long-term system costs. Figure 18 compares the average hourly Dynamic price plan prices with the long-term cost series for May through September by weekday. This result suggests that modifying the status quo Off-Peak period to begin later would improve the long-term cost reflectiveness of that price plan. Guidehouse notes that changing the start time of the Off-Peak period would require a change in regulation, as O. Reg. 95/05 requires that the Off-Peak period begin no later than 7 p.m. on non-holiday weekdays.

Figure 18. Comparison of Long-Term System Costs and Alectra Dynamic Treatment Price – May through September



Source: Guidehouse analysis

Note: Treatment Price shows the average hourly price for the Alectra Dynamic treatment. This includes critical peak pricing events.

This analysis can help inform the evolution of the RPP and the status quo TOU price plan. Specifically, key elements of the structure that could be evolved are: (1) times of day covered by the On- and Mid-Peak periods; and (2) the magnitude of their price ratios relative to Off-Peak prices. Beginning the On-Peak period later in the day and setting a wider differential between On- and Off-Peak prices would make TOU prices more reflective of longer-term costs, as represented by the demand-shaped costs developed by OEB staff. Recommendations for these elements are discussed further in Section 6.1.

4.4 Cost Minimizing

The RPP Manual[135] identifies the third objective of the RPP as being to set a price structure such that it supports efficient investment in the electricity system. Put another way, this objective's goal is to reduce costs ("cost minimizing") to the electricity system and consumers by improving the overall cost-effectiveness of the system.

To assess this metric, Guidehouse estimated the cost-effectiveness of each pilot treatment group. Guidehouse assumed full deployment (i.e., province-wide) of each pilot treatment independently (i.e., no competition or interaction between treatment groups) between November 2021 and October 2035.

Table 4-5. lists the treatment groups from highest to lowest cost minimizing score (i.e., highest to lowest benefit/cost ratio) and the key drivers of the results. For specific detail on treatment group benefits and costs, see the ODS.

[135] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

Table 4-5. Cost Minimizing Scores by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
London Hydro CPP/RT	5	Majority of benefits are for avoided capacity due to CPP events; costly implementation due to high customer engagement and technology costs.
Alectra Dynamic	4	Majority of benefits are for avoided capacity due to CPP events; costly implementation due to billing system upgrades and technology requirements (e.g., thermostats and control systems).
Oshawa Super-Peak	3	Majority of benefits are for avoided capacity. Major costs include app development for the pilot.
Oshawa Seasonal	3	Majority of benefits are for avoided capacity due to CPP events.
London Hydro RT Only	2	Small benefit streams compared to large costs; benefit/cost ratio near zero.
Alectra Enhanced	2	No system benefits in treatment group.
Alectra Overnight	1	Negative avoided energy benefits due to increased overnight consumption that were greater than the avoided capacity benefit.[136]
Oshawa Information Only	1	Negative system benefits due to increased consumption and no avoided capacity benefit.
CustomerFirst Enhanced	1	No statistically significant impacts.
CustomerFirst Seasonal	1	No statistically significant impacts.

Source: Guidehouse analysis of pilot proponent LDC data

One driver of these results is uncertainty regarding how the studied treatments would be deployed at scale. For example, LDCs would be more likely to seek efficiencies in program delivery at scale than in the pilot deployment where an emphasis was placed on customer engagement and robustness of results. Another significant reduction in costs at scale could be a centralized solution for implementation of new price plans, including supporting analytical and customer care tools. Such a solution could be leveraged by all LDCs, obviating the need for each LDC to spend substantial amounts of money on required system upgrades. Moreover, in this analysis, Guidehouse assumed deployment of each treatment individually. At scale, treatments could perhaps be combined, leading to greater impacts and reduced costs.

The parameter of greatest certainty in this cost-effectiveness score is the magnitude of the estimated benefits for each treatment. Avoided cost estimates[137] are the product of on-going research by the IESO, and estimated impacts (that are applied to these costs to deliver the benefits) are all drawn directly from the RPP pilot evaluation reports. To better contextualize the results above, it is helpful to examine a different metric, one that is more intuitive and transparent than the aggregate TRC. Table 4-6. below provides the estimated present value, in 2018 dollars, of system benefits delivered by a single participant

[136] Negative avoided cost benefits are due to the net increase in overall consumption as a result of this price plan. As noted in Section 6.4, the avoided cost benefits of this price plan may be understated due potential (but unverified) shifting of EV charging from day-time charging at public chargers to overnight charging at home, and behavioural fuel switching.

[137] IESO, *Forecast Electricity Avoided Costs*, Provided via Email 2019-09-11
Note that these 2019 avoided costs, developed by the IESO at its 2018 Technical Conference, were the most recently available avoided costs at the time this analysis was conducted. Since that time, the IESO has updated its avoided costs. After reviewing the newer avoided costs, Guidehouse concluded that replacing those used in the analysis with the most updated avoided costs would not change the final ranking of the price plans and so did not update the input values. A discussion of this in more detail may be found in Appendix B. The most important point is that Guidehouse did not use the IESO estimate of avoided capacity cost, but instead used the $130/kW-year ($2018) value used by the OEB, and the vast majority of benefits estimated are due to capacity reductions. This means that changes to avoided energy costs do not have a material impact on the ranking of the price plans for this metric.

enrolled in the given treatment group at the beginning of the period of analysis. This assumes 100% persistence of impacts through 2035.

Table 4-6. System Benefits per Participant Enrolled on Day One

Treatment Group	Total System Benefits per Participant ($)
London Hydro CPP and CPP/RT	$1,145
Alectra Dynamic	$325
Oshawa Seasonal TOU with CPP	$294
Oshawa Super-Peak	$38
London Hydro RT-Only	$1
CustomerFirst Enhanced TOU	$0
CustomerFirst Seasonal TOU	$0
Alectra Enhanced TOU	$0
Alectra Overnight	-$14
Oshawa Information Only	-$56

Source: Guidehouse analysis of pilot proponent LDC data

The London Hydro CPP/RT treatment provided the highest system benefits at $1,145 over the 14-year analysis period. This treatment group requires: an enabling technology – a contractor installed load switch – at an approximate cost of $350 per participant,[138] ongoing app maintenance and data services (~$3/year)[139], in-home support ($~50/year)[140], and on-going customer support (~$25/year). Once LDC-level fixed (one-time and recurring) costs are accounted for, the benefits provided by this treatment group are less than the present value of costs of deploying and maintaining the enabling technologies. As mentioned previously in Section 3.3.2, these cost estimates are based on reported pilot costs and feedback from pilot proponent LDCs.

Except for the Alectra Overnight group, those treatments with zero or negative benefits generally had no significant capacity impacts and either had no significant energy impacts or led to increases in consumption. The Alectra Overnight treatment did show some avoided capacity benefit; however, this treatment also resulted in an offsetting *increase* in overnight consumption. Guidehouse has identified in Section 2.2.3 that participant AMI data (the basis for the pilot evaluations) alone may fail to capture all the benefits being delivered by this treatment group (e.g., EV charge shifting and potentially behavioural fuel-switching).

Overall, only five treatments delivered positive system benefits, the majority of which were principally the result of the high avoided capacity benefits. In particular, the three most cost-effective treatments were those that included CPP events. The total system benefits delivered by these treatments suggest that province-wide deployment would require a substantial reduction in costs (beyond those already assumed by Guidehouse) in order to be cost-effective.

In estimating the cost-effectiveness of treatments if deployed at a province-wide scale, Guidehouse made assumptions about how implementation costs would scale. These assumptions were made through discussions with pilot proponent LDCs who expressed that many efforts made to ensure pilot success

[138]Guidehouse assumed that bulk purchases and procurement would halve the $700 per unit price paid by London Hydro for the pilot.

[139] LDC-provided estimate was $40 per participant per year, scaled down for this analysis to reflect economies of scale.

[140] LDC-provided estimate was $350 per site for the one year of the pilot.

would likely be made more efficient or even eliminated in a province-wide deployment. These assumptions provide a closer estimate of the true costs of deployment at scale.

Actual reported costs provide context and illustrate how costs would need to be reduced to improve the cost effectiveness of each pilot treatment. Table 4-7 provides a summary of the actual reported pilot costs for each pilot. These are the actual input costs provided by the proponent LDCs, adjusted to reflect only those pilot costs applicable to the given treatment. For example: in London Hydro's case, development of the mobile application was reported by London Hydro to cost $800,000. This one-time fixed cost is applied to both the CPP and CPP/RT treatment group and the RT-Only treatment group – i.e., the costs below assume the deployment of the treatment group independent of other treatment groups in the same pilot over which such costs might be shared. An additional $100,000 was reported in fixed year-one costs relate to the load switches deployed for this pilot. These costs are applied only to the CPP and CPP/RT treatment group. This means that a sum of costs by proponent LDC will *not* be equal to the total program costs.

The table includes fixed (per LDC) and variable (per participant) costs for each treatment group. Fixed costs are incurred regardless of the number of participants. These include, for example, overhead costs associated with application development, reporting, and billing systems upgrades, among other costs. Variable costs increase depending on the number of participants, and include costs such as technology installation, ongoing support costs, and incentive payments. In the case of the Oshawa PUC costs, all line-item estimates provided to Guidehouse applied to all treatment groups, so a cost value is only shown for all three together.

Table 4-7. Summary of Actual Reported Pilot Costs† by Treatment Group

Treatment Group**	LDC Cost (Year 1)	Recurring LDC Cost (Annual)	New Participant Cost	Recurring Participant Cost (Annual)
London Hydro CPP and CPP/RT	$900,000	$375,000	$900	$415
London Hydro RT-Only	$800,000	$325,000	$200	$40
Alectra Overnight	$1,100,000	$920,000	$117	$25
Alectra Dynamic	$1,400,000	$920,000	$244	$25
Alectra Enhanced TOU	$1,100,000	$870,000	$25	$25
Oshawa Super-Peak Oshawa Information-Only Oshawa Seasonal TOU with CPP	$2,900,000	$1,900,000	$0	$24
CustomerFirst Enhanced TOU	N/A*	N/A*	N/A*	N/A*
CustomerFirst Seasonal TOU	N/A*	N/A*	N/A*	N/A*

** A value of N/A indicates that cost minimizing was not calculated for the treatment due to a lack of statistically significant impacts.*
Source: Guidehouse analysis of pilot proponent LDC data

*** Each treatment group was analyzed separately from all other treatments, i.e., each treatment was assumed to be implemented individually; therefore certain fixed costs (e.g. app developed) were assumed to apply in full to each treatment, rather than split among treatments that were implemented together.*
† These costs are estimates reported by each respective pilot proponent, rather than final audited costs for each pilot.

The London Hydro CPP and CPP/RT treatment group provides the largest system benefit per participant, as shown in Table 4-6. Significant costs for this treatment group include the procurement and installation of the enabling technologies, including the load switch which is installed by a contractor. As reported by London Hydro, for every new participant enrolled in the program, this cost was $700. In addition, London Hydro reported a cost of $200 per participant in recruitment and incentive costs. In total, the upfront cost for each new participant was $900. This treatment group also required recurring costs for each participant, including: substantial in-home support (reported as $350 per participant per year); app maintenance (reported as $40 per participant per year); and customer support (reported as $25 per participant per year). The largest fixed costs for the treatment group included the development of the application (Trickl) and the integration of the application with internal CIS systems. Overall, while the treatment provided per participant benefits of $1,145 per year, it required substantial investment in hardware, installation, recruitment, and incentives. At scale, implementers must balance efficiency in program design with delivering the greatest impacts.

The Alectra Dynamic treatment group provided the second largest system benefits per participant. The largest fixed cost for this treatment group was reported to be billing systems upgrades and enhancements to advanced metering infrastructure, at approximately $1.1M. New participant costs ($244 / participant-year), similar to the London Hydro treatment, are mostly comprised of the purchasing and installation of enabling technologies – thermostats and meters in this instance.

4.5 Predictability

The RPP Manual[141] identifies the sixth objective of the RPP as being to set prices that are predictable, such that participants know from one day to the next what the price of power will be. Guidehouse assessed each pilot treatment for its predictability. Table 4-8 lists the scores for the predictability metric. Higher scores indicate that the treatment group's price plan is more predictable relative to the other treatments. Treatments received a score of 1 if they were the least predictable of all treatments considered. Guidehouse assessed each pilot treatment for its predictability

Table 4-8. Predictability Scores by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
CustomerFirst Seasonal TOU	5	Treatment involves the least number of price periods in a day, so customers experience fewer price changes over a season. Shoulder months have only a single price.
London Hydro RT-Only	4	Treatment involves price periods and seasonal changes consistent with current customer expectations.
Oshawa Information-Only	4	Treatment involves price periods and seasonal changes consistent with current customer expectations.
CustomerFirst Enhanced TOU	4	Treatment involves price periods and seasonal changes consistent with current customer expectations.
Alectra Enhanced TOU	4	Treatment involves price periods and seasonal changes consistent with current customer expectations.

141 Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

Treatment Group	Score	Summary of Key Drivers of Score
Oshawa Super-Peak	3	Treatment includes a new price period. Seasonal definition changed from status quo.
Alectra Overnight	3	Treatment involves an additional price period in each day, which customers must be aware of.
CustomerFirst Seasonal TOU	2	Treatment includes CPP events, which are inherently dependent on system conditions and less predictable. Events do not occur every day during the season but may occur roughly monthly at least throughout the year.
London Hydro CPP and CPP/RT	2	Treatment includes CPP events, which are inherently dependent on system conditions and less predictable. Events do not occur every day during the season but may occur roughly monthly at least throughout the year.
Alectra Dynamic	1	Treatment includes variable peak pricing, where peak pricing is determined according to system conditions. This treatment is the least predicable, as the prices experienced by customers is determined daily.

Source: Guidehouse analysis of pilot evaluation reports

The drivers of scores for this metric are the complexity of the price signals (and therefore the predictability of price), such as the number of price periods, and the inclusion of critical peak or variable peak pricing events.

The first driver of predictability considered is the number of price periods that a customer experiences in a given day. As the number of periods in a day increase, a consumer must be aware of more timing and pricing information making the price at any given time (all else equal) more difficult to predict. Treatments with fewer period definitions, such as the CustomerFirst Seasonal treatment, provide prices that are very predictable for consumers. There only two price periods (On-Peak and Off-Peak) during non-shoulder months, and only a single flat daily rate during the shoulder months. The CustomerFirst Seasonal TOU treatment group was rated as the most predictable – it does not include CPP or VPP events, has flat pricing for a substantial portion of the year, and only two price periods during the summer and winter months.

Treatments with many periods, such as the Alectra Overnight treatment, which experiences 6 period changes in a 24-hour period, are less predictable. Of note for the Overnight treatment, the shift from ‘Super Off-Peak’ to ‘Off-Peak’ at 6:00 a.m. lasts for only one hour. In this instance, a consumer must be aware of two price shifts within one hour, knowing both the periods and associated prices. Minimizing such frequent price changes is something that should be considered for future price plan designs.

Treatments with low levels of complexity (such as being identical in period definition and pricing to the current pricing structure) include the Oshawa Information-Only and London Hydro RT-Only treatments. These treatments are equally as predictable as pricing that consumers are currently expecting. The Alectra Enhanced TOU and CustomerFirst Enhanced TOU treatments are only marginally less predictable – they include variations to pricing relative to status quo, but neither alter the period definitions nor include other complications such as CPP events or variable peak pricing.

As complexity increases, whether through the modification of period definitions or the inclusion of CPP events, predictability for consumers decreases – the effort required to predict prices in any given period is higher. Treatments that changed both prices and period definitions from status quo (e.g., Alectra Overnight, CustomerFirst Seasonal TOU) also delivered larger impacts in consumption patterns, although the impacts on revenue tended to be quite moderate.

Treatments that included CPP events, the timing of which is dependent on system conditions, received lower scores than treatments that only modified TOU periods. These treatments (e.g., London Hydro CPP/RT, Oshawa Seasonal with CPP) had larger impacts on consumption patterns. The least predictable treatment was the Alectra Dynamic treatment. This treatment is the least predicable relative to treatments without variable peak pricing or CPP events only, due to the increased number of different prices experienced by customers. This treatment had relatively high and varying impacts during the variable peak period compared with other treatments.

4.6 Comprehensibility

The RPP Manual[142] identifies the fifth objective of the RPP as being to apply a price structure that is easily understood – comprehensible – to consumers.

The overall comprehensibility scores were determined by rating each price treatment's performance across three input criteria. The scores of the three criteria were then weighted and aggregated to assign a 1-5 overall comprehensibility score, as described in Section 3.5.

The criteria used in this assessment include:

- Self-reported comprehension
- Number of price periods
- Consistency of price period timing.

