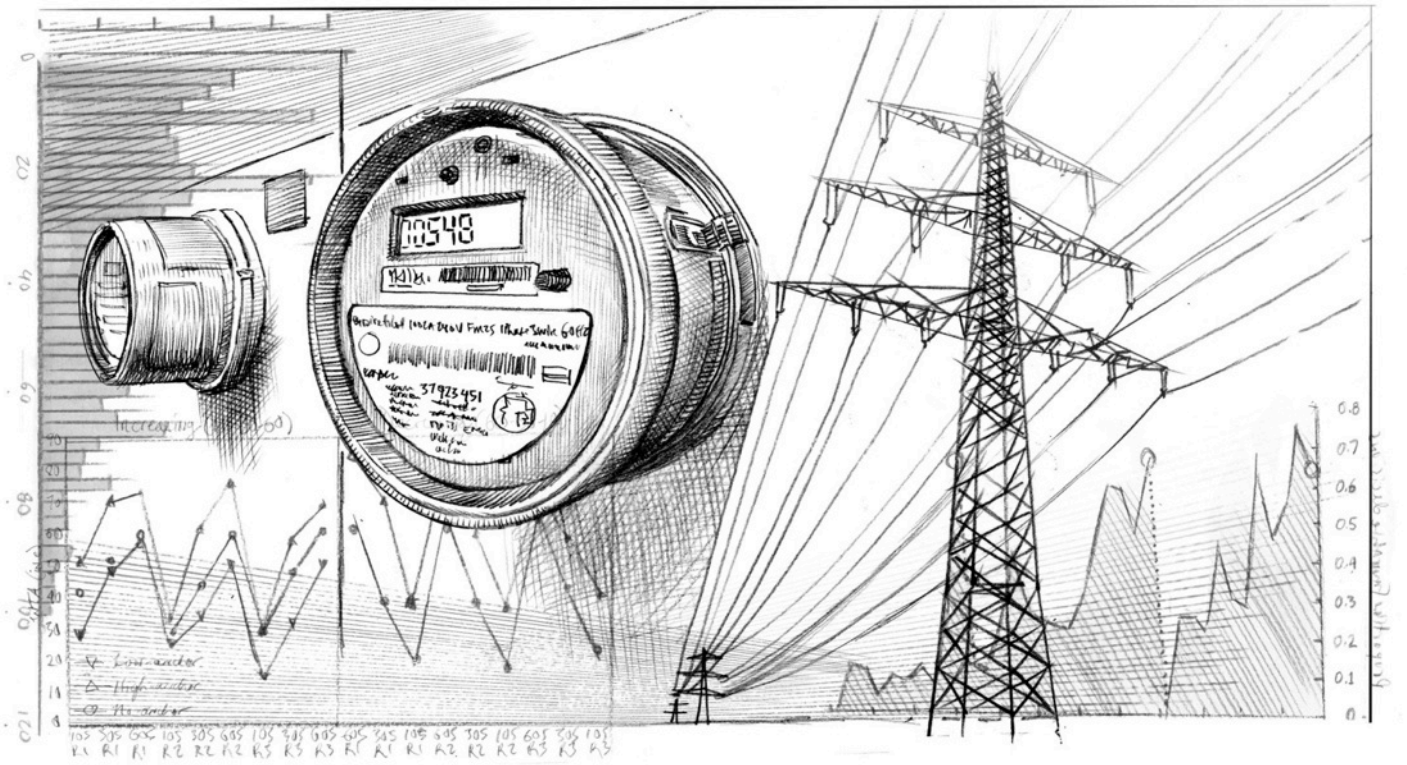
BEWORKS



Behavioural Economics Review

Analyzing and Nudging
Energy Conservation and Demand Shifting
Through Time of Use Compliance

Prepared for the Ontario Energy Board

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Executive Summary

The morning of August 14th in 2003 started like many others. Demand on Ontario's power grid was at a manageable 16,000 megawatts. But as temperatures warmed that summer day to 31°C (87°F), air conditioners roared. By noon, power consumption reached peak loads. Dishwashers, dryers, and the power-hungry accoutrement of modern life were humming away while the grid strained under the load. As people began making their way home around 4pm, the largest blackout of the decade was underway. Ignited by overloaded lines in Ohio and exacerbated by a number of causes, the power grid failed. By midnight most of the province, as well as much of the Eastern seaboard of Canada and the United States, was plunged into a darkness that would last for more than a week in some regions.

While the US-Canada Power System Outage Task Force identified several causes in their *Final Report on the August 14, 2003 Blackout in the United States and Canada*, including electrical, computer, and human error, the blackout sparked discussions among politicians, ministries, and citizens about the urgency of conservation. Many called for massive investments to continue to expand the power grid, but the counter-argument is that increasing supply only spurs further consumption. There is a significant risk that a shortfall in capacity may emerge as early as 2018, but Ontario has set ambitious conservation targets. According to the Ontario Power Authority, a 7,100 megawatt (MW) reduction of peak demand and 28 terawatt-hours (TWh) by 2030 can be achieved through innovative conservation and energy efficiency programs to help families and businesses save energy and manage their costs. Some transformations, when done in small increments by many, are revolutionary.

One response by energy authorities has been the launch of several consumer-centric strategies to influence people's consumption behaviours. To help consumers better understand their consumption, the province invested in an infrastructure that enables people to see both how much and when they use electricity. This has been paired with a pricing schema that is intended to incent the optimization of demand management behaviours. Approximately 96% of Ontario electricity residential and small commercial customers are now billed based on time-of-use (TOU) prices as a part of Ontario's Regulated Price Plan. However, despite incremental improvements in time-of-use compliance, consumers have a long way to go to help the province achieve its energy goals. Consumers are being encouraged to increase their conservation efforts as well as shift their consumption from peak times. When it comes to having access to reliable, relatively low cost electricity, consumers have had fortunate lives in Ontario. Winter heaters blast until consumers enjoy a subtropical comfort; air conditioners cool homes when people are not even in them. Other than the occasional environmental sensitivity that propels people to turn off a light, appliances are indiscriminately left running day and night. The time when people use energy-hogging appliances, such as dishwashers and dryers, is mostly discretionary as is the temperature of thermostats. Changing these behaviours could mitigate the need to make the massive investments required to increase capacity. However, consumers have a limited understanding of where their power comes from, how much they're consuming, and how their behavior impacts the grid. It is our hypothesis that this lack of energy literacy manifests itself in lower than desired compliance with time-of-use goals.

As part of their comprehensive review of the RPP, the OEB engaged BEworks to conduct a review of the ways in which consumers are, and are not, responding to the current pricing structure in Ontario. In addition to uncovering barriers to adoption, BEworks' task was to identify ways of increasing the effectiveness of TOU pricing using behavioural economic nudges. This process included testing non-financial mechanisms to drive the province's conservation and demand management goals under the current pricing structure.

*A prio*ri, it is unclear whether the failure to shift usage to off-peak periods is due to a lack of incentive – indicating that alternative pricing strategies should be experimented with, or that the issue is just a lack of comprehension of TOU pricing, or that there is perhaps just a failure to frame the pricing in the most motivating way. This indicated that the forms in which TOU are communicated should be improved through empirical testing. The studies presented in this report are aimed at the latter consideration because it is unclear if the large investment that the province and utilities have already expended on advanced metering infrastructure has met its full potential. In order to assess this, we needed to better understand non-monetary factors affecting consumer understanding, memory and motivation. Since the electricity bill is a reliable (from the perspective of the consumer) and cost effective (from the perspective of the OEB/Utilities) communication channel, with 85% of Ontarians claiming to read their bill (83% when it's online), we focused our efforts on assaying what Ontarians currently attend to on their bills, subjecting exemplar current bills to a behavioral diagnostics assessment, and empirically tested a wide range of potential redesigned bill elements as well as newly compiled bill statements.

Overall, several strategic directions emerge from this body of work. First, the current communication of TOU pricing in Ontario is not effective in promoting comprehension. Using a behavioural lens to re-engineer communication methods demonstrably increases comprehension of TOU, as validated through the scientific method detailed in this document. The data outlined here provides exciting insights into changes that can drive the shifts in consumption that TOU was intended to motivate. These behavioural insights will also remain consequential as the province considers additional load-shifting or demand-response strategies such CPP and CPP-R to mitigate potential long terms effects of uncurbed peak demand as well as coupling automated technologies with TOU (e.g. PeaksaverPlus). Motivating consumers to stimulate increased adoption of TOU via consumer-centric communication strategies is a cost effective and manifest direction. We recommend that the insights reported here be given due consideration via a large-scale in-field test in partnership with Ontario's LDCs to further streamline and validate these and related strategies, ultimately bringing about real world changes in electricity consumption behaviour.

Introduction

Over the past decade, the province of Ontario has made significant investments in smart meter and energy conservation initiatives. In 2005, on the shoulders of a billion dollar investment, the province simultaneously launched time-of-use (TOU) pricing and set out to equip households and small businesses with smart meters. The aim was to leverage the economic value of conservation by providing financial incentives (or disincentives) to reduce or shift electricity usage away from peak periods. This demonstrated commitment to conservation projects has placed Ontario at the forefront in energy policy. The province was the first geographic region in the world to mandate the installation of smart meters for all low usage customers.[1] To date, about 96%[2] of Ontario's residential and small business customers are billed based on the TOU prices set by the Ontario Energy Board (OEB).

Although the Ontario government has demonstrated its dedication to energy conservation and demand management, adjustments in consumer behaviour have remained limited. Several, studies have shown that there has been little to no change to consumer behaviour in response to dynamic pricing and smart meter initiatives. One study evaluating the impact of TOU rates on consumption found a total seasonal shift of only 1% overall, and a 2.8% average reduction in on-peak consumption over the course of a year.[3] Another study evaluating the effectiveness of TOU pricing in Ontario concluded that the current scheme is far from optimal, and that it has in fact resulted in an increase of the mean peak-to-average ratio rather than a decrease.[4] It is evident, given these and similar studies, that Ontario's TOU pricing model is not adequately achieving its conservation and demand management goals.

As part of their 2014 mandate, the OEB engaged BEworks to conduct a review of the ways in which consumers are, or are not, responding to the current pricing structure in Ontario. In addition to uncovering barriers to adoption, BEworks' goal was to identify ways of increasing the effectiveness of TOU pricing through better communication of TOU pricing and schedules, as well as nudges based on behavioural economics. This process includes testing non-financial mechanisms to drive the province's conservation and demand management goals under the current pricing structure.

BEworks' team of behavioural experts is well suited to address these issues. We use domain knowledge and methods from the behavioral sciences to address business and policy challenges, with a particular focus on behavioral economcs. Behavioural Economics (BE) is grounded in a multidisciplinary approach that combines the fields of cognitive and social psychology, neuroscience, economics, and marketing. Its fundamental premise is that people rely on a number of heuristics to help them make day-to-day decisions, because we simply do not have the time or mental energy to weigh the costs and benefits of every decision we make.

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[1] Ministry of Energy (2013). *Achieving Balance: Ontario's Long-term Energy Plan*. Retrieved from: http://www.energy.gov.on.ca/en/files/2014/10/LTEP_2013_English_WEB.pdf
[2] Ontario Energy Board. (2014). *Backgrounder – May 1 electricity price change*. Retrieved from: http://www.ontarioenergyboard.ca/oeb/_Documents/Press%20Releases/bg_RPP_TOU_20140416.pdf
[3] Navigant (2013*). Time of Use Rates in Ontario. Part 1: Impact Analysis*. Retrieved from: http://www.ontarioenergyboard.ca/oeb/_Documents/EB-2004-0205/Navigant_report_TOU_Rates_in_Ontario_Part_1_201312.pdf
[4] Adepetu, Rezaei, Lizotte, and Keshav (2013). Critiquing Time-of-Use Pricing in Ontario. University of Waterloo.

While this is mainly adaptive, sometimes, our reliance on mental shortcuts that can lead us to make less than optimal decisions, leading us to behaviors that are in opposition to the predictions of by traditional economic models that assume humans always make fully rational decisions.. By understanding the mechanisms underlying these biases, we can begin to unravel the reasons why the rational, incentive-based TOU pricing scheme has not achieved the province's goals as predicted. The current model is designed to provide consumers with a financial incentive to conserve energy and reduce demand during peak periods. The use of BE provides a broader lens into other non-price based tactics that can be used to more effectively draw attention to TOU pricing, and nudge consumers toward conserving energy and managing demand.

The OEB had two core assignments for BEworks: The first was to determine the reasons why Ontarians are or are not responding to TOU pricing. The second was to suggest ways to optimize the communication of the current TOU pricing structure. This report outlines our approach and findings for each of the issues posed by the OEB.

Part 1: Behavioural Diagnostics Overview

Our multidimensional approach to answering the first question began with a literature review that allowed us to glean from academic research, other energy sectors around the world, as well as other industries that have faced comparable challenges. The body of studies we considered, and are reported here shed light on the biases and heuristics that may be impeding the success of Ontario's TOU model. This section of the report also contains insights into behavioural interventions that have been empirically demonstrated to overcome behavioural barriers similar to the ones faced by Ontario's energy sector.

Following this review, are the results of our *Electricity Consumer Survey,* which was designed to measure Ontarians' (residents and small business owners) current awareness of TOU pricing, comprehension of costs and schedules, and to uncover the strengths and weaknesses of the current model. Next we document our *Behavioural Audit* of the bills provided by the two largest utility companies in the province, conducted using in-house academic expertise at BEworks.. This evaluation of the manner of information presentation on the two most commonly viewed bills in the province helped us to uncover roadblocks in awareness, comprehension, and alignment to TOU periods. Since these electricity bills continue to remain the most common and frequently reviewed material used to communicate TOU pricing and schedules to consumers across the Province, they formed the focus of much of our analysis moving forward.

Finally, the last study in this section of the report is our *Bill Click Tracking Study*, which measured the areas of the bill consumers typically look at and sought to determine whether this was associated with improved recall of the information presented in those areas, as well as changes in motivation to shift behaviour as a result of TOU pricing.

Part 2: Nudge Panel & Bill Statement Experiments

Part 2 of the report is dedicated to the second question posed by the OEB, which was to identify ways to increase the effectiveness of the current pricing structure, and/or suggest alternative pricing options or complementary programs.