These criteria capture the theoretical comprehensibility of the prices based on their design and the consumer revealed comprehension. Most of the pilot treatments were reasonably comprehensible in terms of both design and participants' claimed comprehension. A summary of the relative comprehensibility scores achieved by each treatment group is presented in Table 4-9, below. Table A - 1 in Appendix A shows the comprehensibility results for each treatment group, including a score and description for each criterion.

Table 4-9 Comprehensibility Score by Treatment Group

Treatment Group	Comprehensibility Score
London Hydro RT-Only	5
Oshawa Super Peak	5
Oshawa Information Only	5
Alectra Enhanced TOU	4
CustomerFirst Enhanced TOU	4
CustomerFirst Seasonal TOU	4
Alectra Overnight	4
London Hydro CPP and CPP/RT	3
Oshawa Seasonal TOU with CPP	3

[142] Ontario Energy Board, *Regulated Price Plan Manual*, February 2016 https://www.oeb.ca/oeb/_Documents/EB-2004-0205/RPP_Manual.pdf

Treatment Group	Comprehensibility Score
Alectra Dynamic	2

Source: Guidehouse analysis

As shown in Table 4-9, Oshawa's Super Peak and Information Only and London Hydro's RT-Only treatments received the highest score (5 out of 5), as these plans were assessed to be very comprehensible. Price plans with CPP periods generally scored a 3 due to the unpredictable timing of events compared to other treatments without CPP periods. Alectra's Dynamic price plan scored the lowest relative to other treatments due to the number of price periods and participants that claimed comprehension (64%).

The highest scoring treatments had 70% or more of pilot participants indicate in surveys that they understood the price plan and the timing was predictable and consistent. London Hydro's RT-Only participants claimed to have understood that using less electricity during the day will save more money than reducing the same amount of electricity during the evening or overnight. Oshawa's Super-Peak TOU and Information Only participants claimed to have a good understanding of the difference between flat pricing and time-of-use pricing.

In addition to the scored criteria presented above, Guidehouse reviewed elements of the RPP pilots qualitatively, covering the customer support channels, the visual depictions of the price plans, and the clarity of bills.

Alectra excelled at implementation across all three of these elements: they offered varied customer support channels including a call centre, and touchpoints with emails, and a web portal. The website and brochures used best practices to depict the price plan design linearly, rather than in a "dial" format. The sample bill included a shadow bill, allowing customers to clearly understand how their pilot price plan differed from the status quo TOU. While the logistics of providing the shadow bills were complicated and introduced a delay between energy consumption and billing, these shadow bills can help customers understand the price plan and its impact on their monthly energy costs. An improvement on this design would be to include both new and old prices on the same bill and thus avoid any potential confusion. Alectra has indicated that in any future implementation they would not use a shadow bill but rather would make the required billing system updates such that actual customer bills would provide the necessary information about the new TOU period costs.

London Hydro implemented their program comprehensibly as well: their customer support channels were varied, and the price designs were visually accessible on the pilot guide and in the Trickl App, and the sample bills did show the prices by period.

Oshawa's pilot implementation did offer a few customer support channels, including a help section in the app, an email inbox, and a call centre, however the visual reference of the rates used a "dial" format, and the sample bill was not as easily comprehensible, since the price periods were shown in a table as opposed to a graph.

Finally, CustomerFirst did have some customer support channels, but their call centre was limited, their brochures depicted the price plans in a "dial" format, which is not considered best practice per a report by BEWorks[143], and the sample bill was not clear.

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[143] BEWorks, 2014. *Behavioural Economics Review: Analyzing and Nudging Energy Conservation and Demand Shifting Through Time of Use Compliance*. Prepared for the Ontario Energy Board.

4.7 Opportunity for Bill Savings

Guidehouse assessed two bill savings metrics:

- *Realized* bill savings – average bill savings provided by the evaluation reports completed by the pilot proponent LDCs' technical consultants, and;
- *Potential* bill savings – bill savings potential estimated using an own-price elasticity provided by OEB staff, applied to the differentials between the pilot prices and the status quo TOU prices

Table 4-12. lists the *realized* bill savings score for each treatment from highest to lowest, based on average bill savings as a percentage of total commodity bills reported by the technical consultants in the evaluation reports, and Table 4-14 lists the potential bill savings opportunity score for each treatment from highest to lowest. Metric scoring is determined as described in Section 3.6.

Table 4-10. Realized Bill Savings Score by Treatment Group

Treatment Group	Score
Alectra Overnight	5
Alectra Dynamic	4
London Hydro CPP and CPP/RT	3
Alectra Enhanced	2
London Hydro RT-Only	2
Oshawa Seasonal TOU with CPP	2
CustomerFirst Seasonal TOU	2
Oshawa Super-Peak	1
Oshawa Information-Only	1
CustomerFirst Enhanced TOU	1

Source: Guidehouse analysis of pilot evaluation reports

Table 4-11. Potential Bill Savings Opportunity Score by Treatment Group

Treatment Group	Score
Alectra Overnight	5
Alectra Dynamic	5
Oshawa Super-Peak	4
Oshawa Seasonal TOU with CPP	4
London Hydro CPP and CPP/RT	3
Oshawa Information-Only	2
CustomerFirst Enhanced TOU	2
London Hydro RT-Only	2
Alectra Enhanced	1
CustomerFirst Seasonal TOU	1

Source: Guidehouse analysis

These two scores are combined to determine the final bill savings score, shown in Table 4-12. The key difference between the two metrics is that *realized* savings are based on the estimated impacts derived from observed behaviour, whereas the *potential* bill savings values are based on an assumed participant response (i.e., the assumed own-price elasticity). The final score is calculated as a function of the two scores above: the average of the two scores is taken, these averages are ranked, and then a new score is applied that preserves the order of these averages, but retains the conventions of the rubric (i.e., 5 is "best", no decimals). In some cases this results in a final score that may appear counter-intuitive given the input scores (e.g., LH CPP and CPP/RT receives a "3" for both realized and potential opportunity for bill savings, but has an aggregated score of "4").

This, for example, is why the Oshawa Super-Peak price plan offers the third-highest *potential* for bill savings despite being nearly the worst price plan from the perspective of *realized* bill savings. The evaluation report found that while digitally engaged participants delivered substantial impacts (and thus lowering their bills), the vast majority of participants – the ~80% of participants that were *not* digitally engaged, failed to deliver *any* statistically significant reductions during Super-Peak period – savings realized were small. On the other hand, because the price change was quite large during the Super-Peak period, the own-price elasticity of demand applied in this case delivers a relatively large potential for bill savings.

Table 4-12. Potential for Bill Savings Score by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
Alectra Overnight	5	Highest realized bill savings and second highest potential bill savings.
Alectra Dynamic	5	Second highest realized bills savings and highest potential bill savings
Oshawa Seasonal TOU with CPP	4	High potential bill savings, moderate realized savings.
London Hydro CPP and CPP/RT	4	Moderate realized bill savings and potential bill savings.
Oshawa Super-Peak	3	No realized bill savings, but high potential bill savings.
London Hydro RT-Only	2	No realized bill savings or potential bill savings.
CustomerFirst Enhanced TOU	2	No realized bill savings, but moderate potential bill savings.
Oshawa Information-Only	1	Negative realized bill savings, no potential bill savings.
Alectra Enhanced	1	Minimal realized bill savings; potential increases to consumer bills.
CustomerFirst Seasonal TOU	1	No realized bill savings; potential increases to consumer bills.

Source: Guidehouse analysis of pilot evaluation reports

The Alectra Overnight treatment received one of the highest scores for both potential and realized savings; in addition, the magnitude of potential savings ($5.10 per month) was very close to the realized savings reported by the pilot proponent's technical consultants ($5.60 per month in the summer and $6.9 per month in the winter). The Alectra Dynamic treatment scored well in both categories, having the second largest realized bill savings and highest potential bill savings of the treatments analyzed. Table 4-13 lists the realized and potential bill savings for each treatment group.

Table 4-13. Realized and Potential Bill Savings by Treatment Group (Positive indicates a Bill Reduction)

Treatment Group	Realized Bill Savings ($/mo.)	Potential Bill Savings ($/mo.)
Alectra Dynamic	$1.5	$6.9
Alectra Enhanced	$0.1	-$0.9
Alectra Overnight	$6.3	$5.1
CustomerFirst Enhanced TOU	-$0.1	$0.6
CustomerFirst Seasonal TOU	$0.0	-$4.3
London Hydro CPP and CPP/RT	$1.3	$2.4
London Hydro RT-Only	$0.0	$0.0
Oshawa Information-Only	-$3.2	$0.0
Oshawa Seasonal TOU with CPP	$0.6	$3.2
Oshawa Super-Peak	-$8.7	$3.3

Discrepancies between realized and potential (based on the assumed own-price elasticity of demand) consumer savings are material for the CustomerFirst Seasonal TOU treatment and the Oshawa Super-Peak treatment. The CustomerFirst Seasonal TOU treatment reported no statistically significant impacts, and so no consumer bill impacts (savings or increases) in its evaluation report. The potential bill savings calculated using the own-price elasticity were negative, indicating that the treatment would result in an *increase* to consumers bills. This apparently contradictory result actually reinforces a generally observed phenomenon of changing TOU rates – consumption is generally "*stickier*" in price-reduced periods. For example, participants in the Dynamic treatment group didn't deliver any statistically significant increases in consumption during the Off-Peak period, despite a modest incentive to do so. In this case, despite a material discount during the shoulder season, CustomerFirst participants did not increase their consumption (as the own-price elasticity used for this analysis would predict).

4.8 Ease of Implementation

The ease of implementation metric differs from the other six metrics, all of which are drawn from the six renewed objectives of the RPP. The scoring of this metric is intended to provide an assessment of the (primarily[144]) technical practicality of LDCs implementing the piloted treatment groups on a provincial scale.

Scores for ease of implementation reflect the level of effort/cost required by an LDC to implement the price plan identified. Scores are impacted by the level of complexity of the treatment (number of price changes and period definitions), recruitment efforts, technology requirements and customer engagement efforts – lower scores are indicative of larger disruptions to normal business operations and larger requirements for consumer guidance.

[144] Guidehouse has, in its analysis, noted cases in which a piloted price plan might require a change in regulation (i.e., the O. Reg. 95/05 requirement that the Off-Peak period begin no later than 7pm on non-holiday weekdays), but has not performed an in-depth review of the potential regulatory or legal barriers for implementation.

Table 4-14. Ease of Implementation Scores by Treatment Group

Treatment Group	Score	Summary of Key Drivers of Score
Alectra Enhanced TOU	5	Requires only changes of prices for existing TOU period definitions, equivalent to regular annual RPP price-settings. Opt-out treatment reduces complexity of recruitment; no enabling technology (hardware) required for customers.
Oshawa Super-Peak	5	Treatment requires changes to both prices and period definitions. Opt-out treatment simplifies level of effort required for recruitment; no enabling technology (hardware) required for customers.
Oshawa Information-Only	4	Requires no changes to existing systems, as there are no changes to price. Opt-in treatment requires significant recruitment efforts; no enabling technology (hardware) required for customers.
London Hydro RT-Only	4	Requires no changes to existing systems, as there are no changes to price. Opt-in treatment requires significant recruitment effort; no enabling technology (hardware) required for customers.
Alectra Overnight	4	Treatment requires changes to both prices and period definitions. Some period definitions may require some regulatory updates to ensure compliance. Opt-in treatment requires significant recruitment efforts; no enabling technology (hardware) required for customers.
CustomerFirst Enhanced TOU	3	Treatment requires only changes of prices for existing TOU period definitions, equivalent to changing status quo prices. Opt-in treatment requires significant recruitment efforts; installation/maintenance of enabling technology (hardware) required for customers.
CustomerFirst Seasonal TOU	3	Treatment requires changes to both prices and period definitions. Opt-in treatment requires significant recruitment efforts. installation/maintenance of enabling technology (hardware) required for customers.
Oshawa Seasonal TOU with CPP	2	Treatment requires changes to prices, changes to period definitions, and the implementation of CPP events. Opt-in treatment requires significant recruitment efforts.
London Hydro CPP and CPP/RT	2	Treatment requires changes to prices and the implementation of CPP events. Opt-in treatment requires significant recruitment effort. Installation/maintenance of enabling technology (hardware) required for customers.
Alectra Dynamic	1	Treatment requires changes to prices, changes to period definitions, the implementation of CPP events, and the implementation of variable peak pricing. Enabling technology (hardware) involved for some participants.

Source: Guidehouse analysis of pilot evaluation reports

A treatment group's level of disruption to normal business operations is commensurate with the complexity of the changes to the pricing structure relative to the current status quo. LDC survey respondents reported a wide range in the perceived costs associated with the effort of executing marketing and communications, facilitating internal and external stakeholder change management, and preparing the organization for implementation of a new RPP structure. This wide range in estimated costs is likely a function of the current change management practices and the size of the organizations impacted. Most of the respondents to the LDC Survey emphasized the need for enhanced customer care, better tools, and for the OEB to take into consideration complexity of any price plan chosen to implement.

Treatments that require variations to status quo pricing but do not alter the period definitions (e.g., Alectra Enhanced TOU, CustomerFirst Enhanced TOU), require consumer messaging, but are otherwise relatively simple to implement. Implementation of these treatments is approximately equivalent to the annual update to RPP prices. These treatments also require little disruption to normal business functions. Treatments without price implications (e.g., Oshawa Information-Only and London Hydro RT-Only), do not require any deviation from status quo pricing or period definitions.

Treatments that require changes to status quo pricing *and* the definitions of periods (e.g., Alectra Overnight, Oshawa Super-Peak, CustomerFirst Seasonal) are slightly more difficult to implement. There was a wide range of perceived costs among LDCs for implementing price and TOU period definition changes. Seven out of 22 LDC survey respondents did not believe this would pose significant time or cost challenges (<$100,000 and ~3-6 months). These LDCs expect most of the effort would be undertaken by the IESO in modifying the MDM/R to accommodate the changes. Others reported larger challenges (e.g., >$1,000,000 and > 6 months), associated with efforts such as customer communications, integration of CIS systems with the MDM/R, changes to bill presentation, and process changes to support customer choices of price plans. The obvious uncertainty in these estimates, as well as the value in the upper limit of the range, is indicative of potential challenges to implementation.

Complexity increases further when CPP events are introduced. The London Hydro CPP and CPP/RT, and Oshawa Seasonal TOU with CPP treatments require the inclusion of CPP events and deviations from status quo pricing and/or period definitions. Survey respondents reported substantially increased cost estimates for the price plans with CPP events relative to those without. While several still feel this is a <$100,000 endeavour, this cost is not consistent with Guidehouse's expectations of the level of complexity and required effort. In particular, pilot proponents reported actual costs at the higher end of the range (~1 million), which suggests that these low reported estimates may be too optimistic.

The two largest LDCs that responded to the survey both use market leading CIS platforms (SAP and Oracle) and provided an estimate of the potential cost to be greater than $1,000,000. This cost is in line with Guidehouse's expectations, but prudence would dictate that any implementation activities would include follow-up with these LDCs to obtain a more detailed estimate. The price treatments that include a CPP element received a score of 2, as the level of disruption to normal operations is greater than treatments that do not include peak pricing events.

Finally, the Alectra Dynamic treatment includes both CPP events and variable peak pricing. The daily dynamic nature of this price plan and the incremental, additionally uncertain, layer of CPP pricing make this the most complex price plan to implement, of those reviewed. This treatment includes CPP events, variable peak pricing, and modifications to status quo pricing and period definitions. A high level of disruption to normal business functions is expected. Consumers will likely require significant guidance; billing and other systems may require upgrades; and customer care will require significant incremental effort.

Recruitment efforts can also present another challenge for implementation. For example, opt-in treatments require proponents to invest time and money in recruiting consumers. Opt-in recruitment proved to be a challenge for pilot proponents. As noted in Section 2.2.1, only Oshawa PUC was initially successful in attaining the originally targeted recruitment targets for opt-in pilot treatments. All the other proponent LDCs undertook some remedial action to achieve the recruitment goals – in some cases (e.g., CustomerFirst) failing to meet those goals even after taking remedial action. For example, the Alectra Overnight treatment began recruitment on October 1, 2017. Low uptake resulted in Alectra extending the recruitment period, increasing time spent implementing the pilot.

Opt-out treatments do not present these same recruitment challenges and may be easier to deploy province-wide. In the current analysis, opt-out programs therefore scored higher in terms of ease of implementation. As a result, the treatments that were implemented as opt-in pilots would be easier to implement as an opt-out treatment, and vice versa. For example, the Oshawa Super-Peak treatment scored a 5 because it was implemented as an opt-out program but would score lower if it were an opt-in treatment instead.

Installation and maintenance of enabling technologies, specifically hardware such as load switches or thermostats, affects ease of implementation. Both the CustomerFirst Enhanced TOU treatment and the CustomerFirst Seasonal TOU treatment provided half of its participants with a smart thermostat at the beginning of the pilot. Although thermostats could be self-installed by participants, it is possible that the devices may be incorrectly installed. A province-wide deployment of these treatments would require LDC staff or contractors to install the devices. Similarly, the London Hydro CPP and CPP/RT treatment required the installation of load switches by contractors. Cost could be reduced through self-installation, but program success is reliant on the devices functioning correctly – it seems likely that self-installation would result in a lower operability rate and potentially more service calls than if devices are contractor-installed.

Another factor for consideration is the amount of ongoing customer engagement required throughout the duration of the pilot. Some treatment groups required more engagement with consumers than others – for a province-wide deployment, this could result in a less-easily implemented solution. London Hydro's treatment groups (CPP and CPP/RT, and RT-Only) had extensive engagement with their customers, including hosting breakfast events, focus groups, open houses, and the implementation of a call centre to respond to consumer questions. At provincial scale, this would require significant time and effort. Other treatments required customers to install applications on their mobile devices (such as London Hydro's "Trickl" application or Oshawa PUC's "Peak" application). These applications require engagement with consumers to ensure they have downloaded the application (and any ongoing updates required) and are using the application correctly. Provision of an app could mean that consumers may require training, LDCs may need to engage more customer service representatives (CSRs) to answer consumer questions and LDCs would generally need to increase the level of effort required to implement the treatment group.

Finally, there is the matter of existing regulation. The Ontario Regulation 95/50[145] explicitly specifies that "*…the Board shall set an off-peak period associated with the regulated price […] that begins no later than 7 p.m. on every weekday…"* It appears, therefore, that any price-plan requiring the ability to impose CPP events past 7 p.m. or a variable peak pricing period that lasted past 7 p.m. would require a change in regulation. It is beyond the scope of Guidehouse's analysis to identify the potential costs (in terms of time and effort required by the OEB and other public servants) or timelines associated with such a change in regulation, but these additional complications seem likely to reduce the ease with which the CPP and variable peak price treatments tested as part of this set of pilots could be implemented.

[145] Government of Ontario, *O. Reg. 95/05: Classes of Consumers and Determination of Rates under Ontario Energy Board Act, 1998, S.O. 1998, c. 15, Sched B*, August 21 2020
https://www.ontario.ca/laws/regulation/050095

5. SYNTHESIS OF FINDINGS AND REVIEW OF PILOTED FEATURES

Chapter 5 builds on the review of the findings of the technical consultants that have evaluated the pilot proponents' pilots (Chapter 2) and the analysis of pilot primary and secondary data to rank each treatment group on a relative scale according to a set of seven metrics (Chapter 4).

The purpose of this chapter is to synthesize Guidehouse's key findings across these two analyses for the most important aspects, or features, of each pilot or treatment group. This synthesis provides the analytical building blocks that will be combined in different ways in Chapter 6 to create the final recommendations of this report.

Based on the information presented in the RPP Pilot evaluation reports or Guidehouse's metric analysis, Chapter 5 summarizes the benefits and potential barriers to implementation for each feature and identifies mitigation strategies that could be used to address the potential barriers.

This chapter is divided into four sections:

1. **Price Plans.** This section discusses findings related to the pilot price treatments.
2. **Enabling Information and Technologies.** This section discusses findings related to pilot non-price treatments, including mobile apps, Nudge reports, open houses, and enabling technologies deployed as part of the pilots.
3. **Recruitment.** This section discusses findings related to the differences observed between opt-in and opt-out recruitment.
4. **Summary of Features.** This section presents a tabular summary of the features, their benefits, potential barriers, and strategies to mitigate against the potential barriers.

5.1 Price Plans

This section discusses the price plan features of the RPP pilots, and the benefits of, and potential barriers to, their wider deployment, either as a new default price plan, or as an alternative price plan.

5.1.1 Enhanced TOU

The Enhanced TOU price plan, while not from an objective point of view (see Section 4.6) the most comprehensible of the price plans examined, is the one that is most similar to the status quo TOU that is in force today. A transition from the current TOU price differentials to those of this price plan would incur very few "menu" costs.[146] The change would likely not be significantly more disruptive than any other May or November price-setting.

This price plan is reasonably cost-reflective in the longer-term; more so than the Seasonal TOU, the status quo TOU, the London Hydro CPP and the Alectra Overnight price plans, though not as much as the Dynamic price plan.

[146] In economics, "menu" costs refer to the costs to a firm of changing its prices or offerings. The name derives from the costs to restaurants of having to print new menus when dishes or prices change. Simply changing price differentials without changing the timing of periods would require only minimal updates to messaging, equivalent to the costs of a standard annual RPP price-setting.

Unfortunately, neither of the pilots that applied the Enhanced TOU set of prices to customers, either as opt-in (CustomerFirst) or opt-out (Alectra), delivered any statistically significant savings (see Section 2.2.3), and thus no positive avoided cost benefit (see Section 4.4).

The Enhanced TOU price plan is an improvement over the default TOU in terms of its long-term cost-reflectiveness, cost-reflectiveness that could be further improved by extending the summer/winter afternoon Mid-Peak/On-Peak period to 9pm. This is demonstrated in Section 4.3.4.; as is, in Figure 16 and Figure 17, the notion that cost-reflectiveness might be improved still more by increasing the prices of both On-Peak and Mid-Peak periods in the summer (reducing the differential between them), but increasing only the On-Peak prices in the winter.

As noted in Section 4.8, at present regulation (O. Reg 95/05) requires that the Off-Peak period begin after 7pm. This would need to be changed to implement the adjustment to Enhanced TOU price plan periods (i.e., pushing the start of the Off-Peak period back to 9 p.m.) contemplated above.

5.1.2 Seasonal TOU

The seasonal TOU rate, though the most reflective of *short-term* system costs, is (without the CPP element) the *least* reflective price plan of longer-term system costs. It is very comprehensible: for six months of the year; it imposes a flat price in all hours of the day and days of the week and for the remaining six months it imposes only two TOU periods (see Section 4.6).

Unfortunately, only digitally engaged participants in this price plan appear to have delivered any savings. Neither CustomerFirst nor Oshawa PUC non-digitally engaged participants deliver any statistically significant savings (see Section 2.2.3), and the avoided cost benefits of the energy reduced by the Oshawa PUC participants are very small.[147] In fact, non-digitally engaged Oshawa PUC participants delivered a statistically significant *increase* in consumption during both winter and summer On-Peak periods.

Without offering any real avoided cost or improved cost-reflectiveness benefits, implementing this price plan would not deliver any incremental value to Ontario, particularly after the costs associated with the need to update billing systems to accommodate the change in TOU periods and the need to change regulation[148] to allow a non-Off-Peak price (the Shoulder price) to extend past 7p.m. are taken into account.

5.1.3 Super-Peak TOU

The Super-Peak price plan is the price plan that is third-most reflective of long term system costs (see Section 4.3.2), behind only the Dynamic price plan and the Oshawa Seasonal TOU with CPP price plan.[149] It elicited a strong response from digitally engaged participants, who on average reduced their consumption during the Super-Peak period by nearly 10% and their overall consumption during the summer (June through August) months by nearly 4% (see Section 2.2.3).

These impacts result in this price plan delivering positive avoided cost system benefits, though it did slightly increase participants' bills and did over-collect costs: as per Section 4.2, the average revenue per

[147] Most of the avoided cost benefits of this price plan are derived from the avoided capacity costs delivered by CPP response, a feature included in the Oshawa PUC treatment group subjected to the Seasonal TOU price plan.

[148] Costs associated with a change in regulation include the opportunity cost of public servants being required to prepare and execute this change and its downstream effects, costs incurred by stakeholders that might oppose such a change in regulation, etc. Changing the regulation requires, at minimum, diverting public resources from other tasks and so must be considered a cost in this analysis.

[149] Per the discussion above, the Seasonal TOU with CPP price plan scores well in this metric *because* of the CPP element and *despite* the seasonal TOU element.

kWh for the participant group exceeded the average RPP supply cost by 3%, the second largest deviation between average revenue and average supply cost (in absolute value) of all the pilots.

Significantly, *all* the savings were delivered by the 20% of participants in this opt-out price plan that were digitally engaged. The average Super-Peak reduction amongst non-digitally engaged participants was only 0.42% and was not statistically significant. Attrition (see Section 2.2.1) was high; a third of participants exited the pilot before its completion (though some proportion of these were move-outs). Two thirds (65%) of those that did drop out of the pilot did so before June of 2018 – before the period in which the Super-Peak price came into force. It is possible that in a wider deployment, long-term attrition could be reduced by providing participants with bill protection for their first year – this might allow participants to get past any "sticker shock" from the new Super-Peak price. Even just providing bill protection for the first summer might be sufficient to stem attrition; the Oshawa PUC evaluation report notes that 90% of all those that exited the program did so before October – only 10% of those that exited the program did so in the winter months.

This already reasonably cost-reflective price plan could be made even more so by extending the Super-Peak period to 9pm, though, as noted above this would require a change in regulation.

The Super-Peak price plan is, in effect, a compromise – it targets coincident peak demand (in order to be more cost-reflective in the long term) but with a regularly scheduled price plan (which makes it more predictable to consumers). The motivation for the compromise is the desire to maximize peak demand response, subject to the understanding that a CPP structure is unsuitable as a default (mandatory) TOU price plan. Unfortunately:

- *It is not an appropriate default <u>mandatory</u> price plan.*
    - The price differentials it imposes are relatively extreme. The very high attrition rate (33% see Section 2.2.1) is a reasonable measure of the discontent it provoked from consumers.
    - A full year of price protection, while a generally a good long-term policy for enabling recruitment or retention in an alternative (even opt-out alternative) price plan, may be impractical for application to the entire population of RPP consumers.
    - The system benefit trade-off for the discontent is relatively minor. The average Super-Peak period reduction in demand across all pilot plan participants was only approximately 2% (all this deriving from the digitally engaged 20% of the sample).
    - In the context of a default (mandatory) plan from which participants cannot opt out, these savings are likely overstated. Some assumption is needed regarding how much the 33% of drop-out participants *would* have saved had they had no choice but to remain in the program. It is reasonable to suppose that this group might have pulled that average impact down.
- *As an alternative price plan, it delivers less value to the electricity system and society as a whole than price plans with four-hour CPP events.*
    - The CPP elements of all pilots that tested critical peak pricing delivered higher peak demand reductions (and thus more avoided capacity cost benefits) than the Super-Peak price.[150]

[150] It may be regarded as unfair to compare the impacts of an opt-in (Oshawa PUC's Seasonal TOU with CPP) price plan with an opt-out (Oshawa PUC's Super-Peak) price plan in this way. This argument, however, simply reinforces the point that many – most – RPP consumers may not have the flexibility to respond to system needs in the very short term. Recruitment – whether it is opt-in or opt-out – should focus on consumers that may be identified as being already highly engaged, or more susceptible to being highly engaged.Guidehouse's finding in section 5.3 provides some guidance as to how this might be accomplished.

- The price plans with CPP events that lasted four hours were all more cost-reflective in the long-term than the Super-Peak price plan.
- The CPP price plans did not over-recover revenues (and result in higher average consumer bills) to the same degree as the Super-Peak price plan.

- It is not *currently* an appropriate default opt-out price plan, however:
    - As of November 1, 2020[151], RPP consumers have the right to opt out of the default TOU price plan and opt into a Tiered price plan
    - There will likely be an initial wave of attrition from TOU as those consumers with the least flexibility to respond to intra-day price variation exit the TOU price plan in favour of the Tiered price plan.
    - This initial attrition will leave a smaller RPP consumer population enrolled in the TOU price plan, but a population that is generally more flexible, responsive and engaged.
    - This new population – self-selected via opt-out to be more positively disposed to time-differentiated rates – will be more receptive to a more long-term cost-reflective price plan.
    - Therefore, once attrition rates from the existing default TOU price plan have stabilized, the OEB may wish to consider adopting certain aspects of the Super-Peak price plan for default TOU, specifically price ratios and seasonal price patterns that are more reflective of the long-term cost of electricity.

5.1.4 Overnight

Of all the price plans tested in the RPP pilots, the Overnight price plan provides the most dramatic example of a behavioural change in consumption. Participants in this price plan increased their demand in the Overnight Off-Peak period by 45% in the summer and 73% in the winter months (see Section 2.2.3). This was accompanied by substantial increases in the abutting "standard" Off-Peak hours – demand increased in these hours by 16% in the winter months and 5% in the summer hours.[152]

Though participants appeared to have engaged in some load shifting in the summer months (9.6% and 8.1% reduction in On-Peak and Mid-Peak, respectively), this is not the case in the winter months (no statistically significant change in On-Peak or Mid-Peak consumption).

As noted in Section 2.2.3, Guidehouse has developed two hypotheses for these effects.

The first is that consumers that had previously been charging their electric vehicles at public stations during the day are now charging them at home during the night. If this is the case, then an analysis only of participant AMI and billing data will understate system benefits by not quantifying the demand reductions during system peak (i.e., the day-time EV charging at public sites that has been shifted to overnight at the participant's home).

The second is that participants may be practicing some form of behavioural fuel-switching and displacing some natural gas use with auxiliary electric heat. This is supported by the asymmetrical impacts in summer and winter (in particular the "standard" Off-Peak period increases in demand noted above). As with the EV charging hypothesis above, an analysis which does not account for changes in gas

[151] Government of Ontario, *News Release: Ontario Supports Those Struggling with Electricity Bills during COVID-19,* June 2020 https://news.ontario.ca/en/release/57075/ontario-supports-those-struggling-with-electricity-bills-during-covid-19

[152] Unfortunately, the granularity of the analysis presented in the final evaluation report means thatGuidehouse cannot assess to what degree these "standard" Off-Peak period impacts were in the hours abutting the Overnight Off-Peak and what proportion were in the weekend hours. Impacts in that report are presented only by TOU period, and load shapes are not provided.

consumption may be understating the societal benefits of this price plan by ignoring the potentially material decarbonization of home heating it could be incenting.

Unfortunately, this analysis of impacts on other fuels and out-of-home electricity use was beyond the scope of Alectra's evaluation, so these hypotheses cannot be tested within the context of this work, though Guidehouse has made some recommendations regarding how the results of this evaluation may be built upon to test these hypotheses in the future.

As noted in Section 4.2, this price plan fares the worst in terms of cost recovery. Of all the price plans, the Overnight plan's revenues deviated the most from the average supply cost – it under-collected on the average supply cost by 5%. This is an important consideration for any future deployment but is an inevitable outcome when participants respond to price signals. Participants responded to the price signals presented to them in the manner that economic theory suggests: they increased consumption of lower priced electricity (Overnight Off-Peak) and decreased consumption of higher priced electricity (On-Peak and Mid-Peak), thus reducing the average revenue per kWh for this group below the RPA, or average supply cost.

Of more concern are the issues of cost-reflectiveness (see Section 4.3) and recruitment (see Section 2.2.1).

Recruitment for this price plan was a significant challenge, with only 64% of the target acquired within the initially approved period, and a one-month extension required to attain the incremental 24% of the target (total recruitment reached 88% of the target). The evaluation plan for this price plan identifies the key demographics for recruitment as EV owners, shift workers and "*those who would benefit from low overnight rates*".[153]

EV owners make up only a very small percentage of the overall population of Ontario electricity consumers. The 2019 IESO residential end-use survey (REUS)[154] indicates that 2.4% of single-family home residential households own or lease an EV, significantly limiting the available price plan population. Recruitment might be more successful if marketed as a "green" price plan – providing consumers with an opportunity to reduce their carbon footprint by transitioning some of their home heating away from carbon-emitting gas to clean overnight baseload electricity generation. It is also likely that, as EV ownership rates continue to rise, recruitment for an opt-in targeted price plan for EVs would become easier.

The Overnight price plan is one of the least cost-reflective price plans in the long-term, when assessed against hourly cost allocation used in this analysis. Though an improvement on the status quo TOU price plan, it is less reflective of hourly long-term costs than the Enhanced TOU price plan. As noted in Section 4.3 this appears to be largely driven by the winter Overnight Off-Peak price. Though that price period is reasonably cost-reflective in the summer months (it is the fifth-most cost-reflective price plan in the period of May through September, see Figure 5), it is materially lower than the hourly long-term cost of power in that period of the day in the winter months.

A determination of the true value in offering consumers a price plan that incents the decarbonization of home heating and transportation is impossible without assessing the value (or lack thereof) of the external benefits (reduced daytime charging at public stations, reduced natural gas use overnight, etc.) of this price plan. Guidehouse's recommendations (Section 6.4) regarding this price plan identify two approaches to better quantifying these external benefits.