It is our position that, before making substantive changes to the Regulated Price Plan we must determine whether the weak link is the pricing model itself, or simply the way the pricing model is communicated to the public. Much of our work's focus is on looking for and designing simple, non-price based nudges that work alongside the current pricing model and increase its efficacy. Since our insight are broadly applicable to the communication of price based incentives, most of our experimental observations can be applied to other dynamic pricing models or iterations of the TOU pricing model.

Using the knowledge that we gained from the literature and research reported in Part 1 (above), we designed a series of *Nudge Panel Experiments* that tested different behavioural interventions and nudges to improve consumers' awareness, comprehension and motivation to align with current TOU pricing schedules. Our nudge panel manipulations included

- Increased fluency of pricing information
- Increased salience of TOU names
- Linear (as opposed to cyclical) TOU timing visuals
- Visual (as opposed to tabular) displays of energy consumption
- Loss-aversion & social-norm based messaging to increase enrolment in an automated demand control device.
- Higher ratios of peak/off peak prices

In addition, we also assessed participant response to two potential bill-based nudges:

- Consumption feedback and benchmarks
- Pre-commitment

Each of the nudges was tested using a randomized controlled experiment. The best variations of bill components, identified through the *Nudge Panel Experiments,* were then used to inform the *Bill Statement Experiment,* which combined these best performing elements together into a a series of full bills. The results and recommendations for the board follow this series of experiments. Our hope is that our empirically-generated recommendations will help align Ontarians to the province's conservation and demand reduction initiatives in a cost-effective way.

Behavioural Economics Approach to Ontario's TOU Evaluation

The Ontario Energy Board has previously conducted research on the impact of the new Regulated Pricing Plan (RPP) and time-of-use (TOU) pricing on energy consumption patterns. Impact analyses using econometric methods and 'big data' studies can provide useful information on the current state, identifying longitudinal patterns of consumption. A behavioural economics approach complements the progress that has been made thus far by addressing underlying psychological and environmental factors that influence energy consumption patterns. Insights from behavioural economics and an experimental research methodology can gather evidence on why certain pricing schemes and incentives generate behavioural change and others do not. By understanding the causal mechanisms driving specific consumption choices and behaviours, BE methods can generate strong hypotheses about the behavioural response to targeted interventions, and design controlled experiments to test these hypotheses.

Our approach recognizes that:

- Consumer choices are relative and context-dependent. How a choice is presented – the number of options, relative comparisons, framing, positioning – impacts our decisions. Psychological obstacles in the context of a decision can inhibit desired behaviours, often overpowering direct financial rewards and penalties.

- Many decisions are driven by automatic processing. Often consumer decision-making does not involve a deliberative analysis of available options and information. Instead, situational contexts, moods, and the behaviours of others can influence choice. Nudges can be designed in order to leverage or change automatic decision-making.

- Consumers are not always in touch with their own preferences, and their intentions do not necessarily translate into behaviours. Consumers have a tendency to discredit subconscious drivers of choices, and overestimate their sense of control and agency. Consumers are often very bad at predicting their own future preferences and behaviours.

Fundamentally, behavioural economics is about understanding the causes of behaviours that policymakers have long recognized: People often make irrational and impulsive decisions, especially when confronted with difficult or uncertain choices. We procrastinate, we act against our own best interest, and we let our emotions get the better of us. Often well-intentioned energy efficiency policies and efforts fail due to these persistent psychological obstacles.

A behavioural economics approach to changing energy consumption starts by recognizing and analyzing the patterns of consumer behaviour that are driven by social and contextual features, as opposed to only standard economic incentives. A useful framework for applying behavioural economics to household and small commercial energy consumption is to divide the key behavioural drivers into four categories:

- Awareness: People do not review and comprehend all types of information equally. Due to constraints in time and energy, people are wired to filter information using heuristics. These 'mental shortcuts' are designed for efficiency, but they can lead to patterns of biases, especially given the sheer volume of information that modern consumers are faced with. These biases can involve inefficient and misdirected attention, which can lead to irrational behaviours. Behavioural diagnostic of the problem: People are simply unaware of the fact that they pay different rates for energy at different times of the day. One hypothesis is that TOU pricing may have been ineffectively communicated to Ontarians. By increasing awareness and understanding of TOU pricing, we will impact consumer conservation and demand management efforts.

- Comprehension: How information is presented impacts how well it is understood and the types of inferences people draw, and how motivated they are to act on that information. We have a behavioural diagnostic to examine this variable: Both the Auditor General of Ontario and the Commission on the Reform of Ontario Public Services concluded that there is only a low level of consumer knowledge of the electricity system and pricing. The Ministry of Energy Report on Conservation outlines the pressing need to tackle consumer energy literacy as a key means of inspiring conservation. While consumers may know their energy bills are priced based on TOU, they may not know how to interpret their bills, or how to change their energy usage behaviour as a result of this new model. Making significant efforts to increase energy literacy by changing how consumption information is presented will give consumers the information they need in the format that is most effective in driving optimal decisions regarding their electricity use.

- Motivation: Non-financial drivers, such as social norms and notions of identity, weigh heavily on our choices and behaviour. It is crucial to understand these diverse motivational mechanisms in order to influence behaviour.

- Maintenance: Long-term motivational drivers are often very different from short-term drivers. People often fail to follow through on sticking to their commitments and goals. Generating consistent behavioural change and forming habits necessitates effective behavioural reinforcements and feedback loops.

In order to understand behavioural response to the current electricity-pricing scheme, we investigated these four elements of decision-making.

Part 1 Behavioural Diagnostics

The current consumption behaviours of consumers and small businesses in Ontario are challenging energy providers' ability to meet demand within the current energy infrastructure. Energy policymakers are in the difficult position of a) managing the investment in the energy infrastructure, which is a costly and contentious process, and b) influencing energy consumption patterns to reduce this burden. Changing energy usage behaviours in particular requires a comprehensive understanding of the psychological drivers underlying energy consumption choices and how these insights can be used to nudge consumption behaviour.

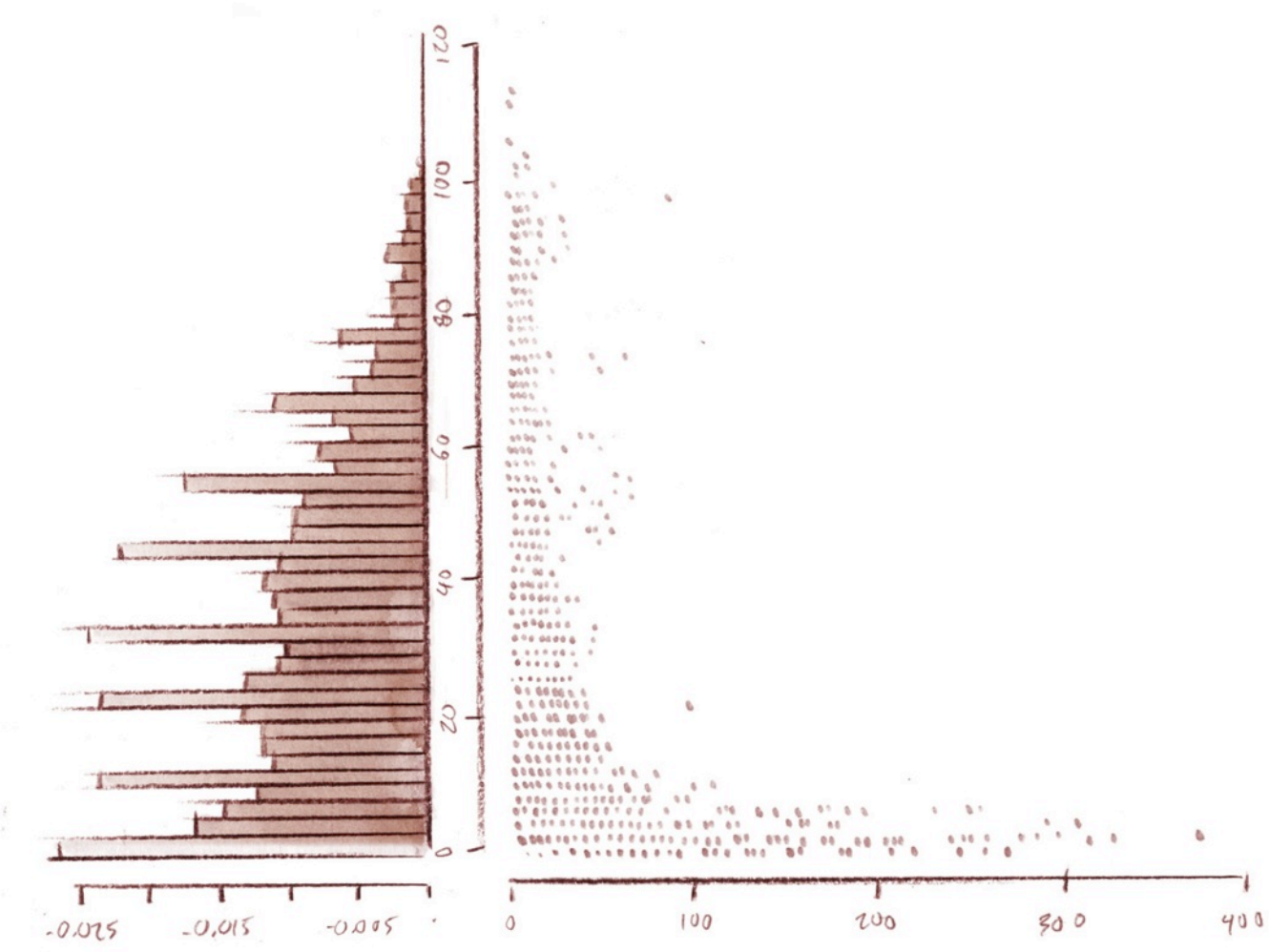
Many approaches to influencing conservation and demand management behaviours rely on consumers making conscientious choices of when and how they use energy. This includes adopting new energy-saving technologies and responding to appeals for conservation. However, despite the introduction of many energy-saving technologies offered with incentives such as subsidized pricing and short payback periods, adoption remains low. This phenomenon is known as the *Energy Efficiency Gap* or the *Energy Paradox.*[5] Several explanations for this gap have emerged and include a lack of relevant information about available technologies that decrease action intentions and relatively low energy prices that decrease motivation.

Conservation-based campaigns, which historically assumed that a favourable attitude towards conservation would automatically produce conservation behaviours, have also had limited success. Results from a survey of 1,664 Canadians found that 72% of the respondents acknowledged that a gap exists between their intention to perform environmentally responsible actions and their actual behaviour.[6] The contributing factors are broad and don't point to a single cause. For example, 60.2% of Canadians attributed the gap to a lack of knowledge or information, while another 25% believed it was a lack of support from other household members. A lack of time to understand the right behaviours was identified by 61.2% of respondents and money required to invest in more environmentally responsible technologies was a contributing factor for 45% of respondents. This reveals that many factors play a role in energy consumption and conservation behaviours.

Using insights from behavioural economics, this section of the report identifies key barriers and levers to influencing energy consumption. Section 1.1 outlines the informational, behavioural, pricing, and technological strategies we hypothesized would lead to a shift in energy utilization. In particular, it reviews the impact of informational challenges such as cognitive effort, the impact of data presentation including the comprehensibility of metrics, and how framing impacts the perception of prices. Behavioural strategies include the role of feedback, social benchmarking, and commitment devices. Finally, the section concludes with a look at how pricing strategies and technology can successfully influence behaviour. Sections 1.2, 1.3, and 1.4 offer observations about consumer beliefs and behaviour based on findings from three of

[5] Costanzo, M., Archer, D., Aronson, E., & Pettigrew, T. (1986). Energy conservation behaviour: The difficult path from information to action. American psychologist, 41(5), 521.
[6] Kennedy, E. H., Beckley, T. M., McFarlane, B. L., & Nadeau, S. (2009). Why we don't "walk the talk": Understanding the environmental values/behaviour gap in Canada. *Human Ecology Review*, *16*(2), 151.

our primary research initiatives: an *Electricity Consumer Survey*, the *BE Audit* of a typical electricity bill in Ontario, and a Bill Click-Tracking Experiment. Together, this research provides a foundation for further exploration into the relevant barriers to awareness, comprehension, and motivation that are inhibiting consumers' load-shifting and other conservation behaviours.



1.1 Key Insights from the Behavioural Sciences Literature

Effective energy-saving behaviours depend on the degree of cognitive effort required.

One of the fundamental insights from behavioural economics is the effectiveness of strategies that do not require cognitive effort. Neuroscientific and psychological data have converged to indicate that both anticipated and actual cognitive demand play an important role in behavioural decision-making, with humans discounting the value of rewards that require effort to obtain.[7] In practical terms, this means that actions that require effort are harder to motivate in consumers, whereas defaulting people into good decisions finds much greater success. An example is defaulting consumer enrolment in a socially desirable program using an *opt-out* rather than *opt-in* strategy. Significant increases in the acquisition and maintenance of desirable behaviours can be achieved by enrolling consumers into programs that bind them to desirable behaviours with an option to opt-out – partly because individuals rarely opt out of the option that requires no action.[8] The persistence of this "default option" may be because of procrastination, because of the endowment effect, because the financial or time cost of changing options, or because of having to acquire information about the benefits of making a change. As a result of this inertia, setting the default option to the socially optimal one can be a very effective strategy.

In the case of energy conservation, programmable devices such as thermostats with feedback mechanisms have shown great success. California's Statewide Pricing Pilot tested Critical Peak Pricing and Time of Use pricing with and without enabling technology such as smart thermostats. Participants with smart thermostats reduced their peak-period energy usage by roughly 27%, which was 11.4% more than the comparable group where only a subset of participants took advantage of the technology.[9]

The OEB has already taken steps to default the population into TOU based pricing. Other options could include defaulting the population into a mandatory installation of programmable thermostats that automatically cycle down, and the introduction of critical peak pricing.

Improving the ease with which information is interpreted will drive conservation behaviours.

Reducing complexity can have a dramatic influence on customer decisions. Presenting information in a simple manner, through minimal text, clean fonts, easy-to-read sentences, and using visuals when possible, increases the subjective impression of ease associated with completing a task.[10] This principle is known as *fluency,* and has been shown to be an influential cue across a wide array of judgments. Fluency is characterized by high speed, low resource demands, high accuracy, and other indicators of efficient processing. The more fluent something is, the easier it becomes to recall at a later time. Research has found that a stimulus that promotes fluent perception is usually more positively evaluated, and is perceived as being

[7] Botvinick, M. M., Huffstetler, S., & McGuire, J. T. (2009). Effort discounting in human nucleus accumbens. *Cognitive, Affective, & Behavioral Neuroscience*,*9*(1), 16-27.
[8] Kool, W., McGuire, J. T., Rosen, Z. B., & Botvinick, M. M. (2010). Decision making and the avoidance of cognitive demand. *Journal of Experimental Psychology: General*, *139*(4), 665.
[9] Allcott, H., & Mullainathan, S. (2010). Behavioral science and energy policy.*Science*, *327*(5970), 1204-1205.
[10] Faruqui, A., & George, S. (2005). Quantifying customer response to dynamic pricing. *The Electricity Journal*, *18*(4), 53-63.

more truthful and credible. For example, a statement was judged to be more credible and truthful when it was presented in an easy-to-read font, than the identical statement was when presented in a more difficult to read font.[11] Even companies with fluent, easy-to-pronounce names enjoy better performing stock prices than companies with less fluent names.[12] On the other hand, information that is not fluent, or difficult to process, is likely to be avoided by the reader. Our *Bill Click Tracking Study* supports this notion. People have a tendency to avoid text heavy regions of the bill and instead focus their attention on total amounts, due dates, and visual information.

The successful adoption of energy saving behaviours is, in part, dependent on the cognitive effort they require. Energy saving activities that imply the monitoring and planning of scheduled actions (e.g. turning off lights when leaving a room, manual adjustment of thermostats) rely on sustained attention and working memory mechanisms. Providing consumers with information that is less cognitively demanding to process and recall is more likely to have a positive influence on energy conservation.

Visual (as opposed to semantic) presentations of information and messaging can be an effective method of shifting behaviour. Simple visual cues draw consumer attention and are often less cognitively demanding that word-based information.[13] In one study, researchers compared the behaviour of participants who were provided feedback on their energy consumption in the form of either ambient lighting signals (red light indicating high consumption and green light indicating low) or factual numerical data (the numbers of kWh usage). The participants given ambient lighting signals were not only faster (39.3 seconds versus 44.1 seconds) at subsequently programming a thermostat, but also used an average of 21% less electricity than those in the numerical data group.[14]

Similar studies have found that consumers are more open to shifting behaviour if the information is presented visually with clear cues. For example, consider the alphabetical A-G scale, used to rank appliance energy efficiency. It was widely adopted in the EU and later transitioned to the A+ scale (i.e. ranging from A+ - F) as a means to reflect increased energy efficiencies of the market (i.e. A+ equating to the highest energy efficiency standards). On the other hand, countries such as China have adopted a numerical scale (i.e. 1-5) to represent energy efficiency. Research examining consumer understanding of these various scales has found that comprehension of energy consumption varies based on how the information is presented. Alphabetic scales (i.e. A-G and A+) are the most comprehensible followed by numeric scales.[15],[16] This is because consumers already know from their days in grammar school that an A+ is excellent, while an F is a failing score. They do not have to exert effort to remember which

[11] Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: is beauty in the perceiver's processing experience?.*Personality and social psychology review*, *8*(4), 364-382.
[12] Alter, A. L., & Oppenheimer, D. M. (2006). Predicting short-term stock fluctuations by using processing fluency. *Proceedings of the National Academy of Sciences*, *103*(24), 9369-9372.
[13] Corradi et al (2013) Oops, I Forgot the Light On! The Cognitive Mechanisms Supporting the Execution of Energy Saving Behaviors. Journal of Economic Psychology. No. 34. P. 88-96.
[14] Ham, Jaap, and Cees Midden. Ambient persuasive technology needs little cognitive effort: the differential effects of cognitive load on lighting feedback versus factual feedback. *Persuasive Technology*. Springer Berlin Heidelberg, 2010. 132-142.
[15] Egan, C. (2001). Testing of International Appliance Labeling Approaches with US Consumers. In *Energy Efficiency in Household Appliances and Lighting* (pp. 603-614). Springer Berlin Heidelberg.
[16] Egan, C. (2000). An evaluation of the Federal Trade Commission's energy guide appliance label: an interim summary of findings, American Council for an Energy-Efficient Economy Report No. A003;

labels are good or bad. This finding ultimately highlights how the visual presentation of information as well as deliberate cues and scoring mechanism that consumers are already familiar with, can help stimulate positive behavioural changes in electricity consumption.

Specific insights for this project from this research include the need to simplify the core elements of the TOU pricing model. For example, research on fluency suggests that improving the TOU clock for quicker and more accurate processing might better garner consumer attention and lead to higher comprehension and recall among both residential consumers and small business owners.

The metrics presented to consumers matter in terms of successfully effecting behavioural change.

The systematic misunderstanding of metrics can have negative consequences when trying to effect behavioural change. For instance, consumers display an impoverished understanding of fuel efficiency when it is presented as miles per gallon (the standard metric on the automotive fuel efficiency label). However, consumer accuracy of fuel efficiency increases when automotive efficiency is presented in terms of Gallons per 100 miles, presumably as this allows for easier computation of the cost of operation – which is a significant factor in making vehicle purchase decisions. Based in a large scale study conducted in 2010, the United States Environmental Protection Agency (EPA) mandated a new label that contains fuel efficiency information expressed as both miles per gallon and as a fuel consumption metric i.e. gallons per 100 miles.[17]

Our primary research reveals that a large proportion of consumers do not understand the concept of a kilowatt hour as a measure of electric energy use, even though this is the metric used on their monthly electricity bills. Not understanding the unit of measure likely contributes to the challenge of monitoring and improving energy usage behaviour.[18]

Based on the premise that kWh is an abstract concept for many consumers, and therefore doesn't effectively influence consumption behaviour, the Department of Energy and Climate Change (DECC) and the Behavioural Insights Team in partnership with John Lewis Department Stores in the United Kingdom introduced a new metric. Instead of just listing the kWh consumption on new appliances, they introduced a new label that provided the typical lifetime energy costs to run the appliance. The study compared the impact the new label had on the overall sales of the appliances (by the average kWh consumption) with the standard-kilowatt hour labels. The results indicate a statistically significant increase in the sales of the lower cost-to-run washer dryers likely as a result of the modified labels. Despite this promising indication, there was no effect on other laundry appliances such as the washing machines or tumble dryers. This may be because their overall cost-to-run was lower, thereby attenuating the effect of the label. However, this study provides new evidence for the importance of providing

[17] Office of Transportation and Air Quality, EPA, and National Highway Traffic Safety Administration, Us DoT (2010). Environmental Protection Agency Fuel Economy Label - Final Report. U.S. Environmental Protection Agency. September, 2010.
[18] Froehlich, J. (2009, February). Promoting energy efficient behaviors in the home through feedback: The role of human-computer interaction. In *Proc. HCIC Workshop* (Vol. 9, pp. 0-10).

information that is meaningful to the consumer. This appears to be particularly effective when combined with a significant, salient price difference.[19]

This knowledge and understanding gap provides an opportunity to enhance conservation behaviour by presenting consumption information using a metric that is more accessible and relevant to consumers. This could leave consumers better equipped to make realistic judgments about the costs of their electricity consumption behaviour.

The way energy costs are framed has a large impact on consumer behaviour.

Price framing can impact consumers' willingness to shift behaviour. A frame refers to a mental model of the decision rule that individuals use to solve a problem. It includes details about the elements of the decision problem to be solved as well as the context.[20] Previous studies have indicated that price framing strategies that break aggregate, one-time payments into smaller, daily amounts can significantly impact demand. In spite of the fact that the underlying payment remains aggregated, research has shown that consumers have an easier time finding payments attractive if they are divided up into a low daily cost – like that of the "Pennies-a-Day" strategy.[21] This effect, however, is moderated by the size of the smaller payment. A large daily dollar amount may actually exaggerate the perceived magnitude, causing a strategy like Pennies-a-Day to backfire, because it is in effect substantially more than just a few pennies a day.[22] In the context of energy conservation, this could prove useful in that it is ideal to instigate cost sensitivity among consumers. Currently the daily price of electricity is deemed by most to be too inconsequential to warrant behavioural change. So reporting weekly, monthly or even annual savings is likely to be more effective.

Similarly, research has also indicated that enhancing price extremes, as in the case of actual significant differences between low and high price points in a TOU model, can help consumers make better decisions about the timing and aggregate amount of their electricity consumption.[23]

Prior research has demonstrated that losses loom larger than gains.[24] In other words, framing something as money you don't save is not as painful as framing that same amount as money you will lose. Framing the price in a comprehensible, negative price frame (i.e. emphasizing the painfully high price of the highest TOU rate) may lead to decreased usage during that time period. Information detailing how much money consumers are losing each month by not investing in energy-saving technologies or behaviours, is likely to be substantially more effective than positioning the same information as a savings gain.

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[19] Department of Energy & Climate Change. (2014). Evaluation of the DECC/John Lewis energy labeling trial. September 2014.
[20] Soman, D. (2004). Framing, loss aversion, and mental accounting. *Blackwell handbook of judgment and decision making*, 379-398.
[21] Gourville, J. T. (1998). Pennies-a-day: The effect of temporal reframing on transaction evaluation. Journal of Consumer Research, 24(4), 395-403.
[22] Soman, D. (2004). Framing, loss aversion, and mental accounting. Blackwell handbook of judgment and decision making, 379-398.
[23] Ariely, Dan. Predictably Irrational. New York: HarperCollins, 2008.
[24] Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.

Providing individualized and real-time feedback on electricity consumption is an effective way to nudge consumers towards conservation behaviours.

Research has indicated that technologies that provide real-time feedback information on electricity consumption can be impactful in reducing electricity demand.[25] Consumers generally receive limited feedback about their energy consumption in the form of a monthly bill statement. The bill itself provides few opportunities for real-time feedback based on behaviour.

A recent meta-study incorporated 5 different review studies and 21 unique papers on the impact of feedback on electricity consumption, as well as consumers' reactions and attitudes towards feedback.[26] The study supports the idea that improved feedback on electricity consumption may provide a tool for consumers to better understand and control their usage and ultimately conserve energy. The findings revealed that feedback stimulates an average electricity savings (i.e. in kWh) of 5% to 12% (Min = 1.1%; Max = 20%).[27]

The meta-analysis also considered different types of feedback and their variable impact; most successful feedback combines the following features:

- Frequent feedback over a long period of time
- Feedback that provides an appliance-specific breakdown
- Feedback that is presented in a clear and appealing way

This study also identified several “best case” features of feedback design. It is suggested that feedback designs:

- Provide computerized feedback
- Offer multiple feedback options at the user’s discretion
- Provide an interactive element that engages households
- Offer a detailed and specific breakdown of usage on a daily -- or even more frequent basis

Thus overall, real time energy efficiency feedback may allow for reinforcement of consumer energy conservation through highlighting the contingencies between conservation and cost savings and/or alternative forms of reward.

Social benchmarking, when implemented correctly, provides a powerful means to nudge consumer behavior.

In recent years there has been an increased understanding and interest in the processes of social influence and conformity in relation to energy conservation. In one study, Nolan and colleagues demonstrated that social benchmarking based on descriptive normative beliefs (e.g., 77% of local residents use fans instead of air conditioning to keep cool in the summer) produced

[25] Faruqui, A., Sergici, S., & Sharif, A. (2010). The impact of informational feedback on energy consumption—A survey of the experimental evidence. *Energy*, *35*(4), 1598-1608.
[26] Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy?. *Energy efficiency*, *1*(1), 79-104.
[27] Froehlich, J. (2009, February). Promoting energy efficient behaviors in the home through feedback: The role of human-computer interaction. In *Proc. HCIC Workshop* (Vol. 9, pp. 0-10).

the greatest change in actual energy use compared to other informational appeals such as environmental protection, or social responsibility.[28] These researchers ran a field study composed of 981 households in a middle-class Californian neighborhood. The households randomly received one of five different door hangers, which varied the type of message used to promote energy conservation. The pleas included descriptive norms, self-interest, environmental protection, social responsibility, or an information-only control door hanger. One month after the start of the study, those participants in the descriptive norms condition significantly reduced their average daily kWh consumption (down to 12.97 kWh), relative to the other conditions combined (down to 14.17 kWh). These results held well into the 2nd month after the study's launch.

Furthermore, it was found that social norms were particularly powerful when the "others" described as engaging in socially responsible behavior were most local. This suggests that informing Ontario residents that other Ontario residents are using less energy will be more effective than informing them that other North Americans are using less energy.

What's perhaps most surprising is that while descriptive social norms had the greatest impact on changing actual conservation behaviours, participants predicted that they were least likely to be effective. The surveyed participants mistakenly believed environmental protection and social responsibility would be the most effective messages. The results of the experiment shed light on the influence of descriptive norms on peoples' behaviour. It also highlights the challenge in predicting what will impact consumer behaviour. This say-do gap supports the need for proper controlled experimentation. In short, what others do influences what we do, whether we are aware of this or not.

Pre-existing individual beliefs can moderate the impact of social benchmarking interventions. Norms and beliefs vary from one person to the next. As a result, norm-based interventions can differ dramatically in their degree of effectiveness. The likelihood of an individual being influenced by a normative message depends on what the individual already believes about other peoples' behaviour in that situation, as well as their level of personal involvement in the cause (i.e. the extent to which an individual finds an issue, event, object or person important). Specifically, research has found that an individual's likelihood to conserve electricity is significantly related to his or her beliefs about how often others conserve. Importantly, people who aren't heavily involved in energy conservation are even more susceptible to the influence of descriptive social norms. This suggests that while descriptive norms confirm the beliefs held by people who are already highly engaged in a particular cause, they also influence those who are less engaged but that don't already hold strong beliefs about the behaviour of other people.[29]

Other demographic and ideological features of households can impact the effectiveness of social benchmarking interventions.[30] A recent study from the US noted a difference in conservation behaviour between liberal and conservative consumers when both were provided

[28] Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality and social psychology bulletin*, *34*(7), 913-923.
[29] Göckeritz, S., Schultz, P., Rendón, T., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2010). Descriptive normative beliefs and conservation behavior: The moderating roles of personal involvement and injunctive normative beliefs. *European Journal of Social Psychology*, *40*(3), 514-523.
[30] Costa, D. L., & Kahn, M. E. (2013). Energy conservation "nudges" and environmentalist ideology: Evidence from a randomized residential electricity field experiment. *Journal of the European Economic Association*, *11*(3), 680-702.

with the same social benchmarking information. Using political party registrations, household donation records to environmental causes, participation in renewable energy programs, and data on the characteristics of the local communities, the researchers created two distinct respondents' pools. One group was classified as "greens" and the other as "non-greens".