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[153] BEWorks, prepared for the Ontario Energy Board on behalf of Alectra Utilities, *Regulated Price Plan Pilot Project Evaluation Measurement & Verification Plan*, June 2018

[154] Cadmus, prepared for the Independent Electricity System Operator, *Ontario Residential End-Use Survey: Final Report*, November 2018
http://www.ieso.ca/homeenergysurvey

5.1.5 Quick-Ramp CPP

London Hydro's CPP events were quick-ramp CPP events. As described in Section 2.1, participants received only 15 minutes' notice of events, which only lasted a single hour. Participants were provided with load switches (discussed in 5.2, below) to automate response, but for approximately 20% of participants on any given event, these devices were not connected[155] and response was entirely behavioural.

The average response from disconnected participants (assumed to be purely behavioural) during summer events was 0.3 kW, only slightly less than the average impact of the mix of technology-enabled and behavioural response delivered by Alectra's Dynamic CPP events (0.35 kW, 17% of baseline), and more than one and a half times more than the behavioural response delivered by Oshawa PUC's Seasonal TOU with CPP price plan's CPP events (0.19 kW, or 10.5% of baseline). Summer behavioural event response was accompanied by a statistically significant reduction of 5% during the summer On-Peak period, but no statistically significant conservation impact overall (i.e., annual savings were not statistically significant).

These strong impacts, accompanied by the impacts of the enabling technology, resulted in this price plan delivering the most avoided cost benefit of those examined (see Section 4.4). However, the very short CPP period means layered on top of the status quo TOU periods and prices[156], as shown in Section 3.2, that overall this price plan was one of the least reflective of long-run costs.

Lengthening the CPP events for this price plan could considerably improve its cost-reflectiveness, although it might also erode the behavioural DR impacts. Most modern homes have a sufficiently tight thermal envelope to allow (for example) residents to completely shut down their central air-conditioner for an hour without experiencing much discomfort, even on very hot days. Over four hours, however, indoor temperature increases might become sufficiently uncomfortable to reduce behavioural response. Determining the optimal length of CPP events is a balance between considerations of the shape (and length) of system peak, the expected size of the participant population (and the potential impacts of snapback), and the tolerance of consumers to curtailment (whether total or cycling). These are all aspects that should be considered by the OEB in any future rate design work undertaken to specify a CPP-related price plan.

5.1.6 Standard CPP

Oshawa PUC's Seasonal TOU with CPP price plan delivered approximately 0.193 kW of behavioural DR per event (approximately 10.5% of baseline demand). Alectra's Dynamic price plan participants delivered an average of 0.35 kW (17% of baseline) across critical peak events in the summer of 2018 and approximately the same in the summer of 2019, much of this behavioural. Approximately 21% (160 out of 770) of participants had registered a communicating thermostat with Alectra that allowed Alectra to directly curtail A/C during critical peak events, though the incremental impact of this control remains uncertain.[157] The persistence of the impacts across years suggests that critical peak pricing demand response should persist so long as the price signal also persists.

[155] Load switches were connected to London Hydro's curtailment signaling system via the customer's WiFi network.

[156] Though the Off-Peak is slightly discounted, Mid-Peak and On-Peak prices for the London Hydro CPP price treatment are identical to the status quo TOU On-Peak and Mid-Peak prices.

[157] Although the technical consultant reports no statistically significant incremental impact from this automatic control, it is Guidehouse's belief this result is an artefact of the approach used by the technical consultant, which is highly susceptible to selection and omitted variable bias. Guidehouse believes it highly likely that automatic curtailment *does* provide substantial incremental demand response, the magnitude of which (in this case) unfortunately remains highly uncertain. Please see Section 2.2.4 for a more in-depth discussion.

As demonstrated in Section 4.3, the longer CPP events deployed by both price plans were highly reflective of long-term system costs – both the Alectra Dynamic and Seasonal TOU with CPP price plans were the most cost-reflective all price plans examined.

These price plans also delivered the second- and third-highest avoided cost capacity benefit of the price plans reviewed (see Section 4.4), but are unfortunately amongst the least comprehensible (Section 4.6) or predictable (Section 4.5) to consumers. Furthermore, like Quick-Ramp CPP (the London Hydro CPP and CPP/RT group) the costs of implementation are likely to be quite significant, particularly the costs of upgrading billing systems to accommodate the irregularly scheduled price intervals.

The benefits of this type of price plan can be maximized by pairing its deployment with technology that automates response (see Section 5.2, below) and recruitment costs and difficulties minimized by targeting highly engaged consumers, potentially using information delivered through consumer usage patterns of mobile apps (see Section 5.2, below).

5.1.7 Variable Peak Pricing

The Dynamic price plan is the most long-run cost-reflective price plan of those piloted. This is particularly evident when examining only the summer months (see Section 4.3.2), and is due to three components: the dynamic nature of the day-to-day pricing, the deployment of CPP events on system peak days, and the fact that the Off-Peak period begins at 9pm rather than, as in all other price plans, at 7pm.

The Dynamic price plan delivers the second-highest avoided cost benefit of any of the price plans (Section 4.4), but does so principally because of the CPP element, which delivers significant avoided capacity cost benefits. The avoided energy cost benefits of the variable peak pricing element are quite modest, in large part due to the avoided costs for energy being so much smaller than those of capacity. For reference, the avoided cost of energy in the summer On-Peak period for 2020 is $24/MWh (2018$), whereas the avoided cost capacity benefit being used for this analysis is $130,000 /MW-year (see Section 3.3).

Variable peak pricing is much more effective at delivering system benefits when the gap between short-term and long-term avoided cost (i.e., energy vs capacity) benefits is smaller, as is the case in Oklahoma, where the Smart Hours variable peak pricing program (the model for Alectra's Dynamic price plan) has been such a success. The steady decline in Ontario's forecast avoided energy costs[158] over time has systematically eroded the value of this type of price plan.

Unfortunately, this price plan is also the most complex (and thus least comprehensible, see Section 4.6), the least predictable (see Section 4.5), and the most difficult to implement (Section 4.8). Daily changes in prices are difficult to predict and react to. They present an additional layer of complexity (and thus expense) that any billing system upgrade would be required to accommodate. In addition to this, a change in regulation would be required to extend any non-Off-Peak period to 9pm.

Finally, this pricing element showed a concerning lack of persistence from the summer of 2018, when the average impact on High priced days was 0.26 kW (13% of baseline), to the summer of 2019, when the average impact on High priced days was only approximately 0.135 kW or ~8% of baseline. The evaluation of this pilot does not include any average temperatures associated with the event impacts so it

[158] In 2010, the Ontario Power Authority's estimate of the 2020 avoided cost for summer On-Peak energy was $92 in 2018 dollars. This is over three times the estimated avoided cost value of energy in that same period today (see text above). The structure of the Dynamic price plan was developed by Alectra (then PowerStream) in consultation with the IESO, OEB, and Ministry of Energy in 2014, when the projected benefit of consumer response to a variable peak pricing plan was much larger than it appears at present. Ontario Power Authority, *Integrated Power System Plan*, Revised Table 3, D-4-1 Attachment 3, contained in GEC IR 28 (I-22-28, p.3).

is impossible to determine whether this may simply be due to High priced days being milder in 2019 than in 2018, or whether it is a result of participants changing their behaviour over time.

The variable peak pricing element of the Dynamic price plan is not appropriate as a default price plan, and, due to changes in the value of the avoided costs of energy over time, no longer likely, as an alternative price plan, to deliver system or societal benefits that justify the costs associated with its complexity.

5.2 Enabling Information and Technologies

This section discusses the enabling informational and technological features of the RPP pilots, and the benefits of, and potential barriers to, their wider deployment, as non-price tools to support RPP price plans.

5.2.1 Mobile Informational Applications

London Hydro and Oshawa PUC both deployed mobile applications as part of their pilots, the Trickl and the Peak apps, respectively. London Hydro's evaluation reported small and uncertain On-Peak summer savings delivered by the users of the Trickl app (see Section 2.2.5). Oshawa PUC's evaluation report indicated that digitally engaged participants (those that used the app) *increased* their consumption in nearly all periods under the status quo TOU price plan (i.e., the Information Only treatment group). In contrast, the digitally engaged participants that were exposed to alternative price plans (Seasonal TOU with CPP and Super-Peak) tended to deliver conservation impacts (see Section 2.2.3).

Guidehouse's conclusion from this analysis was that the differences in savings estimated between digitally engaged and non-digitally engaged Oshawa PUC participants are due in large part to selection issues. That is, it is not so much that the app is influencing behaviour (although this cannot be ruled out), but that it *reveals* those participants that are most likely to adapt their behaviour to the price plan to which they are subject.

This suggests that the informational value of app usage data to program administrators may be considerable. If program administrators can use app usage data to identify highly engaged consumers, they can better target program or price plan offerings to those consumers. The potential exists to leverage such information to substantially lower the acquisition cost of participants for conservation and demand response programs, as well as alternative RPP price plans. Oshawa PUC tested just this functionality by using the platform to promote its Affordability Fund Campaign.[159]

The data collection elements of the app can also be used to supplement and support on-going data gathering exercises by provincial agencies to support program development. For example, judicious use of self-reported app profile data could be used to supplement aspects of the IESO's Residential End Use Survey (REUS). Additional value to the consumer and the LDC is the ability of an LDC-branded application to provide consumers with a trustworthy and secure communications channel with their LDC and thus avoid problems of fraudulent "phishing" emails and phone calls.

Unfortunately, these are all indirect value streams, and cannot easily be quantified in the same way, for example, that the societal benefits of replacing incandescent with LED bulbs can. Apps are ultimately a communication and engagement tool, and they should be evaluated based on the engagement they provoke. The fact that 20% of the randomly selected opt-out Super-Peak participants engaged with the app seems to point to the fact that a wider deployment could reach a significant minority of the RPP population.

[159] The evaluation report does not indicate what, if any, impact this promotion had on participant uptake of that program.

Against these benefits it should be noted that the Oshawa PUC analysis found that app engagement, when combined with the status quo TOU rate, led to increases in consumption – a negative avoided cost benefit. This effect would need to be carefully considered in any further deployment.

Finally, it is noteworthy that one finding of Alectra's RPP pilot focus groups was that consumers "*expect"* to be able to have access to an app dedicated to their electricity use. There now exist apps for public transit, banking, and tracking recycling and garbage pickup among others. As appliances and homes become increasingly virtually connected, the absence of apps for home energy use is becoming an increasingly obvious missing link in Ontario's overall demand side management strategy.

5.2.2 Nudge Reports

Nudge reports were found to deliver modest savings during the summer On-Peak and the winter On-Peak and Mid-Peak periods. Overall conservation savings are not statistically significant and estimated TOU period impacts highest in the most expensive TOU periods, with estimated reductions during the summer On-Peak period of 1.1%, the winter On-Peak of 0.83%, and the winter Mid-Peak of 1.6%.

For context, it should be noted that the IESO's 2018 evaluation[160] of social benchmarking programs administered by five different LDCs estimated an aggregate TRC of 0.71, based on an average savings value of approximately 1.3% (calculated by Guidehouse assuming an average residential annual consumption of 10,000 kWh per year).[161] Given the estimated savings of the Nudge reports in Alectra's pilot, and the current very low level of Ontario's avoided costs of electric energy (lower than in 2018), it is unlikely that this treatment, applied only to electricity, would be cost-effective in its own right, from a societal point of view.

Guidehouse would not recommend a wider deployment of Nudge reports, unless it could be demonstrated that such a wider deployment would be likely to deliver savings more in line with the average values typically observed for home energy reports (e.g., 2% or more annual conservation).

5.2.3 Open Houses (In-Person Technical Support)

London Hydro, as part of its overall pilot engagement strategy, conducted six weeks of "Open House" events. These events were akin to "office hours" – participants were encouraged to make unscheduled in-person visits to consult with London Hydro staff about any issues they were having with the pilot. London Hydro's evaluation report indicates that attendance to an open-house was strongly (and statistically significantly) correlated with higher summer On-Peak energy impacts on non-CPP event days.

Approximately a quarter of those that attended did so at least in part to resolve some relatively basic technical issue – for example, learning how to download and access the Trickl app, how to log in to London Hydro's web portal, etc. While basic, these entry-level issues, had they been unresolved, may

[160] See Table 17 and Table 18 of

Cadmus, Econoler, and Apex Analytics, prepared for the Independent Electricity System Operator, *Evaluation of 2018 Residential Programs*, September 2019

http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2018/2018-Residential-Programs-Evaluation-Report.pdf?la=en

[161] It should be noted that this average value estimated by the IESO includes impacts from very different sets of home energy report programs, although the TRC is reported only in aggregate. The IESO's 2017 evaluation of social benchmarking programs, for example estimated TRC values of 4.75 and 4.17 for Alectra and Hydro One's home energy programs, but a TRC of only 0.29 for Hydro Ottawa's.

Cadmus, prepared for the Independent Electricity System Operator, *Social Benchmarking Local Program Evaluation,* November 2018

http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2017/2017-Social-Benchmarking-Evaluation-Report.pdf?la=en have prevented those participants from using those tools and potentially from exercising any price plan response at all.

Further, approximately half of those that attended the open houses did so to resolve connectivity issues with their CPP price plan enabling technology. The effect of this is evident in the disconnection rate for this group – the evaluation reports that it is approximately half of the entire program population.

In-person technical support is a valuable tool for improving accessibility to price plans and programs. Consumers for whom English is not a first language, or that are uncomfortable with computer and touch-screen technology, may find telephone interactions intimidating, frustrating, or unhelpful.[162]

Such in-person availability is costly, however, and the direct and indirect benefits are difficult to quantify. Only 4% of London Hydro's RT-Only treatment group and 7% of its CPP and CPP/RT treatment group attended these sessions.

The cost-effectiveness of such events could likely be improved both by adjusting the frequency of such events in response to attendance and to call centre activity, as well as by rotating the location of sessions through accessible public locations (such as malls, markets, and civic events) and promoting attendance to LDC customers.

5.2.4 Demand Response Enabling Technology

Four types of demand response enabling technology were employed in two of the RPP pilots. London Hydro provided all participants in its CPP price plan with a smart plug and panel-mounted load switch, both controlled via the home's WiFi connection. Alectra provided some participants of its Dynamic price plan with Energate Foundation thermostats that automatically adjust their set-points in response to price signals from the LDC, according to pre-set preferences selected by the participant. Alectra also encouraged participants already equipped with a smart thermostat[163] to register their device online, allowing Alectra to control it automatically during CPP events.

The incremental impact delivered by registered thermostats owned by participants in Alectra's Dynamic price plan is highly uncertain. As described in detail in Section 2.2.4 the approach used by the technical consultant to evaluate the incremental impact of the control technology appears to be subject to selection and omitted variable bias. Though the estimated incremental impact of the technology presented is not statistically significant in the summer months, Guidehouse believes, and has presented strong evidence in Section 2.2.4, as to why this finding almost certainly understates the impact being delivered by the control technology. Based on the findings of other evaluations of similar programs (e.g., OG&E's Smart Hours program, and the summer 2016 evaluation of the Legacy Dynamic treatment group) it seems probable that participants subject to direct load control contribute one and a half to three times the demand response of those participants not subject to direct load control.

The average incremental summer CPP impact delivered by London Hydro's connected participants (those whose technology was working) was nearly 0.4 kW higher (2.25 times) than that of the behavioural impacts alone. As noted in Section 2.2.4, a 2016 evaluation of the Legacy Dynamic treatment group found that the critical peak price event impacts of participants equipped with thermostats that automatically curtailed A/C use were nearly, or more than (depending on the thermostat type), triple the impacts of those participants without such technology. Likewise, the 2017 evaluation of OG&E's Smart Hours program (upon which the Dynamic price plan's design is based) revealed that those participants

[162] The validity of this claim should be self-evident to any reader that has ever needed to resolve a technical issue via a phone call.

[163] These included EcoBee and Nest thermostats. Honeywell devices were eligible, but not registered by any Dynamic price plan participant. All types of thermostat, when registered, automatically curtailed the owner's A/C use during critical peak events. The Energate device does this by adjusting the thermostat set-point. The Ecobee and Nest both use cycling – not allowing the A/C compressor to run during some percentage of the time an event is taking place.

equipped with the program-supplied Energate thermostat (i.e., those directly curtailed during critical peak events) delivered more than three times the impact of those participants without such technology. Direct load control of A/C is a long-established and very reliable way to procure demand response. Pairing a critical peak price with such technology is an efficient way to obtain incremental behavioural demand response and to enhance participant uptake.

In addition to significantly increasing the societal benefit (via avoided capacity costs, see Section 4.4) of the price plan, these enabling technologies support recruitment and retention by significantly improving the likelihood that participants will realize bill savings and by reducing the need for major behavioural actions by the participant in order to do so.