The "greens" were classified as households that traditionally voted for the Democratic Party, purchased electricity from renewable sources, donated to environmental groups, and who lived in predominantly liberal neighborhoods. The "non-greens" were defined by their Republican voting record, their history of purchasing electricity from non-renewable sources, and their lack of donations to environmental groups. All respondents in these groups received the same Home Electricity Report, which compared their household consumption to their neighbors with similar homes and types of heating. The report also made monthly comparisons and provided tips for reducing energy consumption. Using billing data for the households in the study, the researchers found a significant difference between how "green" Democrats and "non-green" Republican households responded to the Home Energy Report. The Democratic households reduced their consumption by 3%, while the Republican households actually *increased* their consumption by 1%. These results illustrate how the same messaging can be effective at nudging the desired behaviour in one group, but can backfire with another group based on their attitudes, beliefs, affiliations and convictions.

The timing of normative appeals, in terms of effecting consumer behaviour changes, also matters. In an attempt to broaden the understanding of the impact on social norms, Dolan and Metcalfe employed two natural field experiments examining the effectiveness of social benchmarking alongside conservation information, timeframes, and financial rewards.[31] They found that social norms changed energy behaviour over a 15-month timeframe, irrespective of whether additional information about electricity conservation was provided or not. Norms have the greatest impact on the day that information is received and this impact decays over time. Interestingly, online delivery of information on social norms provided little benefit regardless of whether consumers are accustomed to receiving their bill online or not. They did find, however, that describing very large financial rewards is effective in online settings (i.e. reducing consumption over a four-month period), but that the effect of financial incentives was completely removed when information on norms was added online.

Opower, a US-based company that provides IT services to utility companies, has mailed over six million "Home Energy Reports," which are billing statements that include personalized energy use feedback, social comparisons, and energy conservation information. Evidence from randomized controlled experiments suggest that these modified bill statements have lead to a reduction in energy consumption around 2%. To uncover the long-term effects of these interventions, Allcott and Rogers examined the energy consumption behaviours of households receiving these mailings. This research revealed a positive long-term impact on consumer behaviour. Initial observations of the data suggested that participants were exhibiting an "action and backsliding" behaviour. That is, after receiving their first report they show an immediate reduction in energy use but this was only sustained for a short period of time. Interestingly, the

[31] Dolan, P., & Metcalfe, R. (2013). Neighbors, knowledge, and nuggets: two natural field experiments on the role of incentives on energy conservation. Retrieved from: http://eprints.lse.ac.uk/51563/1/dp1222.pdf

degree to which the participants bounced back to old consumption levels lessened over time suggesting that consumers appear to be newly cued or inspired with each report.

The overall reduction in the amount of backslide may be the result of investing in new capital stock. These investments might include new high efficiency appliances and changes in "consumption capital." Consumption capital refers to the repertoire of newly adopted behaviours, such as modifications to thermostat settings. Additionally, the study found that when reports had been discontinued after two years of delivery, the effects were relatively persistent, decaying at a modest 10–20 percent per year, suggesting that the new behaviours had been substantively inculcated.[32]

The above research indicates that specific forms of feedback can be powerful drivers of energy conservation behaviour.

Commitment devices are effective when it comes to keeping consumers on track towards changes in behavior.

Although multiple studies have found that people generally demonstrate a favorable attitude towards conservation, their efforts often fall short of their intentions. A nudge that enhances people's commitment to an action or cause can align their behaviours with their attitudes.[33]

Research has found support for the effectiveness of pledges and other commitment devices in nudging individuals towards behavioural change. According to Allcott and Mullainathan, because humans have a tendency to procrastinate, commitment devices can act as effective interventions that provoke or inspire individuals to lock themselves into taking an action today that they may otherwise prefer to take tomorrow.[34] Simply put, getting people to pre-commit to what they will do tomorrow decreases the likelihood of procrastination.

Examples of the effectiveness of commitment devices have been demonstrated in nudging recycling behaviour.[35] Burn and Oskamp carried out a commitment intervention that was aimed at household recycling.[36] Participants in the commitment conditions were asked to sign a pledge card. If they agreed to pledge, they were given a sticker to remind them of their commitment to recycle. The results showed a significant difference between the commitment condition and the control group in the frequency of recycling during the pledge period. Another experiment found that a signature commitment was significantly more effective at inducing regular recycling than flyers, telephone calls, or face-to-face interactions.[37] A study examining water conservation found people who were made to feel hypocritical about their own conservation behaviour, while

[32] Allcott, H., & Rogers, T. (2012). The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation (No. w18492). National Bureau of Economic Research.
[33] Lokhorst, A. M., van Dijk, E., & Staats, H. (2009). Public commitment making as a structural solution in social dilemmas. Journal of environmental psychology,29(4), 400-406.
[34] Allcott, H., & Mullainathan, S. (2010). Behavioral science and energy policy.Science, 327(5970), 1204-1205.
[35] Lokhorst, A. M., van Dijk, E., & Staats, H. (2009). Public commitment making as a structural solution in social dilemmas. Journal of environmental psychology, 29(4), 400-406.
[36] Burn, S. M., & Oskamp, S. (1986). Increasing community recycling with persuasive communication and public commitment. *Journal of Applied Social Psychology*, *16*(1), 29-41.
[37] Werner, C. M., Turner, J., Shipman, K., Shawn Twitchell, F., Dickson, B. R., Bruschke, G. V., & von Bismarck, W. B. (1995). Commitment, behavior, and attitude change: An analysis of voluntary recycling. *Journal of Environmental Psychology*, *15*(3), 197-208.

encouraging others to save in a public commitment, were subsequently more likely to conserve resources themselves.[38] Commitment devices, when paired with other interventions, can be an effective strategy towards changing behaviour where intention does not match action (i.e., situations marked by the say-do gap).

Commitment devices allow consumers to formalize their goals and can have implications on personal well-being if not fulfilled. Lack of fulfillment can lead to shame, guilt, or even self-contempt. Thus, commitment devices have the potential to be powerful drivers of behavioural change.

Compliance with dynamic pricing models in order to manage peak demand is driven in part by actual and perceived differences in the financial incentives.

Much research has been conducted on dynamic pricing in the energy sector. The majority of these findings point to the effectiveness of dynamic pricing models for modifying electricity consumption behaviour and decreasing peak loads. However, the effect sizes (typically the degree to which peak loads were reduced) have been shown to vary dramatically. In their analysis of nine recent pricing studies from North America and Ireland that represent a total of 74 different tests, Fauqui and Palmer found that effect sizes ranged anywhere from 0% to just under 50%.[39] Interestingly, further analysis of these nine studies suggests that pricing ratios can account for 49% of this variance. The success of an intervention depends on a number of factors, including the local and seasonal climate, the characteristics of the consumers, and the implementation process. However, the importance of financial incentives cannot be discounted.

In many of the experiments conducted, Critical Peak Pricing (CPP) schemes, where consumers are charged at a higher rate for electricity consumed during days of the year when the demand is particularly high, show great promise at reducing peak loads and typically outperform the other TOU models studied.[40] This finding is likely due to the relatively higher ratios between standard and peak pricing that are commonly found in CPP designs. Unsurprisingly, as the difference between the cost of electricity during off-peak and on-peak periods increases so does the incidence of load shifting.

Multiple studies carried out by a major utility company in Phoenix found that increases in the price ratio between a standard rate and peak rate can influence consumer behaviour and impact demand loads during the summer months. One such pricing experiment conducted in 1988 revealed that customers on a 3:1 on-peak to off-peak pricing plan displayed an average decrease of 8.8% in coincident demand (defined as the hourly demand at the time of the utility's summer system peak). This impact can be compared to the more robust finding from customers on a 5:1 plan who demonstrated an 11% decrease in demand.[41] A more recent experiment found similar results. Participants in this study began on either a fixed pricing

[38] Dickerson, C. A., Thibodeau, R., Aronson, E., & Miller, D. (1992). Using Cognitive Dissonance to Encourage Water Conservation1. *Journal of Applied Social Psychology*, *22*(11), 841-854.
[39] Faruqui, A., & Palmer, J. (2012). The Discovery of Price Responsiveness–A Survey of Experiments Involving Dynamic Pricing of Electricity. *Available at SSRN 2020587*.
[40] Faruqui, A., & George, S. (2005). Quantifying customer response to dynamic pricing. *The Electricity Journal*, *18*(4), 53-63.
[41] Kirkeide, L. K. (1989). Reducing power capacity requirements using two-period time-of-use rates with ten-hour peak periods (Doctoral dissertation, Arizona State University).

schedule without TOU or a TOU pricing plan with an off-peak to on-peak price ratio of approximately 3:1. There was a decrease of 25% in coincident demand for both groups when they were enrolled in a shorter on-peak TOU plan where the peak period was reduced from seven hours to three, but was paired with a higher price ratio of 4.4:1. This suggests that consumers, regardless of their starting point, appear to react more favourably to larger financial incentives, where the variance in cost as a function of timing of usage is greatest.

Interestingly, there are limits to this effect. A meta-analysis of over 120 studies examining peak load reduction in response to TOU found that as this ratio increases, the peak load also increases, but at a diminishing rate.[29] The “arc of responsiveness” that results from the relationship between TOU ratios and peak load reductions has obvious implications for Ontario’s TOU pricing structure. Considering the average ratio for these programs lies somewhere around four, Ontario’s relatively low on-to-off peak price difference could be a major factor inhibiting its success.

1.2 Insights from the Electricity Consumer Survey

This survey explores the current level of awareness and comprehension of the TOU program amongst Ontarians. It also looks for plausible reasons why Ontarians are, or are not, responding to the current pricing structure.

Survey Respondents and Research Methodology

Three identical, but targeted surveys were distributed to (1) an online panel of Ontario residents, (2) an online panel of small businesses (<100 employees) in Ontario, and (3) a randomly selected sample of individuals who were approached in downtown Toronto. Both online surveys were administered between August 29 and September 9, 2014. As a reward for their participation, these individuals received either AIR MILES reward miles or points towards a retail gift card*. Participants who were approached on the street were asked to complete the survey for a chance of winning an Amazon Gift Certificate. All participants were asked a series of questions to (i) help establish a baseline of how Ontarians currently engage with their electricity bill and (ii) measure awareness and comprehension of the TOU program.

Ontario Residents Survey

Online Panel

Six-hundred and sixty-six (666) participants met the criteria of having lived in a household that paid an electricity bill in the past year and age > 18 (please refer to Table 1 in Appendix A). There are some notable biases in the sample that should be considered when interpreting the results from these surveys.

1. **Educated** – Participants with post-graduate degrees were over-represented, with an under-representation of participants without a post-secondary degree.
2. **Home Owners** - A large proportion of participants owned their residence (82%).. Most lived in a detached home (64%).
3. **City Dwellers** - A large proportion of participants lived in Toronto (21%). The other top locations that participants resided in were Ottawa (9%), Mississauga (5%), London (5%), and Hamilton (5%). The remaining participants were scattered across Ontario with a bias toward cities over towns.
4. **Aware –** The Ontario Power Authority recently launched a promotional campaign with AIR MILES that rewarded AIR MILES members with 100 bonus AIR MILES reward miles for enrolling in the PeaksaverPLUS program. Consequently, recent campaign blasts may increase AIR MILES members' awareness of the PeaksaverPLUS and TOU program. 55% of participants that completed the *Electricity Consumer Survey* were AIR MILES members.

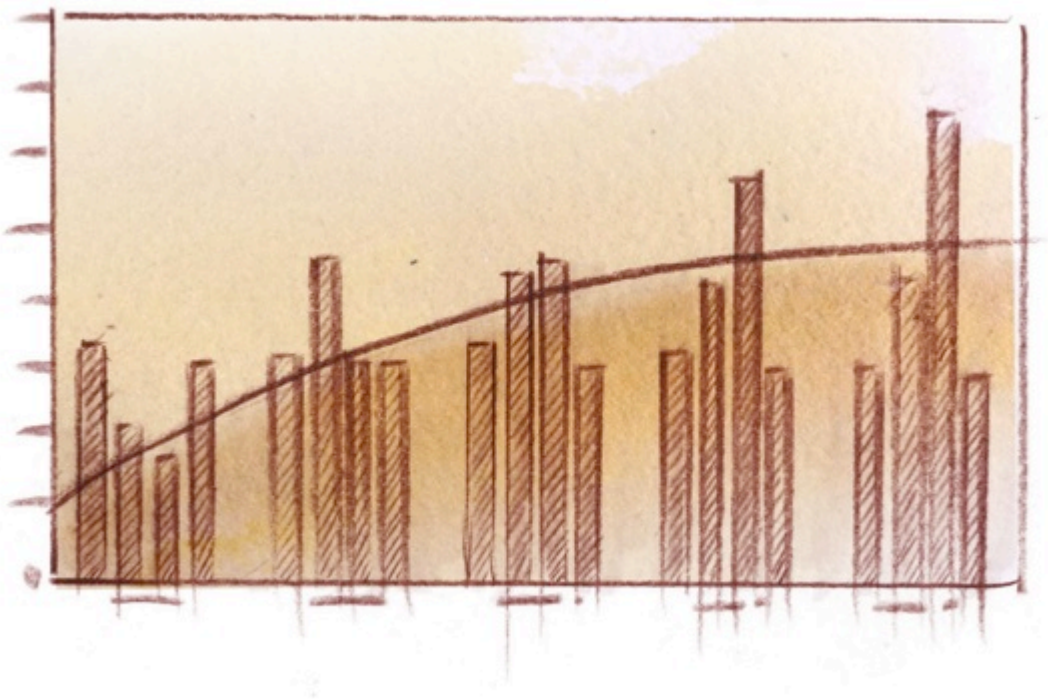
*For the OEB Electricity Consumer Survey, 55% of the Ontario Residents who completed the online survey were awarded AIR MILES reward miles and the remaining 45% received valued opinion points of equal value towards a gift card. For the Small Business survey, participants that completed the survey received AIR MILES reward miles.