Unfortunately, the procurement, deployment and maintenance of enabling technology is costly. As demonstrated in Section 4.4, even after assuming considerable reductions in unit cost due to economies of scale and improvements in process as a result of lessons learned in the pilot, neither price plan appears to be cost-effective, though this may well be the result of the elevated nature of pilot costs. London Hydro estimated an average cost of $700 per home for installation of the load switches, as well as an average cost of $350 per participant for in-home electrician visit for maintenance.[164]. Alectra estimated that it spent approximately $600,000 on thermostats and thermostat incentives across all treatment groups. Note that these costs are based on LDC estimates from their own internal budgets.

Considerable cost reductions could be achieved in wider deployment by relying on technology already in place. Alectra's Dynamic treatment group appears to have demonstrated an approach to successfully deliver technology-enabled CPP without costly technology deployment: using customers' existing and already installed smart thermostats to automatically control loads. A "bring your own thermostat" (BYOT) approach would significantly reduce costs while still delivering automated DR and help to reassure risk-averse participants. The wide-scale deployment of utility-run thermostat or switch controlled residential demand response programs (including the former provincial peaksaverPLUS® program) suggests that cost effective deployment is attainable at scale.

5.3 Recruitment

This section discusses the recruitment features of the RPP pilots, and the benefits of, and potential barriers to, the use of opt-in and opt-out recruitment for an alternative RPP price plan.

5.3.1 Opt-In Recruitment

Opt-in recruitment will, nearly by definition, deliver a more motivated and engaged participant group than opt-out. In the context of the RPP pilots this is clearly demonstrated by the distribution of digitally engaged participants across the three Oshawa PUC treatment groups. Approximately 80% of the (opt-in) Seasonal TOU with CPP and 85% of the Information Only treatment group participants were digitally engaged, in contrast to only 20% of participants in the (opt-out) Super-Peak treatment group.

Engagement and enthusiasm are generally agreed to be participant characteristics highly correlated with participant behavioural electricity savings. It is a truism that the more engaged a participant is, the more they will try, and the more they will try, generally speaking, the more they will accomplish.

Opt-in recruitment, however, does make meeting recruitment goals a challenge. As shown in section 2.2.1, of all the opt-in price plans, only Oshawa PUC met its recruitment goals. OEB staff have, however, noted to Guidehouse that in order to achieve the targets, Oshawa PUC had to exert considerable effort –

[164] The estimate of $350 is an average across all participants in the pilot, including homes that did or did not require in-home maintenance. London Hydro prioritized customer experience during the pilot which led to more in-home visits than would likely be required at scale.

resources were called upon that went well beyond what would be applied for a standard conservation program recruitment, and more than would likely be cost-effective in a wider deployment. It must be remembered that pilot recruitment does not benefit from the network effects of a more wide-spread deployment. Marketing for pilot recruitment is also subject to the requirements of pilot experimental design which may limit the reach of such marketing and therefore make recruitment more challenging and costly (on a per unit basis) than would be expected under a full deployment scenario.

Opt-out recruitment is much faster and less costly. All the RPP pilots that adopted an opt-out recruitment approach attained their enrolment targets, and at a considerably lower per-participant cost. Alectra's marketing costs per participant for the (opt-out) Enhanced TOU treatment group were approximately 2.4% of those for the (opt-in) Dynamic treatment group and 1.4% of those for the (opt-in) Overnight group.

5.3.2 Opt-Out Recruitment

As noted above and in Section 2.2.1, opt-out recruitment is much less costly than opt-in recruitment and can ensure that enrolment targets are met. It is also very helpful for evaluation purposes as it makes the development of a true experimental design (a randomized control trial, or RCT) simpler to execute and validate. Opt-out recruitment also takes advantage of consumers' behavioural inertia. Many participants may find – once they are enrolled – that it is simpler just to learn to adapt to the new price plan than to opt out.

It is possible that an opt-out design may cause some mistrust or resentment amongst participants and contribute to a higher attrition rate. Additionally, the inclusion of less engaged participants will reduce average price plan impacts per participant simply because fewer participants will be highly engaged and actively trying to respond to the price signals. Contrast, for example the differential between average and digitally engaged participants' impacts in Oshawa's Super-Peak (opt-out, 20% digitally engaged) and Seasonal TOU with CPP (opt-in, 80% digitally engaged) price plans.

Attrition for the other opt-out price plan (Alectra's Enhanced TOU) is also high (21%), although this is in large part due to the move-out rate (12%). After accounting for the move-out rates the pure opt-out rate for the Enhanced price plan (9%) is lower than that of both the Dynamic price plan (16% net of move-outs for Dynamic) and the Overnight plan (10% net of move-outs). This finding – that opt-out recruitment does not necessarily yield higher attrition rates than opt-in recruitment – is consistent with the findings of a major United States Department of Energy (DOE) study on consumer behaviour in response to electricity prices. This study found that retention rates are approximately the same for both opt-in and opt-out TOU and CPP price structures, although demand reductions tend to be lower for opt-out designs.[165]

Offering opt-out participants some form of first-year bill protection can help build trust and improve participant retention. A one-year risk free guarantee is demonstration of good faith on the part of the LDC and effectively means that the only economically rational decision (from an expected value perspective) is for the participant to remain enrolled and test the price plan. This additional encouragement may be particularly helpful now that (as of November 1, 2020) all RPP consumers will have the option of shifting to a Tiered (inclining block) price plan. A Tiered price plan is likely to appear to many consumers as the lowest-risk option. Given the high degree of uncertainty due to the current economic and public health factors, consumers as a whole are likely to be highly risk-averse at present – offering a risk-free trial

[165] Page vi of

U.S. Department of Energy, Electricity Delivery & Energy Reliability, *American Recovery and Reinvestment Act of 2009: Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies*, Smart Grid Investment Program, November 2016

https://www.energy.gov/sites/prod/files/2016/12/f34/CBS_Final_Program_Impact_Report_Draft_20161101_0.pdf period for any alternative price plans (or even any new default TOU price plan) will likely substantially reduce attrition.

From a public perception standpoint, the deployment of any opt-out price plan (beyond the default TOU price plan) would need to be done with some sensitivity. Given the emphasis placed in public agency messaging on “customer choice” – the ability to opt out of the default TOU and into the Tiered price plan – consumers automatically included in an alternative opt-out price plan may feel resentful, as if their choice of plan is not being respected. Marketing and messaging strategies that accompany any alternative (non-default TOU) opt-out price plan must account for this and identify approaches to mitigate against such a response from consumers.

Finally, if highly engaged consumer participants can be identified early on (for example, via app usage), the price plan or program offering can be allowed to evolve around the needs or abilities of these consumers. Put another way, on-going changes or updates to the program or price plan design should prioritize improvements identified by highly engaged consumers. These are the highest-value price plan participants in terms of the impact they deliver and thus should be the focus of retention efforts.

5.4 Summary of Features

Table 5-4, below, provides a tabular summary of the pilot features reviewed as part of this meta-analysis, highlights the key benefits of each, notes the potential barriers and identifies approaches to mitigate those barriers, where relevant. Note that this table is divided by features of the pilots, not treatment group.

This may be confusing as in some cases a treatment group will share a name with a price plan feature (e.g., “Seasonal TOU”) whereas in other cases, where a treatment group includes multiple features, they will not. For example, Alectra’s Dynamic price plan includes both a “Standard CPP” feature, and a “Variable Peak Pricing” feature. To aid comprehension, Table 5-1 below lists the LDCs associated with each feature. For concision, Table 5-2 and Table 5-3 abbreviate the names of three of the participating LDCs, CustomerFirst is referred to as CF, London Hydro as LH, and Oshawa PUC as OPUC.

Table 5-4. Summary of RPP Pilot Features Reviewed, Feature Type: Price Plans

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
Enhanced TOU	Alectra, CF	• Comprehensible and predictable: minimal change from status quo. • Does not require any changes to billing systems or to regulation.	• Magnitude of price differentials ineffective at motivating response in the short-term. • Timing of price periods is not reflective of the economically efficient long-term cost of power.	• Extend summer/winter Mid-Peak/On-Peak to 9pm (requires regulation change). • Apply more aggressive price differentials such that prices better reflect system costs and provide consumers with greater opportunity to save. • Identify receptive consumers (e.g., via app engagement) more likely to deliver savings and target them for enrollment (this mitigating action is only appropriate when the price plan is not being considered as a default for RPP consumers).
Seasonal TOU	CF, OPUC	• Very reflective of short-term costs. • Very comprehensible and predictable – flat price shoulder months are easily understood. • Response by digitally engaged participants focuses on conservation rather than shifting.	• Only digitally engaged participants deliver savings. • A shoulder period that extends the weekday price beyond 7pm requires a change in regulation. • Is least reflective of long-term system costs.	• The benefits of this plan are not sufficiently better than those of others to justify attempting mitigating action to remove the barriers.

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
Super-Peak TOU	OPUC	• Reflective of long-term system costs. • Substantial response from digitally engaged participants - ~10% reduction in Super-Peak period demand.	• Average response delivers only modest system avoided cost benefits. • Attrition very high due to sticker shock and opt-out design. • Only digitally engaged participants contribute savings. • Non-digitally engaged participants seem more responsive to discounts than to higher prices. • Extremely high differentials for an opt-out price plan.	• Provide one year of bill protection to reduce attrition due to “sticker shock”. • Extend super-peak period by two hours to 9pm to improve cost-reflectiveness.
Overnight	Alectra	• Most substantial response of any price plan. Estimated changes in demand reflect price signals.	• Absent data to quantify external benefits (behavioural fuel-switching, EV charging location and timing changes) net avoided cost benefit is negative. • Target population (EV owners) very small. Recruitment challenging. • Some (5%) under-collection relative to average supply cost.	• Procure additional analysis to identify any external benefits not captured by AMI data evaluation. • Change marketing to target behavioural fuel switching – the “Green Your Heat” price plan. • Account for behavioural response in price-setting.
Quick-Ramp CPP	LH	• Significant behavioural response: 0.3 kW on average • Delivers some energy savings in non-CPP periods as well.	• CPP period of only one hour less cost-reflective than longer periods. • Adjusting billing systems for CPP may be costly.	• Lengthen CPP events.
Standard CPP	OPUC, Alectra	• Modest but statistically significant behavioural impacts. • CPP event timing, length, and prices	• Virtually no impact from non-digitally engaged participants (Oshawa). • Adjusting billing systems for CPP may be costly.	• Target only consumers revealed to be highly engaged (e.g., through app use) for recruitment. • Pair price plan with low-cost enabling technology (see below).

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
		second-most cost-reflective.		
Variable Peak Pricing	Alectra	• Very reflective of longer-term system costs.	• Complex and unpredictable. • Costly changes required to billing systems. • Energy avoided costs are quite low in all periods – societal benefits of variable peak pricing are much lower than well-targeted critical peak pricing.	• The benefits of this plan are not sufficiently better than those of others to justify attempting mitigating action to remove the barriers.

Table 5-5. Summary of RPP Pilot Features Reviewed, Feature Type: Informational Supports

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
Mobile Informational Applications	LH, OPUC	• High engagement consumers self-identify through use of app. • Can yield modest desirable behavioural impacts (LH On-Peak summer reductions). • App availability becoming expected by consumers (per focus group findings). • Direct communication between consumer and LDC – builds engagement that can be used to promote other programs or initiatives.	• Direct avoided cost benefits are small and uncertain. • Indirect value (identifying high engagement consumers, communicating with customers) is difficult to quantify for cost-effectiveness assessments. • App engagement under status quo prices correlated with increases in consumption. The leading hypothesis for this correlation is that it is due to low TOU prices, and not a result of the existing TOU structure.	• Recognize that the principal benefit that apps deliver is engagement, not kW or kWh savings. • Deploy apps and app marketing in sync with updates to status quo price plan (Nov 1 and May 1) and when alternative price plans are introduced.
Nudge Reports	Alectra	• Deliver modest statistically significant	• No material incremental effects on participants under alternative pricing plan.	• Use alternative approaches to presentment and content that deliver higher levels of savings. Do not proceed unless savings

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
		savings in some TOU periods.	• Lower savings than most social benchmarking home energy report (HER) programs • Unlikely to be cost-effective as a stand-alone energy efficiency measure.	can be demonstrated that result in a TRC>1.
Open Houses (In-Person Technical Support)	LH	• 25% that attended open houses required assistance with basic treatment functionality. Improves accessibility. • Substantially reduced disconnection rate, boosting demand response impacts.	• Attendance was relatively low – 4% - 8% of participants. • Maintaining in-person availability is costly. Incremental value of accessibility and the appeal to less technically proficient demographics over telephone support unclear.	• Improve attendance by offering open houses in public locations on a rotating basis. • Improve cost-effectiveness of the open houses by adjusting frequency based on attendance – if attendance is low and call centre traffic is low, reduce frequency, if attendance and call centre traffic are high, increase the frequency of events.
Demand Response Enabling Technology	Alectra, LH	• Automatic response significantly increases summer DR impacts; on average by ~0.4 kW London Hydro. • Automatic response reduces participants' real and perceived participation risk, allowing for more aggressive price ratios.	• Technology deployment as observed in the RPP pilots is not cost-effective. • Maintaining connectivity can be costly and may depend on consumer intervention.	• Recruit as a bring-your-own-thermostat (BYOT) price plan, enable smart thermostats already in place for DR. • Identify approaches used in other jurisdictions (and previously, by the IESO for peaksaverPLUS) to ensure cost-effectiveness of direct load control measures.

Table 5-6. Summary of RPP Pilot Features Reviewed, Feature Type: Recruitment

Feature	LDCs Tested	Benefits	Potential Barriers	Barrier Mitigation (Where Relevant)
Opt-In Recruitment	All	• Volunteer participants are, by definition, more engaged. Will deliver higher savings.	• Opt-in recruitment failed to meet targets in most pilots. • Marketing costs can be considerable.	• Where possible or practical use opt-out recruitment. • Where possible target marketing to those most likely to enroll based on observed

				past behaviour (e.g., enrollment in CDM programs, use of informational app, etc.)
Opt-Out Recruitment	Alectra, OPUC	• Recruitment targets met. • Experimental design for EM&V attainable and robust. • Consumers that might not volunteer for opt-in may not also opt out – inertia is favourable for opt-out.	• Attrition may be high if expectations not managed. • Participants less engaged than opt-in, on average. Fewer will respond to treatments.	• Build trust and mitigate attrition with six to twelve months of bill protection. • Identify highly engaged participants in opt-out price plans and evolve price plans around their abilities and needs.

6. RECOMMENDATIONS

Chapter 6 provides Guidehouse's recommendations to the Ontario Energy Board. Our recommendations are informed across two dimensions. They draw on design elements across the different pilots based on observations made by Guidehouse while reviewing the pilot evaluation reports (Chapter 2), and Guidehouse's quantitative and qualitative assessment of the results of the scoring metrics (Chapter 4). These findings were synthesized into feature-level findings and conclusions in Chapter 5. In this chapter, we integrate the findings and conclusions into a set of discrete recommendations. Our recommendations are also informed by observations drawn from the professional evaluation literature and Guidehouse's professional experience.

It is important to note that all pilots were completed prior to emergence of the COVID 19 pandemic in late 2019, and the subsequent cessation of many public-facing activities (e.g., school, office work, etc.) in early 2020. This means that none of the impacts or findings in the pilot evaluations were impacted by COVID shut-downs, shifts in behaviour, or the changes to RPP price plans implemented on March 18, 2020 (all RPP consumption priced at previous Off-Peak level – the "COVID recovery rate") and June 1, 2020 (when it was announced that RPP consumers could opt out of the TOU price plan and into the Tiered price plan[166]).

Our recommendations are informed by a perspective that views COVID-motivated changes in consumer and societal behaviour as largely temporary – the embedded expectation being that the most significant behavioural changes (office work, schooling, travel, etc.) are likely to revert to pre-pandemic patterns within two to three years.

In each of the sections that follow, the relevant key findings identified in Chapters 2, 4, and 5 are summarized, and the reasoning provided for the recommendation that concludes each section.

The sections below are:

2. **Existing TOU Price Structure and Price Differentials.** Guidehouse's recommendation for adjustments to the existing/default price plan.

3. **Informational Support for Price Plans**. Guidehouse's recommendations for the use of informational treatments (Nudge reports and mobile applications) to support existing and potential alternative price plans.

4. **Opt-Out Technology-Enabled Critical Peak Pricing.** Guidehouse's recommendation for the development and deployment of an opt-out critical peak pricing pilot for smart thermostat owners.

5. **Better Understanding the Decarbonization Potential of the Overnight Price Plan.** Guidehouse's recommendation for some additional analysis to ensure that the societal benefits of the Overnight price plan are not being understated and to assess whether there is any value in a price plan that may incent decarbonization.

6.1 Existing TOU Price Structure and Price Differentials

Guidehouse has considered carefully what pricing elements tested in the RPP pilots would be appropriate to replace or augment the default status quo TOU price plan.