Street Survey

A shortened version of the *Ontario Resident Survey* was administered on the streets of Toronto between September 8, 2014 and September 12, 2014. The purpose of the survey was to provide an additional data point for awareness of TOU pricing. Participants who met the same criteria as the Online Survey were asked to complete a short 5-minute survey for a chance to win a $25 Amazon Gift Card. Comparatively, participants who completed the on-the-street survey (n = 53) tended to be younger and more likely to live in a condo/apartment. Additionally, half the participants (51%) were from Toronto, and the other half were mostly from cities near Toronto. For example, 7% were from Richmond Hill and 5% were from Hamilton.

Small Business Survey

68 participants met the criteria for taking part in this study. All participants were responsible for reviewing the electricity bill at a business that employed less than 100 workers. Participants varied across demographic measures, such as business location, its primary business focus (e.g. construction vs. retailer), office type, and property square footage. Notably, a large proportion of Small Business participants (60%) worked at a business with fewer than 20 employees.



How the survey was designed

All surveys took approximately 15 minutes to complete, and were broken down into 9 sections in the following order:

	Section	Description
Responses to section 1 and 2 provided a baseline of how Ontarians engaged with their electricity bill.	**1. Bill awareness**	• Assessed awareness of the household's electricity bill - did they receive an electricity bill, did they pay / contribute to the electricity bill, and how frequently did they receive the bill?
	2. Bill delivery	• Assessed interaction with the household's electricity bill, such as the method of receiving and paying their electricity bill and the reasons for why they did or did not read their bill.
Questions in sections 3, and 4 were used to create a TOU score (out of 12) to measure awareness and comprehension of TOU pricing in Ontario. (see Table 3) ***** For these four sections, participants were instructed to not look at their electricity bill, but instead recall information from memory.***	**3. Awareness** Unit Knowledge TOU Knowledge	• Assessed awareness and comprehension of the unit of electricity = kilowatt hour (kWh). • Assessed awareness of Ontario's TOU timing and pricing schedules.
	4. Comprehension Unit Application TOU Application	• Assessed knowledge of the factors and behaviours that increase the kWh usage – participants were asked to identify appliances that use the most amount of electricity (based • on kWh) and to identify behaviours that would • reduce electricity usage during the summer. • Assessed knowledge of how to change behaviours to lower the electricity bill based on TOU pricing and timing schedule.
Questions in sections 5 and 6 were used to assess personal and societal beliefs about TOU pricing and the PeaksaverPLUS program	**5. Usage Beliefs**	• Assessed beliefs about the effectiveness of TOU pricing in changing behaviour – evaluated the impact of TOU pricing on electricity usage.
	6. PeaksaverPLUS	• Assessed appeal of the current PeaksaverPLUS program.
Questions in sections 7 gathered demographic information	**7. Demographics**	• This section gathered demographic information, such as income and education, and information on household electricity usage, such as kWh consumed and total amount due for the last bill read.

What we found

Our hypotheses and main findings from the *Electricity Consumer Survey* and highlighted below.

Hurdles	Survey Findings
Awareness - Ontarians may be unaware that electricity prices vary depending on the time of day, day of the week (weekday/ weekend), and season.	• **Ontarians have a moderate level of awareness of the TOU program.** Overall, a large proportion of participants were aware of how electricity was priced in Ontario, but were unable to recall the basic details of the program, such as changes in mid-peak times during summer and winter months (Table 7 in Appendix A). • **Ontarians who stated that they read their electricity bill had higher awareness of Ontario TOU program.** Participants who claimed to read their bill scored 8% higher on awareness questions (Figure 3 in Appendix A). Females, Ontarians who received their bill via email, and non-primary account holders were significantly less likely to state that they read the electricity bill. • **How Ontarians choose to receive or pay their electricity bill had no impact on their awareness.** Ontarians who received their bill online had the same level of awareness as those who receive their bill through the mail. Ontarians who opted in to automatic payments had the same level of awareness as others who chose more active forms of payments (e.g., paying online). • **Ontarians who received their bill on a quarterly basis had lower awareness.** Participants who received their bill every 4 months scored lower on awareness than those who received their bill monthly or bi-monthly. There was no significant difference between those who received their bill monthly and those who received it bi-monthly . • **Participants living in detached homes were found to have higher awareness than those living in other residence types.**
Comprehension - Ontarians who are aware of TOU pricing may still not understand when and how TOU pricing is enforced and what behaviours will reduce their monthly electricity bills.	• **Comprehension of TOU pricing is low.** A large proportion of participants had difficulty defining a kilowatt hour (kWh) and selecting the actions that would reduce their total electricity cost. • **Participants living in detached homes were found to have better comprehension than those living in other residence types.** • **Ontarians with more education had a better grasp of the factors and behaviours that impacted the total bill amount, leading to higher comprehension scores.** • **TOU pricing is harder than it seems.** A large proportion of Ontarians indicated that they found the current TOU illustration (see Figure 7a an 8a in Appendix A) easy to understand and many believed that others would too (see figure 7b and 8b in Appendix A). However, only a very small proportion of Ontarians were able to correctly apply the information to reduce costs (23% got both questions correct).

Value - The perceived or actual monthly savings accrued as a result of shifting consumption behaviours may not be incentive enough to warrant sustained behaviour change.	• **Ontarians with larger homes had higher scores and were more likely to say that TOU pricing has affected how they consume energy.** This is not surprising, as larger homes generally use more energy and thus save more in dollars by switching to more efficient behaviours. • **Ontarians care about the bill in so much as it informs them of how they can lower their personal financial costs.** The top two motivators for reading the bill were to find out the amount due, and learn about consumption patterns (presumably to lower costs). Participants who did not read the bill cited either a lack of personal financial investment (i.e., someone else pays the bills) or a lack of change in the total charges as the top reasons for not reading the bill (Figure 2 in Appendix A). • **There is a complex relationship between financial incentives and behaviour that may vary by customer.** Ontarians who believe TOU has changed their behaviour cite financial savings as a driver, whereas those who have not aligned their energy consuming activities to TOU prices do not blame a lack of incentive as the reason for not doing so.
Complexity - The behaviours required to shift from high to low peak hours are perceived as being too complex and time consuming.	• **Ontarians do not feel that TOU pricing is too complex to understand.** Most participants who have not shifted their behaviour did not cite complexity of the program as a reason for this lack of change. Similarly, when asked about the reason why other Ontarians would not shift their behaviour, most participants did not choose complicated TOU pricing structure as the reason. • **kWh is a difficult concept to grasp.** Only 34% of respondents were able to correctly identify both the unit of electricity consumption (kWh) and its definition. Of those who correctly defined a kWh, a large proportion (47%) did not have confidence in their response. Moreover, 80% of participants who got the question correct believed that less than 5 out of 10 randomly selected Ontarians would be able to answer the questions correctly (Figure 4 and 5 in Appendix A) • **Ontarians that had a higher education level were more knowledgeable of the factors and behaviours that impacted their electricity bill.** • **For Small Business, it is too complex to switch many of their activities to off-peak periods.** A primary driver for Small Businesses to shift to TOU periods was “To save money on monthly electricity bills”. However, a large proportion of participants expressed that it was only somewhat convenient for them to shift their business’ electricity consuming behaviours (Figures 14 and 15 in Appendix A).
Misunderstanding/ false beliefs - Ontarians may believe that they are already doing everything they can to reduce their energy consumption.	• **Ontarians seem to underestimate their own energy consumption.** 83% of participant felt that their electricity consumption was about the same or less than other households their size (Figures 12a/b in Appendix A). This mirrors findings in other contexts, such as most people thinking they are above average drivers. However, the reality is that approximately half of participants are likely to consume more than the average household their

	size. Consistent with this, when asked to provide the amount of kWh used last month, participants who only estimated their electricity usage provided a significantly lower amount than participants who had inputted an actual number from their bill. • **Participants seem to overestimate their understanding of the program**. Although a large proportion of participants found the TOU illustration easy to understand (77%) and believed that others would too (66%), a very small proportion of participants were able to correctly apply the information in a way that would lead to reduced electricity costs. • **82% of participants felt that they have already shifted their behaviour in response to TOU pricing.**
Habits - Automatic or routine behaviours are hard to break. Even those Ontarians who understand TOU pricing and intend to shift their consumption behaviours may not do so because TOU schedules are not top of mind.	• **For many people, scheduling hassles interfere with TOU adoption**. When asked about their reasons for not shifting their usage to off-peak hours or the reason why other Ontarians may not shift their behaviour, the statement that respondents agreed with the most was: "it is difficult for me to schedule electricity consuming activities during off-peak hours (such as overnight)".

Thoughts and Considerations

The findings from these surveys provide additional data to aid our understanding of the current level of awareness and comprehension of the TOU program amongst Ontarians. The results also highlight the plausible reasons why Ontarians are, or are not, responding to the current pricing structure. Nevertheless, this survey remains prone to the same biases and demand effects (what the participant thinks the researcher wants) as any other survey. The biases present across the different samples (some of which are highlighted in the "Participants" section above) need to be taken into consideration when interpreting the results. Additionally, because this survey was administered online, it was possible for participants to "cheat" on our comprehension and awareness measures. We tried to mitigate this concern by explicitly asking participants to not look at their bills when answering the questions, and using electronic tracking to record the time taken per question. Although participants who took longer on our online survey were not found to perform better on awareness and comprehension than those who took less time, we did find that awareness of the TOU program was much lower for the participants who completed the on-the-street survey versus the online panel as can be seen in Table 7 of Appendix A. Consequently, we stress that the implications and recommendations derived from the main findings of the surveys are meant to provide some guidance on what areas to further explore and test rather than serve as a final view of the world today.

Implications and Recommendations

- **The paper electricity bill is a good place to change behaviour.** A large majority of participants still receive their electricity bill through the mail (82% of online respondents and 69% of on-the-street respondents). Many of these participants stated that they read their electricity bill upon receipt (86% of online respondents and 71% of on-the-street respondents). Consequently, the paper electricity bill may be a good channel to test new messaging strategies due to (1) its current widespread reach, (2) relatively low barriers to implementing change, and (3) the ease of measuring impact on individual behaviours. Further, the lessons learned through the paper bill, can also be used inform other communications strategies.

- **Ontarians are interested in learning about their own consumption patterns as long as it translates into financial savings.** Helping Ontarians understand how their consumption behaviours are impacting their bottom line may lead to more Ontarians shifting their electricity consumption to off-peak periods or purchasing energy efficient appliances. However, since even significant alignment with TOU schedules is unlikely to lead to notable personal financial saving, highlighting the amount of money saved *per se* might not be the optimal strategy.

- **The unit of measure – kilowatt hour – is a difficult concept to grasp.** Ontarians who could not define this term also had trouble selecting appliances that were the highest consumers of electricity, and struggled to identify the behaviours that would reduce their electricity consumption. Finding a more relevant way to discuss usage, such as creating an easier-to-comprehend unit of measure, or by defining usage in dollar amounts versus kWh, may help Ontarians better understand the consequences of their behaviour.

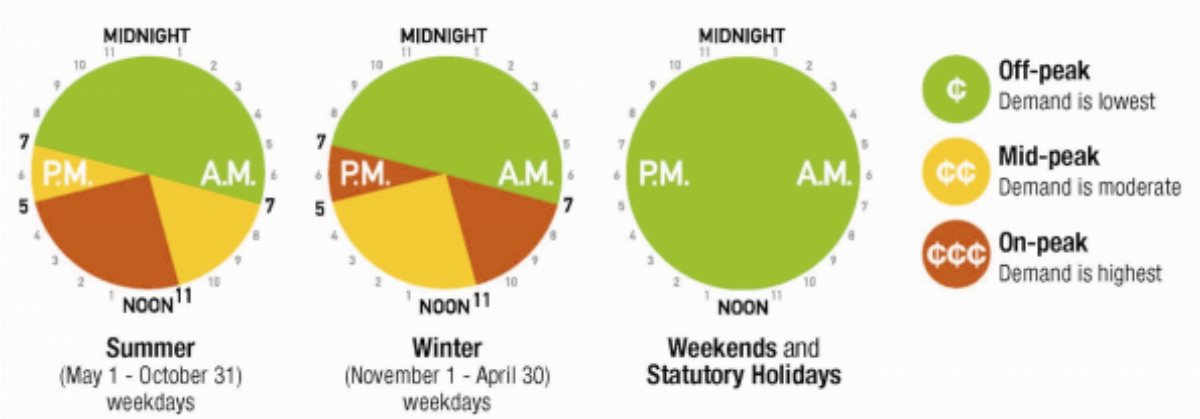
- **Ontarians have misperceptions of their own usage behaviours.** They underestimate their own usage and believe that their consumption behaviour is in line with other households of the same size. This is problematic as people may be less likely to change their habits if they believe that they are already engaged in the "right" behaviours. Social benchmarks could be used to help reduce these misperceptions and lower energy consumption.

- **The amount of control that a person has over their electricity costs influences their likelihood to shift behaviour.** Small business owners, as well as tenants, were less likely to say that the TOU program has shifted their behaviour. This suggests that in order to reach these groups, messaging surrounding TOU pricing should focus on basic behaviours that renters and businesses can perform that don't require investing in new appliances.

- Although participants feel that the current illustration explaining TOU pricing is easy to understand, they have trouble using it to reduce electricity costs. It is possible that this gap exists because the image lacks fluency resulting in poor comprehension. Some of these fluency issues include: (1) unfamiliarity with a 24 hour clock displayed in this manner, (2) people in Western societies tend to scan visuals from the top down. Having the labels at the

bottom increases the likelihood of missing the weather labels entirely (this may explain why only 23% of participants correctly knew that there is a different charge depending on the season).

Current image commonly used to illustrate TOU schedules



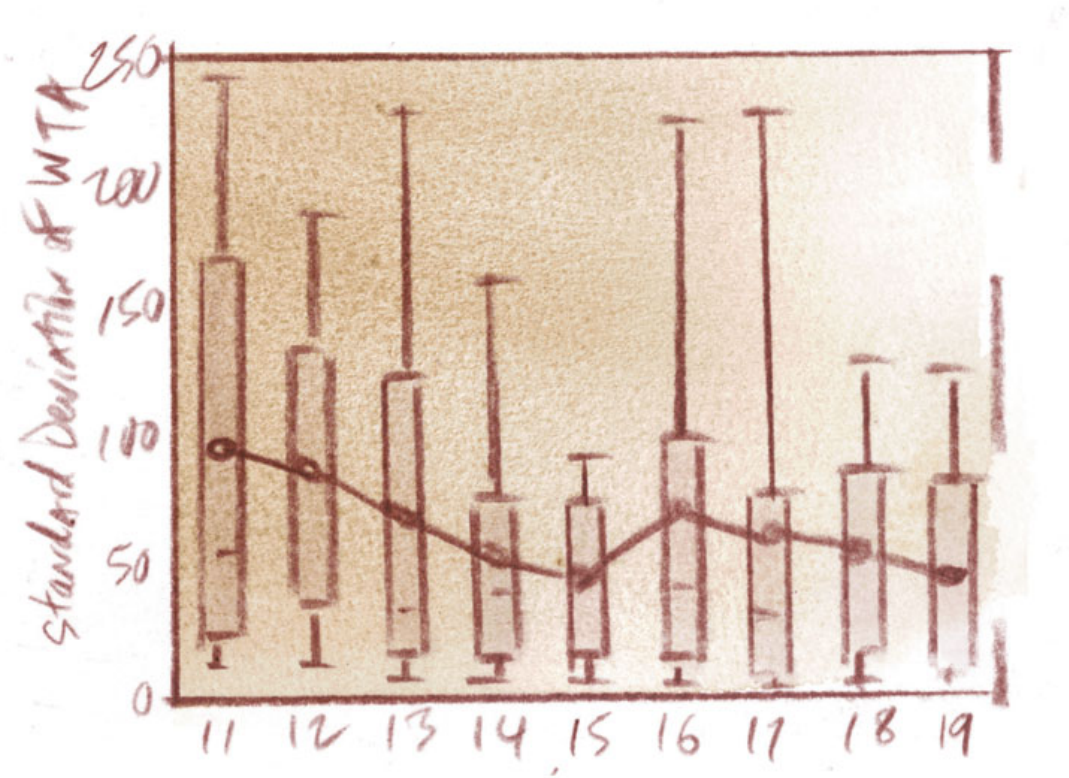
- **Small business owners showed the same errors as residents**. There were no significant differences found between the responses of residents and small business owners. This could be attributed to our relatively small sample size of small business owners as well as the disproportionate number of sole proprietors in our sample. Therefore, we caution against drawing any conclusions regarding the similarity or dissimilarity between residents and small business owners.

Additional Findings regarding the PeaksaverPLUS Program

- **A large portion of Ontarians still remain unaware of the PeaksaverPLUS Program.** Although the Peaksaver initiative has been in the market for almost a decade, many Ontarians aren't familiar with the program. Our results suggest that slightly less than half of Ontarians know about PeaksaverPLUS – a statistic that is likely inflated due to sample biases outlined in the "Participants" section above. The 30% awareness rate that was captured amongst the on-the-street sample is probably most accurate, suggesting that there is significant opportunity to increase Ontarian's exposure to communication materials describing the program and its benefits.

- **Current descriptions of the PeaksaverPLUS Program are unattractive to the majority of Ontarians.** The majority of Ontarians sampled (67%) expressed that they would not be interested in participating in the PeaksaverPLUS after being shown a typical description of the program. Participants that revealed disinterest were prompted to provide some rationale for their choice. The leading responses for not participating in the program were either that they did not believe that the program would reduce their electricity bills, and/or that not having control over their temperature would negatively impact their business (please refer to Figures 13 and 16 in Appendix A for more information). Positioning the PeaksaverPLUS program in a manner that reduces

concerns related to control, and highlights the financial benefits of enrolling, could plausibly lead to increased interest and uptake. This hypothesis is further explored in the PeaksaverPLUS nudge panel experiment discussed in section 2.10 of this report.



1.3 Insights from the BE Bill Audit

The purpose of the *BE Bill Audit* was to identify areas of a typical energy bill in Ontario that can be optimized using behavioural economics. The audit was designed to highlight elements of the bill that are likely barriers to the awareness, comprehension, and utilization of TOU pricing among Ontarians. We evaluated two of the most widely received electricity bills in Ontario. A segment of the behavioural assumptions identified through this audit were explored further through subsequent nudge element design and the Bill Statement Experiment.

Summary of Biases Affecting Bill Interpretation

Temporal Discounting: A central finding of behavioural economics is that people tend to overweigh present outcomes relative to future outcomes. This natural "present bias" causes people to use a large discount factor (i.e. under weigh the future) when making choices where the implications span across time periods.[42] People have a tendency to value small, near-term benefits over larger but distant ones. Things that are distant (in time and space, or socially) feel more abstract and are discounted in importance relative to more concrete, immediate outcomes.[43] This is part of the reason why we give into temptation today even though we know it's not in the best interests for ourselves in the long run. The present bias is likely a significant reason for why energy consumers fail to change their behaviours in accordance with appeals for conservation: today's comfortably warmed/cooled house overweighed while the larger economic and social costs of the future are underweighed.

Information Overload: Providing people more information does not always lead to better decisions. Too much information can overload decision-making and force individuals to rely on mental shortcuts, which are vulnerable to bias.[44] Furthermore, it can be difficult to appropriately weigh the relative importance of different pieces of information, contributing to errors in judgment. Energy consumers are faced with too much information on their bills, instead of information that is prioritized to reinforce energy literacy and targeted behaviours.

Self-Concept Maintenance: Individuals strive to maintain or enhance their self-esteem.[45] They may discount or reinterpret information that doesn't conform to their positive self-view.[46] The fact that most people believe they are already conserving and shifting their behaviour to align with TOU schedules is evidence of this positive self-view. Information that challenges this view will face the resistance of self-concept maintenance.

Scarcity of Social Norm Information: According to Social Norms Theory, if consumers are provided with normative information about the behaviours of others, they are likely to conform.[47]

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[42] O'Donoghue, T., & Rabin, M. (1999). Doing it now or later. *American Economic Review*, 103-124.
[43] Train, K. (1985). Discount rates in consumers' energy-related decisions: a review of the literature. *Energy*, *10*(12), 1243-1253.
[44] Bargh, J. A., & Thein, R. D. (1985). Individual construct accessibility, person memory, and the recall-judgment link: The case of information overload. *Journal of personality and Social Psychology*, *49*(5), 1129.
[45] Gecas, V. (1982). The self-concept. *Annual review of sociology*, 1-33.
[46] Mazar, N., Amir, O., & Ariely, D. (2008). The dishonesty of honest people: A theory of self-concept maintenance. *Journal of marketing research*, *45*(6), 633-644.
[47] Berkowitz, A. D. (2004). The social norms approach: Theory, research and annotated bibliography. Higher Education Center for Alcohol and Other Drug Abuse and Violence Prevention. US Department of Education.

Additionally, the Social Desirability bias states that if consumers believe that it is socially or interpersonally desirable to alter their behaviour, they are more likely to do so. This type of normative information is currently missing from the bill statements we have seen in Ontario.

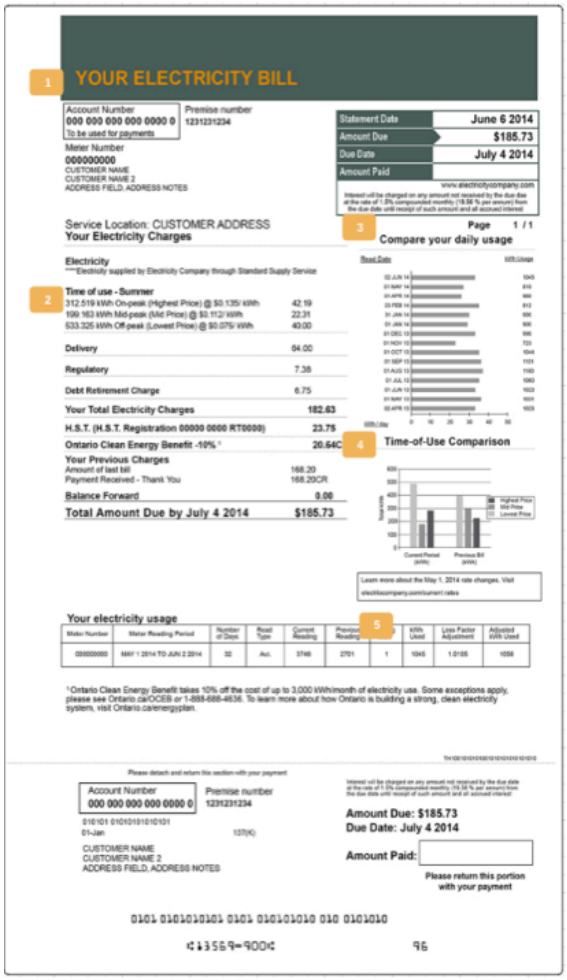
Lack of Fluency: People often lack the motivation or cognitive capacity to process complex information in the form of tabular consumption feedback. Eye tracking research has shown that we devote more attention to images than we do heavy-text content. Additionally, pleasing images are quicker to activate pleasure centres of the brain than text that conveys the same information. A recent experiment found that ambient feedback (in the form of either a red or green light indicating high or low levels of consumption in the home) led to more conservation than factual feedback, which showed consumption in kWh.[48] The current design of the bills used in this audit do not provide information and graphics that are easy to interpret quickly. With the exception of the *Total Due* amount, most consumption information requires a high degree of attention and mental energy to process. This can result in important consumption information being overlooked or misunderstood.

Lack of Cues for Action: People are willing to look for information that is helpful to them, but only within limits of attention and effort. Simplified text with clear directional tips will help consumers identify and process information quickly. Indeed, there is a significant opportunity to help improve energy literacy. People have a weak understanding of the drivers of energy consumption and savings. They vastly underestimate their energy use and the potential savings for a number of household, transportation, and recycling activities.[49] Their predictions were an average of 2.8 times less than the actual energy used or saved by a given device or appliance. For instance, 20% of participants felt that turning off the lights was the single most effective thing a person could do to conserve energy. This was the most frequently selected activity across respondents, along with a high prevalence of other curtailment activities, such as reducing the use of equipment (e.g. drive less, unplug appliances) rather than replacing them with energy efficient alternatives (e.g. energy efficient appliances). This represents another opportunity to correct the misperceptions of consumption and savings, as efficiency-improving investments generally save more energy than curtailing behaviours. It may be the case that these same misperceptions exist within the Canadian population as well. This research sheds light on the importance of correcting such deficiencies so that people's efforts are tied to the activities most likely to impact conservation and demand shifting goals. However, current bills in Ontario contain no information or tips on how to most effectively conserve or shift consumption behaviours.

In what follows, we audit two of the most widely used electricity bills in Ontario. The bills have been scrubbed of any identifying information. The *BE Bill Audit* contains our recommendations to improve these specific bills. Additional nudges that go beyond these recommendations will be detailed and tested in the *Nudge Panel* and *Bill Statement Experiments* that follow.

[48] Ham, J., & Midden, C. (2010). Ambient persuasive technology needs little cognitive effort: the differential effects of cognitive load on lighting feedback versus factual feedback. In Persuasive Technology (pp. 132-142). Springer Berlin Heidelberg.
[49] Attari, S. Z., DeKay, M. L., Davidson, C. I., & de Bruin, W. B. (2010). Public perceptions of energy consumption and savings. Proceedings of the National Academy of Sciences, 107(37), 16054-16059.

Toronto Hydro Bill Audit



1) There is an opportunity to refocus the message to be around electricity consumption, as opposed to. simply billing. Changes could include using different-coloured headers or symbols to visually reward households that conserve electricity, and signal overuse to those who have consumed more than average. Other changes could include rewording the header to include the household surname in order to create greater endowment and ownership over the amount of energy consumed. For example, *"Smith* Household Electricity Consumption" or a more general header such as "Your Electricity Usage and Charges" could be used in order to achieve these aims.

2) We hypothesise that a key driver of awareness and comprehension would be the simplified presentation of TOU information on the bill. Currently, the TOU header is not made salient relative to the other text on the page. Improvements such as a larger title surrounded by more white space can be used to draw the reader's attention. The depth of information presented in the small space is cognitively taxing and ilkely avoided by most bill readers. Presenting the information in a tabular or graphical format, and simplifying the values to the hundredths or whole unit would make processing faster and easier for readers.

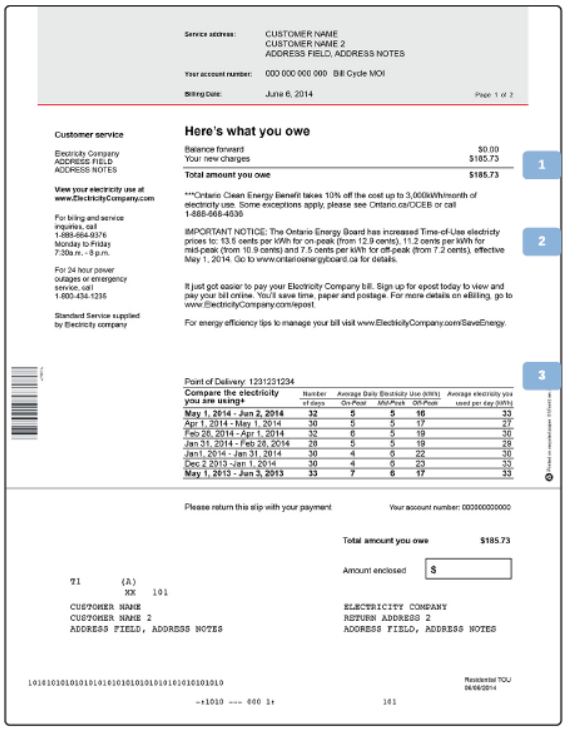
3) This visual presentation of consumption information is a quick and useful way for consumers to compare their consumption to prior months. However, the graph is confusing because it is titled "Compare your daily usage", yet the values on the right represent monthly usage averages. The second issue with this graphic is the font size. Many people may have a hard time reading their consumption averages unless the font size is increased. Our *Electricity Consumer Survey* revealed that the desire to understand one's usage was among the top reasons people read their electricity bill. Therefore, graphs that make understanding consumption patterns easier should be made more salient and central on the bill.