[166] Consumers were first able to opt out of the TOU price plan on October 13, 2020.

The Dynamic and CPP elements are inappropriate for integration into a default TOU price plan. These price elements offer significant benefits (see Section 4.4), but require the consumer to have central air-conditioning to respond effectively (see Section 2.2.4), and in any case score very poorly in the predictable (see Section 4.5) and comprehensible (see Section 4.6) metrics. The price differentials of the Super-Peak rate are relatively extreme, and in any case deliver savings only from a fraction of consumers. The relatively minor avoided cost benefit would be small compared to the magnitude of potential consumer discontent (attrition for this price plan was 33%[167]), given the price differentials. The Super-Peak price plan is, at this time, an inappropriate price plan for the provincial default TOU price plan. Given the ability of consumers now[168] to opt-out of the default TOU price plan to a Tiered price plan a price plan borrowing features of the Super-Peak structure may be worth reconsidering in the future as an optional plan which would offer more consumer choice, once the initial wave of default TOU opt-outs is complete, and the overall level of engagement of consumers that have elected to remain on the default TOU can be assessed.

As part of Guidehouse's cost reflectiveness analysis, Guidehouse found that the Enhanced TOU price plan price differentials were more cost-reflective in the long-term than the status quo TOU prices.

This is clearly demonstrated in Section 4.3.2 which shows that the root mean squared error (RMSE) of the difference between the Enhanced TOU price series and the hourly allocation of the long-term cost of power is smaller than that of the status quo TOU price series (particularly in the summer months). This shows that – again, particularly in the summer months – the higher On-Peak and Mid-Peak prices of the pilot price plan were more cost-reflective in the long-term than those of the status quo TOU price plan.

Similarly, Guidehouse found that the Dynamic price plan was the most cost-reflective of all price plans. This is partly due to the dynamic nature of the pricing, but also is in large part due to the variable peak pricing period extending until 9pm. In every other price plan, including the status quo TOU, Off-Peak prices start two hours earlier, at 7pm.

As revealed in both Figure 16 and Figure 17 in Section 4.3, long-term system costs tend, on average, to remain quite high until two hours past the end of the status quo (and Enhanced) TOU evening On-Peak/Mid-Peak (winter/summer) period. The long-term cost and treatment price from an average of summer and winter Mondays shown in those figures is reproduced immediately below in Figure 19.[169]

[167] Approximately two-thirds of those participants that opted out of this price plan did so before June 1 – before they actually became subject to the elevated summer Super-Peak price. Nearly all participants that exited this pilot (93% of the 33% that dropped out) did so prior to November 1.

[168] As of November 1, 2020, RPP consumers may elect to opt out of the default TOU price plan and into the Tiered price plan.

[169] Note that the absolute levels of current status quo TOU prices (as of the 2020-11-01 price-setting) are higher than those of the Enhanced TOU price plan, due to the re-assignment of the OER from the prices to a line-item on the bill (this re-assignment occurred as part of the 2019-11-01 RPP price-setting). Current status quo TOU prices are 21.7, 15, and 10.5 cents/kWh in the On-Peak, Mid-Peak, and Off-Peak periods, respectively (compared to Enhanced TOU prices of 17.5, 13.2, and 4.4 cents/kWh).

Figure 19: Alectra/CustomerFirst Enhanced TOU Price Plan Long-Term Cost Reflectiveness

In the summer months, the long-term hourly costs only peak toward the final hours of the On-Peak period. In the winter months, the average daily peak long-term cost of electricity occurs *after* the end of the On-Peak period at 7pm.

Based on these findings, there is an opportunity to adjust the existing TOU price plan to be more reflective of the long-term costs (as defined here by the hourly allocation of Global Adjustment costs developed by OEB staff).[170] Such an adjusted price plan could have the following characteristics:

a) **Later Off-Peak.** Extend the summer Mid-Peak period and winter On-Peak period to 9pm, to avoid providing a low-price during periods when long-term system costs are very high.

   Adjusting the existing TOU price plan by extending the summer/winter Mid-Peak/On-Peak period by two hours would require a change in regulation (O. Reg. 95/05 currently requires Off-Peak prices apply after 7pm). However, the mechanics of implementing the adjustments would be much simpler than for the Dynamic price plan (see Section 4.8), or any other alternative price plan that doesn't share the same structure as the current TOU price plan. In fact, this change in TOU period timing is simply a reversion to the TOU price structure in place provincially until May of 2011.

b) **Price Differentials.[171]** In the summer months, increase the absolute level of On-Peak and Mid-Peak prices such that they better reflect the long-term costs. In the winter months, increase On-Peak prices, and consider reducing Mid-Peak as well as Off-Peak prices to better reflect the intra-daily distribution long-term costs.

   Increasing the differentials between On-Peak and Off-Peak periods will improve consumers' opportunity for bill savings and thus the motivation to respond to the (more aggressive) price signal in the late afternoon/early evening period when long-term system costs are highest.

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[170] This demand-based hourly allocation of GA was developed as part of an OEB staff paper, and it was found to be the most economically efficient allocation of GA, of the nine pricing prototypes examined. OEB continues to do research in this area.

Ontario Energy Board, *Staff Research Paper: Examination of Alternative Price Designs for the Recovery of Global Adjustment Costs from Class B Consumers in Ontario*, February 2019

https://www.oeb.ca/sites/default/files/rpp-roadmap-staff-research-paper-20190228.pdf

[171] OEB staff are continuing to study alternative demand-based allocations of the GA that better reflect long-term system costs in an economically efficient manner. While it is clear from this on-going analysis that a price plan in which the Off-Peak period begins at 9pm instead of 7pm is more reflective of long-term costs, the question of the relative *magnitude* of these costs (and thus the appropriate TOU period price differentials) remains open. Guidehouse's recommendation with respect to price differentials is conditional on the most recently available information at the time of writing, and as a result, may need to be reconsidered as this work of the OEB's progresses.

Although neither of the piloted Enhanced TOU price plans delivered any short-term behavioural energy savings, a set of more aggressive On-Peak and (summer) Mid-Peak prices could accelerate longer-term structural price response by increasing the incentive for consumers to acquire more efficient appliances, particularly more efficient space-cooling equipment.

Since, as of November 1, 2020, RPP consumers have the option to opt out of the default TOU price plan and on to a Tiered (inclining block) price plan, increased TOU period price differentials will not “trap” consumers into higher bills. If consumers believe they cannot effectively respond to a higher On-Peak/Off-Peak ratio, they have the opportunity to opt out of the default TOU price plan into the lower risk Tiered plan.

Some consideration may be given to eliminating the summer Mid-Peak period entirely and making the entire 7am to 9pm period On-Peak. The current relative long-term cost-reflectiveness of the winter Mid-Peak period argues against its elimination. The OEB may also wish to consider offering RPP consumers a risk-free trial period for a new default TOU price plan, three to six months, to allow risk-averse consumers an opportunity to observe how effectively they can respond to such a TOU rate, rather than simply abandon it.

Based on the findings of the cost-reflectiveness analysis, Guidehouse recommends:

- **Increasing the summer On-Peak and Mid-Peak and winter On-Peak price differentials to improve long-term cost-reflectiveness and provide consumers with more opportunities to reduce their bills.**
- **Adjusting the default TOU price plan to better reflect long-term system costs by restoring the pre-May 2011 TOU period definitions and starting the Off-Peak period at 9pm.**
- **Consider offering consumers subject to a new default price plan some period of bill protection to mitigate against high levels of initial attrition due to consumer risk-aversion. Guidehouse expects that bill protection would be most important for default price plans that are materially more aggressive in price differentials than the status quo default TOU price plan in force on November 1, 2020.**

6.2 Informational Support for Price Plans

Two types of informational support were tested: Nudge reports and mobile applications (apps). Each is discussed in the two sub-sections below. The third sub-section summarizes Guidehouse’s recommendations with respect to both types of informational support.

6.2.1 Nudge Reports

Nudge reports were found to deliver savings both for participants in Alectra’s Enhanced TOU price plan, as well as consumers subject to the status quo default TOU price plan. Overall conservation savings were not, however, statistically significant, though estimated TOU period impacts in the On-Peak period (summer and winter) and Mid-Peak period (winter only) were statistically significant, if modest, with estimated reductions during the On-Peak period of 1.1% (summer) and 0.8% (winter) and winter Mid-Peak reductions of 1.8%.

Estimating the TRC of the price plans or of elements of the price plans was not an evaluation requirement for any of the LDCs that participated in the pilots. As a result, Alectra’s evaluation report did not contain an estimated total resource cost (TRC) ratio[172] identifying the cost-effectiveness of this component of its pilot design. . .[173] For context, it should be noted that the IESO's 2018 evaluation[174] of social benchmarking programs administered by five different LDCs estimated an aggregate TRC of 0.71, based on an average savings value of approximately 1.3% (assuming average residential annual consumption of 10,000 kWh per year).[175] Given the estimated savings of the Nudge reports in Alectra's pilot, and the current very low level of Ontario's avoided costs of electric energy (lower than in 2018), it is very unlikely that this treatment, applied only to electricity, would be cost-effective from a societal point of view.

Guidehouse would not recommend a wider deployment of Nudge reports, unless it could be demonstrated that such a wider deployment would be likely to deliver savings more in line with the average values typically observed for home energy reports (e.g., 2% or more).

6.2.2 Mobile Applications (Apps)

Mobile applications (apps) appear to deliver modest but uncertain savings. These apps, however, provide important non-energy benefits that, while difficult to accurately quantify, suggest that they could deliver meaningful societal value over the longer term. Furthermore, the lack of availability of an app (or apps) to allow consumers to track their consumption in near-real-time acts as an implicit signal to consumers that there is little value in doing so.

The Government of Ontario has published a regulatory proposal for province-wide implementation of the Green Button standard.[176] According to a presentation to the Ontario Energy Association[177], the proposed regulation would require Ontario LDCs with more than 25,000 customers to implement Green Button within two years of the regulation being enacted. The Green Button "*Connect My Data*" (CMD) standard allows individual utility customers to grant access to their historical hourly data to third parties so that these third parties can provide the utility customers with analytics to help them manage their electricity use.

The implementation of the Green Button CMD removes one significant barrier to the development and distribution of energy-monitoring apps to Ontario consumers. Although necessary, the access to customer data is not a sufficient condition for ensuring the development and deployment of such apps to consumers. Other conditions such as customer demand for mobile apps that include the management of

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172 The total resource cost (TRC) ratio is a benefit/cost ratio typically used for evaluating the cost effectiveness of energy efficiency programs. The TRC measures the net costs of an energy efficiency program based on total costs of the program including both the participants' and the utility costs.

173 Estimating the TRC of the price plans or of elements of the price plans was not an evaluation requirement for any of the LDCs that participated in the pilots.

174 See Table 17 and Table 18 of

Cadmus, Econoler, and Apex Analytics, prepared for the Independent Electricity System Operator, *Evaluation of 2018 Residential Programs*, September 2019

http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2018/2018-Residential-Programs-Evaluation-Report.pdf?la=en

175 It should be noted that this average value estimated by the IESO includes impacts from very different sets of home energy report programs, although the TRC is reported only in aggregate. The IESO's 2017 evaluation of social benchmarking programs, for example estimated TRC values of 4.75 and 4.17 for Alectra and Hydro One's home energy programs, but a TRC of only 0.29 for Hydro Ottawa's.

Cadmus, prepared for the Independent Electricity System Operator, *Social Benchmarking Local Program Evaluation,* November 2018

http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2017/2017-Social-Benchmarking-Evaluation-Report.pdf?la=en

176 Environmental Registry of Ontario, *Regulatory proposal for province-wide implementation of Green Button,* Proposal posted October 8, 2020

https://ero.ontario.ca/notice/019-2564

177 Ministry of Energy, Northern Development and Mines, *Proposals for Green Button and Community Net Metering: Presentation to Ontario Energy Association Climate Change and Energy Efficiency Committee,* November 6, 2020

customer energy data as well as clarity on the features regarding energy use that the app should provide, will help to stimulate the development of a market for these apps. While a few energy apps currently exist that conform to the Green Button standard, public agencies in concert with app developers and other third parties can facilitate and expedite the further development of these apps by working together, to support their availability and the inclusion of certain core features that support energy policy goals.

The regulation the Ministry of Energy, Northern Development and Mines is currently proposing for Green Button would give utilities two years from the time of its enactment to implement Green Button. During this time, there would be opportunity to conduct broad-based discussion and identify core features that energy apps should contain to meet energy policy goals.

Based on the findings of the evaluations of pilots that test app-based treatments, Guidehouse has identified a set of core features whose inclusion in any Greenbutton-enabled app would support current public policy goals – these are outlined in sub-section 6.2.2.2, below. This is preceded by discussion of how widespread adoption of energy monitoring apps (with the appropriate functionality) could materially support policy goals related to consumer price response and energy efficiency (sub-section 6.2.2.1). These discussions are then followed by Guidehouse's recommendations for informational treatments.

6.2.2.1 Using Apps to Improve Recruitment Cost-Effectiveness and Build Consumer Engagement

The findings that the London Hydro Trickl app yielded modest On-Peak savings from volunteer participants, and that app usage in the Oshawa PUC pilot was very strongly correlated with participant price response (both reductions and increases in demand) suggest that app usage is less a *driver* of conservation than it is an *indicator* of who is a highly engaged consumer. Highly engaged consumers will deliver substantial savings when the price signal indicates it is worth it, but may, conversely, relax their on-going (existing) conservation behaviours when the price signal indicates it is *not* worth it (as shown by the Oshawa Information Only treatment group which *increased* consumption in most TOU periods).

The use of Oshawa program participants' app usage data to identify the most engaged price plan participants, and to estimate the impact they delivered separately from the balance of consumers, allowed the pilot evaluator and Guidehouse to gain a much more nuanced understanding of the price plan impacts. It is a valuable contribution to the electricity pricing professional literature.

If an app (or group of apps with similar functionality) were made available to a wider group of consumers, app usage statistics could allow program administrators to target highly engaged consumers for enrolment in other alternative price plans or conservation or demand management (CDM) programs. As these consumers are more engaged, they are more likely to enroll and more likely to respond to the program treatments, reducing the acquisition cost of conservation and demand response.

As noted in Section 5.2.1, mobile apps also provide consumers with a trustworthy and secure communications channel with their LDC, a channel which could, for example, help consumers transition to an alternative TOU price plan, or to a new default TOU rate such as that recommended above. Mobile apps can be a powerful tool for building consumer engagement – for example, as cited in Chapter 5, Oshawa PUC was able to use the Peak app to promote the AffordAbility Fund (Affordability Fund Trust) to participants.

Offering consumers an app that allows consumers to engage with their own behaviour and, if they are interested, understand and alter that behaviour can improve recruitment cost effectiveness and engagement. This means that active engagement by consumers is no longer limited to enthusiasts and can be undertaken even by consumers with a more casual interest in their electricity use. Improved access to information lowers the psychic cost of entry to consumers and makes them more likely to become engaged in the future.

Consumers can now use mobile apps, for example, to: do their banking, book or plan their immediate travel needs, monitor and control their home's temperature, monitor their doorbell camera or "nanny cam", and access virtually limitless video streaming entertainment. Most Ontario consumers cannot, however, access their electricity bills via an app, cannot receive push notifications of bill due dates, and cannot navigate hourly historical consumption directly through an app.[178]

Chapter 5 of this report notes that the Alectra focus group analysis found that an energy monitoring app was an "expectation" of its customers.

The potential effect on consumer engagement of signaling to consumers the value of their engagement by meeting this expectation and ensuring the availability of an energy monitoring app could be considerable. Likewise, the improved ability to monitor and harness consumer engagement via one or more apps could substantially help improve aggregate consumer price response and energy efficiency achievements.

6.2.2.2 App Features

The features an app should contain will depend on the goals set out for the app. The OEB's goal for non-price tools, as tested in the RPP pilots, is to improve consumer price response.

An app that works to build consumer engagement and improve consumer price response over time should provide consumers with transparency into their usage patterns, direct and intuitive indications of bill impacts (e.g., $/period per day as well what each period's cost contribution is to their average daily billed cost), and the functionality to connect participants with information about new or existing programs or price plans that will help them reduce the costs they impose on the electricity system.