4) This graphic is the second area on the front of the bill that references the TOU model. Each bar graph represents the price associated with each peak period (e.g. Highest Price, Mid Price, Lowest Price). While the graph makes relative comparisons between each of the periods easy, it typically shows consumers that their household consumes less "High priced" energy than "Low priced" energy. This is a standard pattern of consumption for the majority of households that are at work during the day and home during evenings and weekends. There is a risk that people may misinterpret the graph and instead view their relatively lower on-peak consumption as a good thing. Since one of the province's aims is to reduce on-peak consumption, focusing

the graph on the relative differences in on-peak usage from month-to-month might be a way to increase the salience of this information. This graph also lacks relevant benchmarks, which means that consumers are largely unaware of how their consumption compares to recommended norms.

5) The total monthly kWh consumed is only highlighted once on this bill. This important measure is buried in a table and is likely unnoticed by most readers. One way to highlight this information would be to highlight the consumed amount and present it with relevant feedback information to help readers understand how their consumption compares to others like them, as well as to their own consumption from comparable previous periods.

Hydro One Bill Audit



1) The presentation of total charges is clearly displayed in this bill. In contrast to the other bill, this one is simpler with less information on the front page. While simple, this bill requires customers to turn to the back for more detailed information regarding their charges, which may lead to lower attention to the usage breakdown.

2) Important information regarding changes to the TOU electricity prices is presented centrally on the bill. This type of information, though important, is likely better conveyed using visuals (as opposed to text). Information overload caused by the high number of numbers presented throughout the text, might lead to shallow or negligible processing of the information presented here.

3) Readers of the HydroOne bill might face issues regarding usage metrics that are similar to the ones faced by Toronto Hydro customers. Although the usage amounts across each of the peak periods are easier to read, they are presented without much context. Improvements would include adding relevant usage benchmarks or scores for how well the household is performing relative to suggested consumption amounts. Again, because off-peak usage is higher relative to mid or on-peak, consumers have no guidance on reducing their usage. The connection between amount consumed and cost is disjointed, as this information is only presented on the back of the bill.

Service address: CUSTOMER NAME
CUSTOMER NAME 2
ADDRESS FIELD, ADDRESS NOTES

Your account number: 000 000 000 000 Page: 2 of 2

How we calculated your charges

Balance forward	Amount of your last bill		$166.20
	Amount we received on May 20, 2014 - thank you		$166.20 CR
	Balance forward		**$0.00**
Your electricity charges	Your service type is Residential - Medium Density		
	Electricity used this billing period		
	We read your meter 000 000 000 on June 2, 2014	003746.0070	
	We read your meter on May 1st, 2014	– 002701.0000	
	Difference in meter readings	001045.0070	
	Metered usage in kilowatt-hours (1045.007 x 1)= 1045.007 kWh		
	Electricity: On-Peak: 312.5196 kWh @ 13.5000¢		$42.19
	Mid-Peak: 199.1630 kWh @ 11.2000¢		$22.31
	Off-Peak: 533.3256 kWh @ 7.5000¢		$40.00
	Delivery		$64.00
	Regulatory Charges		$7.38
	Debt Retirement Charge		$6.75
	HST (12345-1234-RT0001)		$23.74
	Total of your electricity charges		**$206.37**
	Ontario Clean Energy Benefit: 10% off applicable electricity charges and taxes***		$ 20.64 CR
	New total of your electricity charges		**$185.73**

Electricity: This is the cost of the electricity supplied to you during this billing period and is the part of the bill that is subject to competition.

Delivery: These are the costs of delivering electricity from generating stations across the province to Electricity Company than to your home or business this includes the costs to build and maintain the transmission and distribution lines poles, and poles and operate provincial and local electricity systems. A portion of these charges are fixed and do not change from month to month. The rest are variable and increase or decrease depending on the amount of electricity that you use.

The delivery charge also includes costs relating to electricity lost through distributing to your home of business*. Electricity Company collects this money and pays this amount directly to our suppliers.

*When electricity is delivered over a power line, it is normal for a small amount of power to be consumed or lost as heat. Equipment, such as wires and transformers consumes power before it gets to your home.

Regulatory Charges: Regulatory charges are the costs of administering the wholesale electricity system and maintaining the reliability of the provincial grid and include the costs associated with funding Ministry of Energy and Infrastructure conservation and renewable energy programs.

Debt Retirement Charge: The debt retirement charge pays down the debt of the former Ontario Hydro.

Residential TOU
03/06/2014

NOTE: For a detailed explanation of electricity terms, please visit www.electricityexampany.com or www.ontarioenergyboard.xx

*Your consumption is based on metered use. Historically this was based on adjusted use.

Time-of-Use Periods for Summer and Winter

Time Period	Summer (May 1st - Oct 31st)	Winter (Nov 1st - Apr 30th)
On-Peak	Weekdays: 11 a.m. - 5 p.m.	Weekdays: 7 a.m. - 11 a.m. & 5 p.m. - 7 p.m.
Mid-Peak	Weekdays: 7 a.m. - 11 a.m. & 5 p.m. - 7 p.m.	Weekdays: 11 a.m. - 5 p.m.
Off-Peak	Weekdays: 7p.m. - 7 a.m. & Weekends and Holidays	Weekdays: 7 p.m. - 7 a.m. & Weekends and Holidays

4

5

6

4) The number of digits used to convey consumption (e.g. 003746.0070) makes it extremely difficult for an individual to understand their total monthly consumption. The information is provided in a way that is atypical of how we generally read numerical information. Like an odometer, the leading zeros can act as a signal to convey that one's consumption isn't at the maximum usage typically presented on a bill. This could be one of the reasons why most households believe they are not consuming large amounts of electricity. Improvements to this presentation format could include things like simplified consumption values (removing the leading and trailing zeros), as well as metrics showing whether this consumption is higher or lower than average.

5) The TOU periods are presented simply and clearly on this bill. With the exception of the number of digits shown for the consumption amounts and costs, a person reading the bill could discern the connection between the amount used and the price per kWh for each period. Improvements to this section would include bringing the total amount per period closer to the usage figures. The way the information is presented currently doesn't allow the reader to make a clear connection between usage and the total cost. The reader must look at one side of the page and then the other, as the text spacing between the two related pieces of information is too great

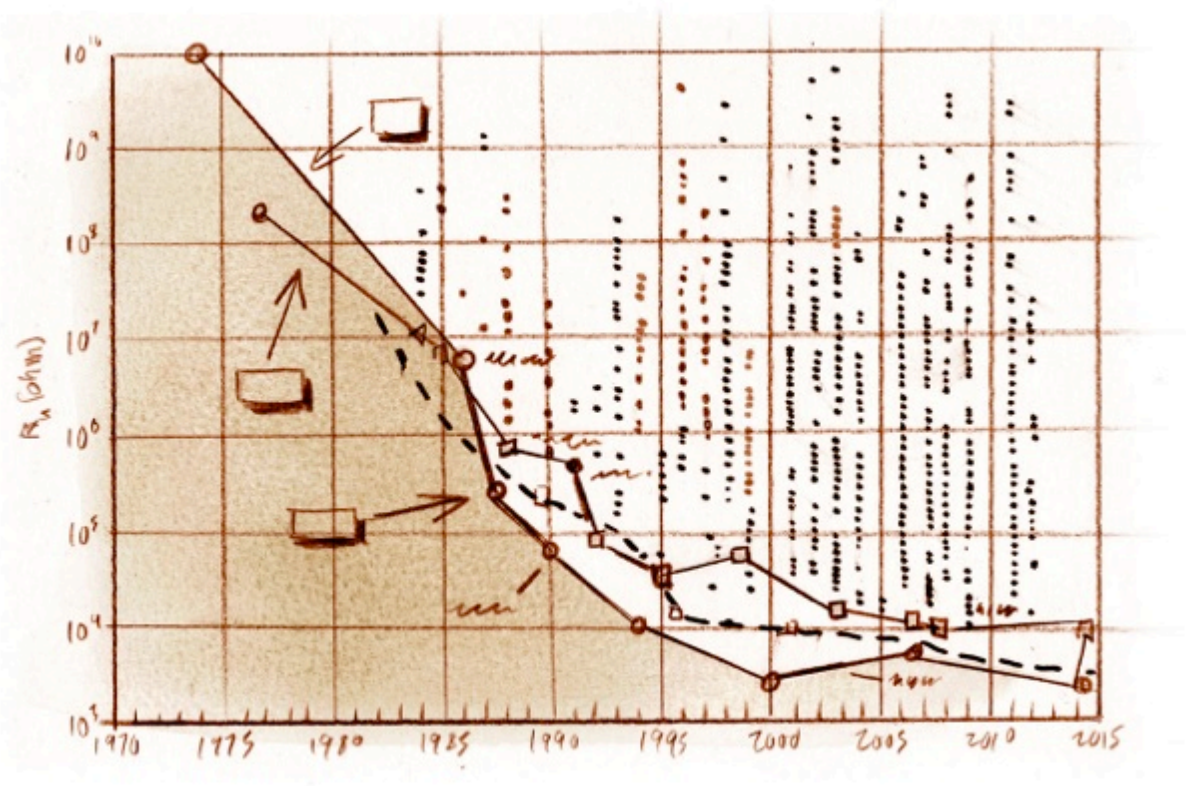
6) The TOU periods have been presented in table format rather than graphically. This type of presentation, especially following a large amount of text and fine print, is at risk of being ignored by a busy and information-overloaded reader. This hypothesis was tested in the *Bill Click Tracking* Study. One simple improvement would be to include a visual rather than text-based overview of the periods.

Conclusion

Electricity bills across the province vary greatly in the way they present TOU consumption information. As can be seen in the two examples above, some show consumption visuals while others lay out this information in table format. Some bills show TOU breakdowns on the front of the bills, while others reserve this detailed information for the back. We suggest a number of changes that can be used to aid consumers' awareness, comprehension, and ultimately motivation to change behaviour in alignment with the province's conservation and demand management goals. These insights include simplifying the billing information with graphs that

are intuitive, and that facilitate the quick and accurate interpretation of consumption information, as well as and removing unnecessary digits when presenting the kWh consumed or per period costs. Other recommendations include creating a greater sense of endowment on the bill by making the household or business name more prominent on the bill, and visually highlighting on-peak consumption to increase the salience of energy consumed during that period.

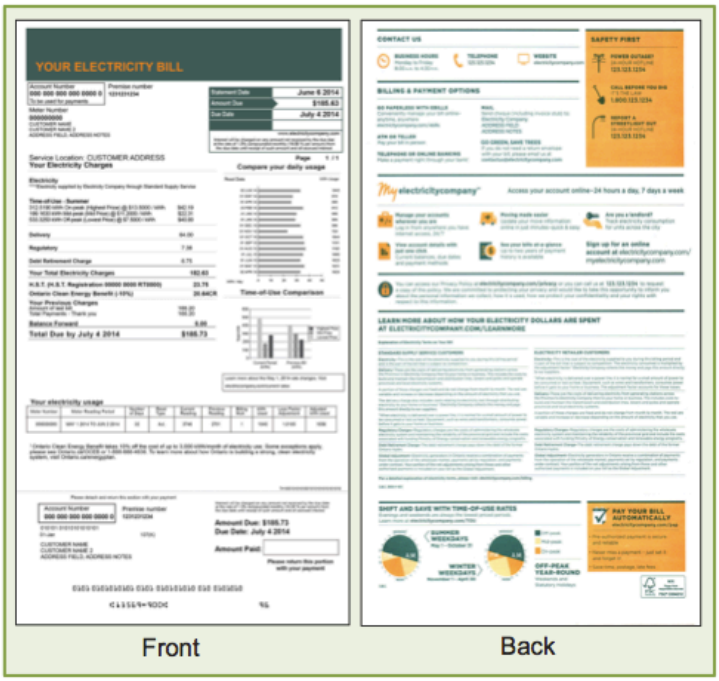
These, and other suggested changes to the bill, were tested in a series of *Nudge Panel Experiments,* detailed in a subsequent section of this report. Our aim was to empirically validate some of the hypotheses stated above so that the Ontario Energy Board and Ontario's utility companies are equipped with evidence-based recommendations for changes to their bills. In the next study, we examine the regions of the bill people tend to look at and how this influences their understanding of the TOU pricing scheme. We show that small changes to the way TOU information is presented on a bill can have a significant impact on people's knowledge of the pricing scheme and intentions to shift behaviour.



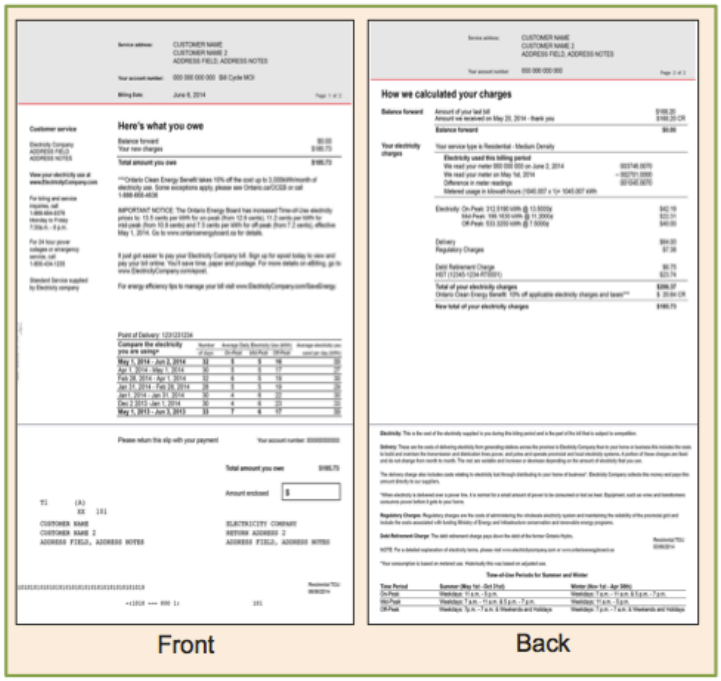
1.4 Insights from the Bill Click Tracking Study

The purpose of the *Bill Click Tracking Study* was to explore consumers' reading habits with regards to their electricity bill and to identify the regions of the bills that are most salient, overlooked, or misunderstood by consumers. To measure this, 175 Ontario residents were asked to look at one of two electricity bills and to click on the areas of the bill that they would typically read. This information was then used to explore the relationship between where participants looked (indexed by clicking in that region), and their recall of specific information on the bill - (i) TOU pricing and timing (4 questions) and (ii) kWh usage metrics (4 questions). Finally, we compared responses from participants across the two different bill presentations. Participants were randomly assigned to one of two conditions. They either saw a bill that looked exactly like the Toronto Hydro bill (hereafter referred to as Toronto Hydro), which displays usage information graphically, and presents all billing information on the front page of the bill (n = 94), or a bill that looks exactly like the Hydro One bill, which displays the same information in a table rather than a graph, and breaks up billing information on two pages with a more detailed TOU breakdown on the second page (n = 81). Again, both bills are almost identical to bills that are currently in circulation, however any recognizable branded information was removed from the stimuli.