More specifically, app features that would help to achieve enhanced consumer price-responsiveness to OEB price plans could include:

- **Data Sharing (suggested core feature).** The most important feature from a policy and program administration perspective. It is vital than any apps deployed provide price plan and CDM program designers with some individual consumer usage statistics that can be joined with hourly electricity consumption data. This will enable statistical inference to estimate the impacts of price plans and CDM programs delivered to the most engaged consumers. This previously unavailable ability to differentiate between engaged and less-engaged consumers can help improve the designs of price plans and CDM programs and can help policy makers understand how to increase the number of consumers that are engaged.
- **Consumption Data (suggested core feature).** Near real-time (e.g., no more than 1-day delay) hourly consumption information, and the ability to aggregate these values by a variety of time increments. This is a key feature and is the one most likely to interest consumers (e.g., use of this feature by Oshawa PUC participants climbed steadily throughout the pilot – see Figure 98 of the evaluation report). This could also include access to view past and present electricity bills.
- **Cost Data (suggested core feature).** The ability for a consumer to look at their consumption in a given day or hour and understand the cost of that consumption. Ideally, this should be presented as absolute and relative values (e.g., consumption between 9am and 10am costs $0.75, or 0.8% of your monthly bill). Cost values should include all variable costs, not just commodity costs.
- **Push Notifications (suggested core feature).** A dynamic push notification that alerts consumers when their consumption is higher than usual in a costly period. For example: send a push notification when demand during the On-Peak period is 1.5 times the average value for the given season.

- **Program Cross-Promotion (suggested core feature).** The Oshawa PUC Peak app was used to cross-promote the provincial AffordAbility Fund (Affordability Fund Trust). A feature such as this would enhance consumer awareness of opportunities to save electricity as well as support other provincial programming that encourages conservation and demand management, leading to overall improvements in program recruitment cost-effectiveness.
- **Technical Assistance (suggested secondary feature).** This could include a technical connection to a utility call centre or provincial call centre that provides technical tips for saving energy.
- **Peer Benchmarking (suggested secondary feature).** Information feedback and peer benchmarking (e.g., through home energy reports) have long been demonstrated to yield modest savings. Presentation via an app could reduce delivery costs sufficiently to make such functionality cost-effective.

The first feature above enhances the ability of the regulator and system operator to develop, deploy, and continuously improve the price plans and CDM programs that are offered.

The remaining features noted above all enhance consumers':

1. **Understanding of the prices they face**. This better aligns consumer motivations with system needs communicated via their price plan's price signals.
2. **Engagement with the prices they face**. Nudges in the form of push notifications or peer benchmarking help consumers become more habitual in their engagement with prices.
3. **Ability to respond to the prices they face**. Cross-promotion of programs or alternative price plans and the ability to monitor their own demand in near-real time empowers consumers to take actions to reduce their demand in higher priced periods.

These features support the OEB's goal of improving consumer response with non-price tools and may also support the goals of other provincial agencies or stakeholders, for example by improving the cost-effectiveness of CDM program delivery. There may be other app features not considered above that could deliver benefits to consumers or the province, in line with the goals of other agencies or stakeholders.

Engagement with other provincial agencies and stakeholders in a formal working group setting could increase the value of any app eventually deployed by considering a broader range of benefits other than just price response. This is the basis of Guidehouse's recommendation below regarding the use of a mobile app.

6.2.3 Informational Support Recommendations

In summary, Guidehouse recommends that the OEB:

- **Not proceed with Nudge reports.** The Nudge reports tested by Alectra appear highly unlikely to be cost-effective. Until such time as a robust third-party evaluation can demonstrate the cost effectiveness (e.g., TRC > 1) of these, no further action should be taken.

- **Convene a stakeholder working group to develop principles, objectives and guidelines for informational support from apps to enhance customer price responsiveness to OEB price plans.** The working group should be composed of: IESO, Ministry of Energy, Norther Development and Mines, LDCs, app developers, consumer groups and others, as appropriate. Consideration should be given to seeking input from experts in behavioural research.

  These public agencies must enable such a working group to ensure that there is a path forward for the development and deployment of energy-monitoring apps that can support and enhance provincial policy and offer meaningful benefits to consumers. Energy tracking apps have the potential to be an important policy tool for these agencies, but if these agencies cannot – through a working group or some other venue – clearly articulate their policy needs and how these can be addressed by apps, then network and other market effects may lead to an ecosystem of apps unsuited to serving the province's policy goals or the needs of consumers. This remains an infant industry, and as is often the case with infant industries, it, and the public, may benefit from direction and momentum provided by public agencies.

The working group could be convened by either OEB or IESO or jointly as both have key roles regarding energy efficiency, with OEB responsible for approving any conservation and demand management (CDM) proposed by utilities within their distribution system plans to defer infrastructure and IESO responsible for both provincial CDM and regional planning within which utilities may have a role in providing geo-targeted CDM or demand response to help with system constraints.

Because of these roles, the OEB and IESO are well positioned to ensure that application development can take these regulatory and planning frameworks into account effectively. Since the recommendations regarding the applications arise from this meta-analysis, the OEB has a more comprehensive understanding of the findings and how to build on them, making OEB best suited to take a leadership role in convening the working group.

The working group should be tasked with:

- ***Specifying a List of App Principles and Objectives****.* This list should include principles or ultimate goals (e.g., "*Educating consumers and improving price response*") as well as objectives or proximate goals, which should be more concrete (e.g., "*X% improvement in the ability of app users to estimate the impact of action Z on their monthly electricity bill by year Y*").
  In developing the list of app principles and objectives, the working group should explicitly address the importance of enabling policy-makers to use consumer app usage data without compromising consumers' privacy.
- ***Defining the App Features that will Deliver on the Principles and Objectives.*** The working group should define which features are most important to meet the principles and objectives, considering criteria such as, usability, ability to have consistent messaging and customer experience, ease of implementation, and cost.
- ***Articulating the Major Barriers to Implementation***. The working group should identify and discuss key reasons why energy-monitoring mobile apps have not flourished previously in Ontario, and identify successes in other jurisdictions that could be more effective in Ontario.
- ***Identifying the Appropriate Delivery Model****.* The working group should consider key questions in delivery such as: Should an app (or apps) be procured by a central agency (e.g., the IESO)? Or by LDCs? Others? How can the delivery model help to remove barriers to access and app use? How can the delivery model contribute to app developers offering "freemium" (no cost for some features, payments required to "unlock" others) mobile apps to consumers?
- ***Developing Draft Guidelines for Broader Stakeholder Input***. The guidelines should specify a list of app principles and objectives, define the appropriate app features and identify the appropriate delivery model. The description of each feature could include, for example, what information should be offered and what functionality should be prioritized.

6.3 Opt-Out Technology-Enabled Critical Peak Pricing

The key findings to support Guidehouse's recommendation with respect to an opt-out technology-enabled CPP price plan are summarized below:

- **Critical peak pricing delivers statistically significant demand response.** Critical peak pricing has been demonstrated across all three pilots in which it was employed to deliver statistically significant demand response in the summer months (see Table 2-10).

- **Critical peak pricing response persists over time.** As the 17-month Alectra evaluation report shows, CPP response by the Dynamic treatment group was remarkably consistent from the summer of 2018 to the summer of 2019, despite some decline in price responsiveness in the other price periods. Investments in building CPP capacity appear to continue to deliver returns so long as the price signal remains.

- **CPP should be confined to the summer months.** Demand response at times of system peak delivers significant societal value by reducing the long-term cost of power. As Ontario is a summer peaking jurisdiction, demand response offers little value in the winter months from a provincial perspective.

  All the CPP treatment groups evaluated have clearly demonstrated what is intuitively clear: residential participants' capacity to deliver demand response is concentrated in the summer months. A/C use is, in most homes, the largest truly discretionary load for which there is a single point of control. As the benefits of demand response are vastly greater in the summer than in the winter (when there is no avoided capacity cost benefit), it does not make sense to alienate participants by subjecting them to winter events to which they have only a limited ability to respond.

- **CPP events should be longer than one hour**. As the cost-reflectiveness analysis (Section 4.3.2) demonstrates, CPP events must be longer than one hour. In that analysis, the Seasonal TOU price plan was found to be less cost-reflective in the long-term than the status quo TOU price plan, but the Seasonal TOU with CPP price plan was found to be more cost-reflective than London Hydro's CPP price plan. As London Hydro's CPP price plan is just the status quo price plan with 36 one-hour CPP events, it is clear that the four-hour Oshawa PUC Seasonal TOU with CPP critical peak events were more cost-reflective (in the long run) than the one-hour London Hydro events. As demonstrated in Section 4.3.2, four-hour CPP events are much more cost-reflective than single-hour CPP events.

- **Technology-enabled CPP yields the greatest avoided cost benefits of the plans reviewed**. DR-enabling technology greatly increases demand response as demonstrated by the results from participants enrolled in CPP price plans, with technology increasing DR impacts by approximately 0.4 kW in the London Hydro pilot. This result matches the findings of other technology enabled critical peak pricing programs, as detailed in Section 2.2.4.

- **Deploying and maintaining technology can be costly.** Under the assumptions currently in place none of the technology-enabled price plans are cost-effective from a societal perspective (see Section 4.4). As demonstrated by Alectra's Dynamic price plan (and other utilities outside of Ontario)[179], smart thermostats already in consumers' homes may be enabled to provide automatic demand response.

[179] Consider for example this bring-your-own-thermostat program in Colorado:
Nexant, Inc., prepared for Xcel Energy, *Xcel Energy Colorado Smart Thermostat Pilot – Evaluation Report*, May 2017

- **Opt-out recruitment is much faster and less costly than opt-in recruitment**. All the RPP pilots that adopted an opt-out recruitment approach attained their enrolment targets. Of all the opt-in treatment groups, only Oshawa PUC met its recruitment target, and then only through an extremely resource-intensive effort. The per-participant recruitment cost of opt-out programs is much lower than for opt-in programs, improving cost-effectiveness. As shown in Section 5.3, the marketing cost per customer for Alectra's Enhanced TOU (opt-out) was approximately 2% of the marketing cost per customer of the Dynamic price plan.

- **Attrition can be limited by offering first-year bill protection**. First-year bill protection has been demonstrated to be very effective at limiting attrition. The legacy Dynamic participants had the lowest pilot period attrition rate of *any* treatment group subjected to alternative prices (bill protection was cited as one of the most important motivators for enrolment in the 2016 process evaluation of this program). OG&E's Smart Hours (variable and critical peak pricing) program has enrolled 15% of its residential customer base in the program in part by motivating enrollment by offering bill protection for the first 12 months of participation – a risk-free trial.

  Bill protection eliminates the short-term risk to participants of experimenting with the new price plan, and so encourages participation (and discourages dropping out) even amongst risk-averse consumers.

  In the case of Oshawa PUC's Super-Peak opt-out price plan, although attrition was very high, two thirds of those that did drop out did so before June 2018 when Super-Peak prices began to be applied. These participants dropped out because of a *perception* of risk, not because of bill impacts. This attrition might have been significantly reduced had participants had the option of a year of bill protection so that they could better understand their financial exposure under the new price plan.

- **In-person technical support could make the price plan more accessible and improve participant retention.** Retention – and impacts – can be increased over the long term by focusing on encouraging consumers to register their devices in order to allow them to be automatically curtailed by a program administrator, and providing in-person "office hours" style technical support, to help empower potentially marginalized consumers, including in demographics that tend to be less technically adept, and those for whom English is not their first language. Such engagement has been effectively demonstrated by London Hydro to help some consumers cross initial technical hurdles and improve program results.

Given these findings, Guidehouse recommends:

The OEB work with LDCs to deploy an opt-out CPP price plan adder. This would not be a separate price plan, but rather an additional layer that could be applied to any consumer's existing price plan, analogous to a rate rider.[180] The development of this deployment should consider the following:

- *Deployment Costs.* A precise costing of a CPP price plan adder for provincial deployment is outside of the scope of this analysis. The analysis that is in scope – a review of reported pilot costs and high-level estimates provided by a sample of LDCs in a survey – suggests such costs are highly uncertain, though they could be substantial. LDC estimates of implementation costs for deploying a CPP price plan provided as responses to Guidehouse's survey (see Section 3.7) ranged from less than $100,000 to more than $1 million. Given the use of CPP in other

https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/CO-Smart-Thermostat-Pilot-Evaluation.PDF

[180] Rate riders are typically temporary chargers or credits applied to customer bills, often related to operational costs (or revenue) not included in regulator-approved rates.

jurisdictions[181], the value of avoided capacity, and potential scale economies of provincial deployment, it seems likely that the benefits of an opt-out CPP price plan adder would exceed the costs of implementing it, but OEB Staff should conduct additional targeted analysis to confirm this assertion.

- *Eligibility.* The list of consumers to be included in the opt-out price plan should be derived from the transaction records of GreenON, the IESO, and utilities (gas and electric) to target consumers that have received a free, or heavily rebated, smart thermostat. Only those that have received a free, or heavily discounted, thermostat capable of automatic curtailment should be automatically included. The message to consumers should be that the province is asking (but not compelling – opting out is possible) for help reducing costs for all rate-payers from those consumers who are most capable of providing it through equipment partially or wholly funded by tax- and rate-payers. Other consumers that have the requisite thermostats purchased on their own without Ontario government or utility subsidy could opt-in to participate.
- *Target Summer Peak.* Only customers of summer peaking LDCs (that have received a free or heavily rebated smart thermostat) should be included automatically, though all consumers with the requisite technology should have the option to opt in should they so choose.
- *Offer a Reward.* Consider, rather than offering participants a modest discount on the Off-Peak price, offering an annual bill credit. A single more substantial payment is likely to be a greater enticement to consumers than a discount of a fraction of a cent per kWh of Off-Peak consumption. The magnitude of the annual payment can be determined through a comparative analysis of the avoided cost benefits of a projection of forecast consumer price response against the projected costs of deployment (per above). As evaluated impacts and audited costs become available, this value should be updated accordingly, and this incentive should be contingent on a full summer of participation.
- *Undertake a Staged Deployment.* As with the deployment of RPP TOU rates in the 2008 – 2012 period, the CPP price plan adder should be rolled out gradually. Begin with a volunteer LDC, and course-correct on-going deployment based on the lessons learned in the initial deployments.
- *Encourage Registration of Smart Thermostats for Automatic Control*. Encourage consumers included in the price plan to register their smart thermostat to allow for automatic curtailment, as was done as part of Alectra's Dynamic price plan pilot. This will substantially increase demand reductions and reduce bills – as noted in Section 5.2.4, critical peak pricing enhanced with enabling technologies can deliver demand response up to three times that provided when price alone is used. Alectra successfully registered the thermostats of approximately 20% Dynamic price plan participants. Guidehouse believes that this proportion could be significantly increased by reducing barriers for consumers to contact their LDC for help[182], and through a more focused marketing effort.[183] The OEB should consider working with a market research firm to assess the most effective way to persuade enrolled consumers to register their thermostat.
- *Provide Some Limited Bill Protection.* Provide participants with bill protection for the first two summer months of participation. This will reduce short-term attrition due to sticker shock and encourage risk-averse consumers to stick with the price plan adder for at least a month or so to better understand their financial exposure.
- *Allow, and Consider Encouraging, Opt-Ins.* As part of the analysis undertaken to determine the appropriate incentive to offer prospective participants, assess the value of marketing the price plan adder to those not eligible for automatic enrollment. This should be based on the observed recruitment rates of the RPP pilots with CPP components, and potentially with advice from a market research firm on how to most cost-effectively acquire opt-in participants.

[181] Southern California Edison's CPP-D pricing plan, Green Mountain Power's Rate 9, Xcel Energy's Critical Peak Pricing Program, etc.

[182] The focus group analysis procured by Alectra indicated that participants that called the Customer Service Centre with questions: "*did not always receive a satisfactory response*" and noted that there was considerable confusion between the pilot-specific web-site and the more general Alectra customer portal.

[183] The same focus group above noted "*an almost complete lack of awareness of the value"* of the program-provided (or registered) smart thermostats.

6.4 Better Understanding the Decarbonization Potential of the Overnight Price Plan

The Overnight price plan elicited the most substantial purely behavioural impact of any treatments tested, with a 45% increase in demand between midnight and 6am during the summer and a 73% increase in demand in the same time period in the winter. Summer overnight demand increases were partially off-set by On-Peak and Mid-Peak demand reductions of approximately 10% and 8%, respectively - the largest purely behavioural demand reductions delivered by any treatment group in a static price period.[184] Overall, the average annual consumption of participants increased by nearly 15% (20% in winter months).

The Overnight price plan analysis uncovered three key issues which must be addressed:

- **The Overnight price plan under-collected revenues by 15%. This can be mitigated by relaxing the assumption of no change in behaviour when setting revenue neutral prices for this price plan.**

  The under-collection for this group – the difference between the average pilot revenue per kWh and the average RPP supply cost (RPA) – of 15% was the largest deviation (in absolute value) of any price plan[185]. This under-collection is much more significant in winter than in summer (where under-collection was only 5%). This is a not unexpected result. Given that the purpose of the price plans is to shape behaviour through a price signal, it should not be surprising the behaviour change provoked by the price signal results in a reduction in average revenue per kWh (or, conversely a reduction in the consumer's average cost of consumption). The principal implication here is that any deployment on a large scale would need to set revenue neutral prices based on the load profile of consumers *already subject to the price plan* (to account for the change in behaviour).

- **The Overnight price plan did not meet its recruitment target. This is likely to become more readily achievable as the penetration of EVs grows**.

  As noted in Section 2.2.1 this pilot only succeeded in enrolling 320 consumers (64% of the goal) prior to its deadline. Following an extension of that deadline by one month, the pilot was able to achieve 88% of targeted enrolment. While unfortunate for the statistical power of the evaluation, this is not entirely surprising. The IESO's REUS[186] reports that between 2.2% and 2.4% of residential consumer households own or lease an electric vehicle. This substantially reduces the pool of potential volunteers for a price plan that explicitly targets EV owners, though 43% of those participants enrolled in this pilot did own or lease an EV during the pilot period. The implications for a wider roll-out of such a price plan depend largely on the assumed growth of EV penetration in the province. Guidehouse Insight's Q4 2019 forecast of EV penetration predicts that by 2030 approximately 700,000 light duty vehicles in Ontario will be EVs.[187] At present there are approximately 13 million registered light duty vehicles in Ontario.[188]

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[184] i.e., excluding variable and critical price periods

[185] The second-largest deviation (in absolute value) was the over-collection of 3.1% by the Oshawa Super Peak treatment group.

[186] Cadmus, prepared for the Independent Electricity System Operator, *Ontario Residential End-Use Survey: Final Report*, November 2018
http://www.ieso.ca/homeenergysurvey

[187] Guidehouse Insight, *Market Data: EV Geographic Forecast – North America*, 4Q 2019
https://guidehouseinsights.com/reports/market-data-ev-geographic-forecast-north-america

[188] Statistics Canada, *Table: 23-10-0067-01 (formerly CANSIM 405-0004) Vehicle Registrations, by type of vehicle – Ontario*, accessed September 2020.

- **By limiting the analysis of price plan impacts to participants' home electricity consumption data, it is likely that the analysis has understated the benefits of this plan.**

  Based on the data in hand, response to the Overnight price yields a negative system benefit. The avoided cost benefit of the peak demand and On-Peak and Mid-Peak energy reductions are less than the incremental system costs of the additional overnight consumption, with a net present value of a lifetime avoided cost benefit of -$14 (see Section 4.4), and a net average increase in consumption of 5% in the summer and 20% in the winter for an average annual increase of nearly 15%.

  Guidehouse has hypothesized that two most probable sources for the net additional Overnight Off-Peak and non-Overnight Off-Peak load are:

  - **Shifting EV Charging Location.** Participants with EVs shifting from paying a per-hourly charge for EV charging (for example, at their workplace) outside of their home, to charging their EV at home overnight.

  - **Behavioural Fuel Switching.** Participants satisfying an increasing share of their overnight thermal load with auxiliary electric space heating equipment instead of natural gas heating equipment. This would be most likely to occur in older homes well-equipped with auxiliary electric baseboard heat (more common in homes with hydronic gas heating systems than forced air systems) where it could make financial sense to reduce the use of central heat in favour of targeted room heating via the auxiliary electric equipment.

  Additional discussion of the reasoning for these hypotheses may be found in Section 2.2.3, above.

If either or both of Guidehouse's hypotheses above are correct, then an examination of only participant household electric loads will understate – potentially quite substantially - the price plan's benefits.

If the net additional load is derived from participants shifting from charging electric vehicles at public or workplace stations during On-Peak periods, then there is a potentially substantial avoided cost of energy (and of capacity) benefit not being counted because it has not been estimated. Additionally, if a long-term effect of such a price plan is to affect consumer vehicle purchasing decisions and encourage the adoption of electric vehicles, there is a potentially meaningful societal decarbonization (and avoided carbon cost) benefit. Some jurisdictions already recognize this fact by offering EV-specific rates.[189]

Likewise, if some of the net additional load is derived from participants engaging in behavioural fuel-switching – supplementing the use of natural gas space heat with auxiliary electric space heat – and the avoided cost benefits of reduced gas use, including any benefits that flow from reduced carbon emissions due to such behavioural fuel-switching are not counted, the societal benefit of this rate will be understated, possibly quite substantially.

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[189] See for example:

Southern California Edison, *Cal. PUC Sheet No. 68210-E Schedule TOU-EV-1 Domestic Time-of-Use Electric Vehicle Charging*, January 2020

https://library.sce.com/content/dam/sce-doclib/public/regulatory/tariff/electric/schedules/residential-rates/ELECTRIC_SCHEDULES_TOU-EV-1.pdf

Pacific Gas and Electric, *Cal. PUC Sheet No. 44831-E Electric Schedule EV Residential Time-of-Use Service for Plug-In Electric Vehicle Customers*, August 2019

https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_EV%20(Sch).pdf

Comparing electricity and natural gas avoided costs in common units[190] it can be shown that the avoided cost of natural gas (including the federal carbon charge) in 2022 (2018$) is $7.79 per GJ, whereas the avoided cost for Off-Peak winter electricity in the same year (in 2018$) is $6.67 per GJ. If behavioural fuel-switching *is* taking place as hypothesized, then it is likely that this price plan is delivering potentially quite significant societal benefits that Alectra's evaluation report has not captured.

There is potential that this price plan, or one like it, could help to support decarbonization of the home heating and transportation sectors. There is therefore value in gathering additional data and conducting additional analysis to determine if either of the hypotheses above can be rejected. If it is found that both hypotheses can be rejected, and no other evidence is uncovered for additional benefits offered by this price plan, it should not be pursued.

Some specific actions that can be undertaken to better quantify the value of the Overnight price plan (or one very much like it) could include: leveraging existing data to determine if Guidehouse's hypotheses can be rejected, and authorizing another pilot, building on the findings of this one, to better quantify the value of an EV-targeted overnight price plan.

Leveraging Existing Data.

- Survey pilot participants to determine:
    - EV ownership[191]
    - Typical charging behaviour (EV owners) – proportion at home and proportion in public.
    - Space-heating shares
    - If any behavioural fuel-switching was undertaken as part of their response to pilot pricing.
- Use survey data to segregate EV owners from non-EV owners.
- Re-run the analysis to identify overnight impacts of non-EV owners.
- Combine with survey findings regarding behavioural changes to assess whether it is possible to reject the hypothesis of behavioural fuel switching.

Authorize Another Pilot

- The RPP Overnight pilot has delivered valuable intelligence. EV owners appear able to be highly responsive to price signals. Unfortunately, by measuring only home electric use, the true magnitude of the benefits remains unknown.
- Undervaluing the benefits of rate-based EV charging mitigation could lead to sub-optimal policy-making; for example, by favouring command-and-control technology-based interventions (e.g., public charging demand response) over a more consumer-centric price-motivated behavioural intervention.
- Conducting one or more additional pilots designed as randomized control trials (RCT) in which participants are subject to an EV-targeted price plan and all participants and control EVs are equipped with data loggers allows the benefits of a shift away from public charging to be accurately quantified.

[190] Natural gas avoided costs are based on Enbridge's 2017 30-year set of avoided costs for residential space-heating, as well as the federal carbon charges for marketable natural gas listed in the Greenhouse Gas Pollution Pricing Act (S.C. 2018, c. 12, s. 186), Schedule 2, Section 3, subsections 166(4), 168(1), 168(3), and paragraph 168(2)(b) and (c) https://laws-lois.justice.gc.ca/eng/acts/G-11.55/page-41.html#h-74

[191] Guidehouse understands that the existing survey data that identifies that 43% of pilot price plan participants own an EV are anonymized and cannot be linked to AMI hourly consumption data.

Given the above, Guidehouse recommends:

- **Conduct additional analysis; leverage existing data. Carry out additional analysis of the Overnight Plan data to assess whether the winter behavioural fuel switching hypothesis can be rejected by identifying and assessing the electricity consumption behaviours during the Overnight Plan of EV owners and non-EV owners.**

- **Authorizing a new Overnight price plan pilot in one or more utility service territories. This pilot should track the *vehicles'* as well as the dwelling's electricity demand. This would allow for an accurate and complete accounting of the benefits to participants and to the electricity grid of the charging behaviour induced as a result of the Overnight price plan. The pilot would also monitor and measure any changes to electricity consumption that are not due to EV charging during Overnight Off-Peak period. The new pilot would build on the first pilot by providing greater clarity and accuracy regarding the benefits of the Overnight price plan and the behavioural changes motivated by the price plan, and by providing guidance on the components of the Overnight price plan necessary to induce desired participant behaviours.**

APPENDIX A. TABULAR SUMMARY OF COMPREHENSIBILITY RESULTS BY TREATMENT GROUP

Table A - 1 Comprehensibility Results by Treatment Group

Treatment Group	Criteria	Description	Score	Overall Score
Alectra Enhanced TOU	1. Number of Price periods	Three price periods.	2	4
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	58% of participants indicated that remembering the new pricing plan structure was easy.	2	
Alectra Dynamic	1. Number of Price periods	Four varying price periods (Off-Peak and Low, Mid, and High On-Peak).	1	2
	2. Consistent and Regular Timing	CPP period by design is less consistent and not regular in terms of timing.	1	
	3. Self-reported Comprehension	64% of participants indicated that remembering the new pricing plan structure was easy.	2	
Alectra Overnight	1. Number of Price periods	Four price periods.	1	4
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	58% of participants indicated that remembering the new pricing plan structure was easy.	2	
CustomerFirst Enhanced TOU	1. Number of Price periods	Three price periods.	2	4
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	62% of participants indicated that they plan to change their consumption patterns as a result of their participation in the TOU pilot.	2	
CustomerFirst Seasonal TOU	1. Number of Price periods	Flat price throughout the shoulder months (March through May, September through November) and two price periods otherwise (June through August, December through February).	3	4
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	61% of participants indicated that they plan to change their consumption patterns as a result of their participation in the TOU pilot.	2	
London Hydro	1. Number of Price periods	Three price periods.	2	3

Treatment Group	Criteria	Description	Score	Overall Score
Quick-Ramping CPP and CPP/RT	2. Consistent and Regular Timing	CPP by design is less consistent and not regular in terms of timing.	1	
	3. Self-reported Comprehension	82% of participants indicated that they understood that using less electricity during the day will save them more money than reducing the same amount of electricity during evening or overnight.	3	
London Hydro RT-Only	1. Number of Price periods	Three price periods.	2	5
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	79% of participants indicated that they understood that using less electricity during the day will save them more money than reducing the same amount of electricity during evening or overnight.	3	
Oshawa Super Peak	1. Number of Price periods	Three price periods.	2	5
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	92% of participants indicated that they have a good understanding of the difference between flat pricing and time-of-use pricing.	3	
Oshawa Seasonal TOU with CPP	1. Number of Price periods	Three price periods.	2	3
	2. Consistent and Regular Timing	CPP by design is less consistent and not regular in terms of timing.	1	
	3. Self-reported Comprehension	88% of participants indicated that they have a good understanding of the difference between flat pricing and time-of-use pricing.	3	
Oshawa Information Only	1. Number of Price periods	Three price periods.	2	5
	2. Consistent and Regular Timing	The price period schedule is consistent and regular.	3	
	3. Self-reported Comprehension	86% of participants indicated that they have a good understanding of the difference between flat pricing and time-of-use pricing.	3	

APPENDIX B. IMPACT OF UPDATED AVOIDED COSTS

The cost minimizing analysis (reported on in Section 4.4) compares the net benefit offered by the various price plans piloted. The benefit stream for each price plan is derived from two sources:

- An assumed avoided cost of capacity of $130/kW-year (2018 dollars), selected to remain consistent with previous work conducted by OEB Staff and contractors.
- The 2019 avoided costs of energy developed by the IESO at its 2018 technical conference (never published).

Since this analysis was conducted, the IESO has updated its avoided energy costs again, as a result of work conducted as part of its 2019 technical conference.

Guidehouse has examined these updated avoided costs and concluded that the changes to avoided energy costs would not affect any of the conclusions drawn in the analysis in this report and so has not updated that analysis with these newer avoided costs.

In general, the most important contributor to the long-term benefits (in terms of avoided costs) of the different price plans is the avoided cost of capacity, which has not changed. Changes in the IESO avoided energy costs are insufficiently large to overwhelm the effects of the capacity benefits. Table 6-1, below provides a relative comparison of the 2019 and 2020 avoided costs, showing the percentage change from 2019 to 2020. It should be noted that the IESO definitions of TOU periods used for the avoided cost calculation do not align with the TOU period definitions that are part of the RPP.

Table 6-1. Comparison of 2019 and 2020 Avoided Energy Costs

Year	2020 Avoided Energy Cost by Season and Time-of-Use Period (2019$/MWh)							
	Winter On Peak	Winter Mid-Peak	Winter Off-Peak	Summer On Peak	Summer Mid-Peak	Summer Off-Peak	Shoulder Mid-Peak	Shoulder Off Peak
2020	-38%	-18%	-30%	0%	19%	-5%	20%	38%
2021	-43%	-27%	-46%	6%	22%	-21%	40%	13%
2022	-17%	-4%	12%	18%	15%	-6%	6%	10%
2023	0%	-1%	-13%	31%	19%	0%	1%	5%
2024	12%	-4%	21%	10%	10%	1%	6%	21%
2025	-8%	-13%	-1%	9%	6%	4%	-4%	-11%
2026	-1%	-10%	-6%	7%	3%	1%	-1%	1%
2027	3%	-7%	-2%	8%	6%	-5%	-14%	-21%
2028	3%	-3%	-12%	14%	8%	1%	-7%	-3%
2029	0%	-8%	-15%	11%	11%	-13%	-11%	-9%
2030	6%	-2%	-2%	17%	10%	7%	3%	-2%
2031	7%	-3%	-14%	14%	9%	2%	-1%	-16%
2032	13%	3%	-8%	17%	7%	3%	-9%	-14%
2033	9%	3%	1%	13%	8%	8%	-2%	-21%
2034	0%	-9%	-35%	17%	7%	-5%	0%	1%
2035	-3%	-8%	-42%	16%	9%	4%	-4%	-12%

As may be seen, the principal effect of the IESO's update has been to increase the relative value of Summer peak period (On-Peak and Mid-Peak) compared to the winter and shoulder periods as well as the Off-Peak periods.

By comparing the above to Table 4-6 from Section 4.4 (reproduced below as Table 6-2), which shows the avoided cost benefits of each price plan, a qualitative assessment of the impact of updating the energy avoided costs can be performed.

Table 6-2. System Benefits per Participant Enrolled on Day One

Treatment Group	Total System Benefits per Participant ($)
London Hydro CPP and CPP/RT	$1,145
Alectra Dynamic	$325
Oshawa Seasonal TOU with CPP	$294
Oshawa Super-Peak	$38
London Hydro RT-Only	$1
CustomerFirst Enhanced TOU	$0
CustomerFirst Seasonal TOU	$0
Alectra Enhanced TOU	$0
Alectra Overnight	-$14
Oshawa Information Only	-$56

Source: Guidehouse analysis of pilot proponent data

Updating the avoided costs would result in:

- **London Hydro CPP and CPP/RT**. Most benefits flow from the capacity benefit delivered by CPP events. Modest increase in benefits as a result of relative increase in summer On- and Mid-Peak avoided costs.

- **Alectra Dynamic**. Slight increase in benefits due to higher summer On- and Mid-Peak avoided costs, partially offset by decreased winter and shoulder month avoided costs. Impact of change wholly insufficient to close the gap with the benefits offered by the London Hydro price plan.

- **Oshawa Seasonal TOU with CPP.** The increase in the benefit of the 4% reduction in On-Peak energy will be partially off-set by the reduction in Off-Peak avoided cost benefits (2% reduction in winter Off-Peak demand from this price plan). Most benefit for this price plan flows from capacity benefits associated with CPP events.

- **Oshawa Super-Peak.** Slight increase in avoided cost benefits of the Super-Peak. This price plan provoked approximately. a 2% reduction in the summer On-Peak avoided cost period, and a 2 – 3% increase in winter consumption in most of the TOU periods. Changes in avoided cost would be insufficient to change its position.

- **London Hydro RT-Only.** Given magnitude of impacts (~2% impact in Summer On-Peak consumption) the change in avoided costs will have only a trivial impact on the benefit of this price plan and will not affect its order in the list above.

- **CustomerFirst Enhanced TOU, CustomerFirst Seasonal TOU, Alectra Enhanced TOU.** No impacts, therefore no impact from changes to avoided costs.

- **Alectra Overnight.** Changes in the avoided costs will increase the system benefits (the increased winter consumption reduces the overall benefit by less than previously), but total avoided cost benefits would still be negative, given the magnitude of the net increase in overall consumption.

- **Oshawa Information Only.** This non-price tool treatment group delivered estimated increases in energy consumption in nearly all periods. Changes in the avoided costs will not change the ranking of this price plan relative the others.