Toronto Hydro



Hydro One



The experiment was designed with the following hypotheses in mind:

Hurdles	Hypotheses	Findings
Limited Attention Participants only attend to the total price and overlook important information regarding TOU rates, schedules, and usage.	• Regions of the bill that participants attend to (clicked–on) will have higher recall than areas on the bill the participants don't attend to. • Most Ontarians only attend to the total amount due. Consequently, recall of information pertaining to TOU pricing and timing and kWh usage will be poorly attended to and recalled. • Participants will only look at the back of the bill if they are motivated to do so by important information on the back.	• **Participants who clicked on more regions of the bill had a higher recall score.** • **The most attended region across both bills was the total amount due and statement billing date.** As a result, we found most participants were able correctly recall the total amount due. • **Recall of both TOU and Usage information was poor across both bills.** The average recall score across both bills was less than 30%. Participants' performance on questions related to TOU pricing and energy consumption was equally poor. • **Participants were more likely to view the back page of the bill when additional pricing information was presented there.** Participants who saw the Hydro One bill were more likely to view the back page than participants who saw the Toronto Hydro bill.
Layout Information presented in tables is less salient than information presented in graphs.	• Graphical presentations of monthly usage will be attended to more than tabular presentations of monthly usage. Consequently, participants in the Toronto Hydro conditions (with more graphic elements) will have better recall of their usage information than those who view the same information in tabular form.	• **Participants who saw the Toronto Hydro bill were more likely to click on regions highlighting usage information than participants who saw the Hydro One bill.** • **Participants who saw the Toronto Hydro bill had better recall of their monthly consumption than participants who saw Hydro One.** • **The graphic visuals presented in the Toronto Hydro bill are not intuitively clear.** Participants who saw the Toronto Hydro bill had difficulty determining their daily electricity consumption. Participants who saw the graph highlighting daily electricity consumption were just as likely to select the unsure option regarding their daily electricity consumption as those who did not attend to that region.

Survey Respondents and Research Methodology

The *Bill Click Tracking Study* was conducted online using a click tracking technology that recorded a participant's timing, and the sequence and location of mouse clicks when shown a visual stimulus – in this case an electricity bill. This survey was administered between September 15 and September 22, 2014. Participants for this study were obtained from a panel of Ontarians that had chosen to participate in online surveys. To be included in the Ontario Resident Survey, participants had to be an Ontario resident over the age of 18 and were required to have received or contributed to an electricity bill within the past year. Additionally, participants who completed the *Electricity Consumer Survey* were not eligible for this study.

Data was collected from 175 Ontarians over the age of 18 who had received a household electricity bill sometime in the past year. As reward for their participation, 60% of participants were assigned to receive AIR MILES reward miles as a reward and 40% were assigned to receive the equivalent value in points towards a retail gift card. The research methodology for the *Bill Click Tracking Study* consisted of two parts:

- **Click Tracking:** Participants were shown the front page of one of four variations of an electricity bill and were asked to click on the areas they would look at if it were their own bill. They were also asked if they would like to see the back of the bill. Participants who answered "yes" completed the same clicking task on the reverse page. The bill designs were modelled after two of the most prevalent bills in the province, however any branding and references to the utilities and the province were removed.

- In order to accurately test our hypothesis, two decoy bill versions were also created. This was done to ensure that participants answering TOU related questions correctly were doing so as a result of the information they were just shown rather than recalling it from memory or looking it up online. The "Decoy" bills contained the same elements as a regular bill with a few modifications. We changed the kWh price of each TOU period by 1 cent, and shifted the TOU scheduled by two hours (changing off-peak from 5pm-5am rather than 7pm-7am) on each of the decoy bills. Everything else on the bill was held constant across conditions. The existing bills will be referred to as "Real Bills", while the altered versions will be referred to as "Decoy Bills".

- **Recall Process:** Participants were then asked a series of questions about the bill they saw in part 1. Half of these questions assessed a participant's ability to recall information on TOU pricing and timing presented in the bill (e.g., timing and pricing schedules for the three periods – on-peak, off-peak, and mid-peak). The number of questions correctly answered formed a participant's "TOU Recall Score" out of 4. The other half of the recall questions assessed participants' ability to recall kWh usage measures presented within the bill, such as the average daily usage and whether or not there was a change in overall energy consumption in this period compared to the last period about which information was presented. The number of correctly answered questions in this section formed a participant's "Usage Recall Score" out of 4. The combined total of both scores (TOU Recall Score + Usage Recall Score) is referred to here as the "Overall Recall Score" out of 8.

What we found

Recall of TOU and Usage information was poor across both bill types

- Participants across all conditions performed poorly on the Overall Recall Score, with the average total score across all conditions being less than 30% correct (Table 14 in Appendix B).

Looking at the individual scores within each section, two interesting observations stand out:

- Participants in the Decoy bill conditions performed worse on their recall of TOU period schedules relative to those in the Real bill conditions. Participants who were in the decoy conditions (Toronto Hydro Decoy: 6%, Hydro One Decoy: 7%) across both bills performed significantly worse on recall of the TOU Period schedules than participants in the real conditions (Toronto Hydro Real: 32%, Hydro One Real: 45%), $p<0.05$. Higher accuracy of recalling TOU period time schedules was likely driven by memory effects (i.e. Ontarian participants' recollection of current TOU schedules in the province), as total time spent reviewing the bill did not significantly differ between real and decoy bills. Interestingly, this was not the case for recalling the rates for each TOU period; all groups performed equally poorly on this question, $p>0.10$.

- Participants who saw the Real Toronto Hydro bill performed worse on recalling average daily electricity consumption than those who saw the Real Hydro One bill: Only 2% of participants in the Real Toronto Hydro condition correctly recalled the average daily electricity amount compared to 13% in the Real Hydro One condition, $p<0.05$, (Table 14 in Appendix B). This may be driven by errors in understanding the currently used TOU monthly usage visual graph in the Toronto Hydro bill, as it purports to show the average daily electricity consumption, but instead includes data labels that represent the overall monthly consumption.

Participants were more likely to look at the back page when pricing information was presented there

- Participants who saw the Real Hydro One bill, which presents the detailed price breakdown on the back page, were more likely to view the reverse side of the bill than those who saw the Real Toronto Hydro bill which includes the entire pricing breakdown on the front (58% versus 27% chose to view the back page). This suggests that these participants were generally interested in seeing the entire price breakdown and would expend the effort necessary to view the reverse of the bill if that information was presented there. Notably, although participants who saw the Hydro One bill were more likely to look at the back page, the number of these individuals (only ~ half the population) is still far from ideal.

Total number of clicks and bill viewing time were positively correlated with the Overall Recall Score

- **Overall, the more time spent reviewing the bill, the higher the Overall Recall Score.** Across all the bills, each 10% increase in the total time spent reviewing the bill (in sec) was found to increase the Overall Recall Score by 9.3%, $p<0.001$.

- Overall, the more regions on the bill that a participant attended to (as indicated by clicks), the higher their Overall Recall Score. Across all the bills, each 10% increase in total clicks on the bill was found to increase the Overall Recall Score by 3.2%, $p<0.001$.

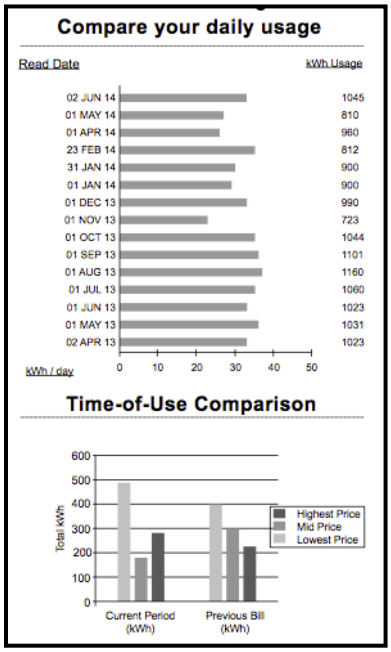
- Gender, paying the bill online, and thoroughness of reading the bill (self-reported) were all found to be significant predictors of the total number of clicks. To determine the factors that predict the total number of clicks, a multiple regression analysis was performed utilizing total clicks as the outcome measure. Three factors were found to share a positive relationship with the number of clicks. First, females tended, on average, to have more clicks than males ($p=0.08$). Second, participants who agreed more with the statement that they thoroughly read the bill, clicked more often ($p<0.001$). Finally, participants who paid their electricity bill online were found to click more than those who received their bill through the mail or paid their bill through other means ($p=0.03$).

The most clicked on region across both bills was the *Total Amount Due*.

- Figures 20 and 21 highlight the top 10 regions that participants clicked on, in order of importance for both bills. The top regions across both bills were regions that provided the total amount due. Consequently, it is not surprising that a large proportion of participants were able to correctly recall the total amount due across all bills. Average score across all 4 conditions was greater than 60% (Figure 22 in Appendix B).

- Additionally, Ontarians who click on the Total Amount Due on the Toronto Hydro bill significantly outperformed (71% correct) those who did not select that region of the bill (33% correct), $p = 0.02$. This effect was not significant for those in the Hydro One condition.

Toronto Hydro: TOU Usage Graphs



Hydro One: TOU Usage

Point of Delivery: 1231231234

Compare the electricity you are using+	Number of days	Average Daily Electricity Use (kWh) *On-Peak*	*Mid-Peak*	*Off-Peak*	Average electricity you used per day (kWh)
May 1, 2014 - Jun 2, 2014	**32**	**5**	**5**	**16**	**33**
Apr 1, 2014 - May 1, 2014	30	5	5	17	27
Feb 28, 2014 - Apr 1, 2014	32	6	5	19	30
Jan 31, 2014 - Feb 28, 2014	28	5	5	19	29
Jan1, 2014 - Jan 31, 2014	30	4	6	22	30
Dec 2 2013 -Jan 1, 2014	30	4	6	23	33
May 1, 2013 - Jun 3, 2013	**33**	**7**	**6**	**17**	**33**

People are more likely to look at TOU information when it is represented in a graph than when it is shown in table format. There is also reason to believe that those who actively attended to these regions would have higher recall of the information than those who do not look at TOU consumption information.

- The graphical representation of TOU Usage information was the fourth most clicked on region on the Toronto Hydro bill. On the other hand, when the same information was presented in table format, as was the case on the Hydro One bill, it was far less likely to be attended to. Participants in the Toronto Hydro conditions who did look at the usage graphs performed significantly better (32% correct) than those who did not click on these regions (22% correct), p=0.02. Notably, 32% correct is still a poor result, suggesting that improvements should be made to the consumption visuals to improve recall.

As hypothesized, participants who attended to the graphical representations of TOU information performed better on the TOU Usage Scores than those who viewed the same information in table format.

- Participants in the Toronto Hydro condition who clicked on either of the graphs that highlighted usage information performed significantly better on the TOU Usage Score (Mean Score 1.27 out of 4) than participants who did not click on any of these regions (Mean Score 0.87 out of 4), p = 0.02. Comparatively, participants in the Hydro One condition who clicked on the table highlighting usage information did not perform any better on the usage score (1.14 out of 4) than those who did not click on any of these regions (1.15 out of 4), p>0.10. These findings underscore the importance of depicting information in visual formats marked by fluency.

Participants who viewed the Toronto Hydro bill had difficulty recalling their average daily electricity consumption:

- Participants who clicked on the graph highlighting their daily electricity consumption were just as likely (82%) to select the unsure option when asked to recall the current period's average daily consumption, as those who did not attend to that region (77%). Given the finding about TOU usage scores noted above, one would predict that their recall would be better. This suggests that the current graphical representation, while better than tabular versions of the same information, is still difficult for participants to comprehend and/or does not contain the right/salient information. As noted previously, the misleading title of the graph results in difficulty recalling this information correctly. The participants must extrapolate the average daily usage using the values on the x-axis. This misrepresents the values shown along the right hand side of the graph, which actually depict overall consumption rather than average daily usage. Thus it appears that that while graphs capture more attention, improving the fluency of information presented therein would improve recall scores as well as basic understanding.

Conclusion

The purpose of this experiment was to gain a better understanding of what information on the bill typically gathers attention, and how this attention predicts comprehension and recall. Participants who clicked on a higher number of regions displayed higher recall, providing credence to our methodology whereby clicks are used as a proxy for attention.

Actionable findings that are tested in our nudge panel include:

- Utilize the lack of attention to page 2 of the bill – either increase attention to the back by placing pricing information in that location, or decrease attention to the back by removing pricing information from that location

- Present TOU information in a graphical as opposed to a tabular fashion

- Place information that needs to be attended to next to total price

Part 2 Choice Architecture: Applying Behavioural Economics

The *Nudge Panel Experiments* consisted of ten independent randomized controlled experiments that manipulated specific elements of a typical electricity bill. By isolating specific elements of the bill, and displaying several variants of that element in a randomized fashion, we were able to generate insights into how people process that piece of information, and why they respond the way they do.

Through the nudge panel experiments detailed here, we identified the specific aspects of the bill that people don't understand. We generated evidence about why these elements are obstructing the incentives of TOU pricing. This was followed by the generation and testing of bill elements and nudges that can overcome behavioural barriers followed. The ten *Nudge Panel Experiments* addressed the following questions:

- What types of comprehension errors are consumers making? Are there consistent patterns?
- What are the nudge strategies that can most effectively mitigate these comprehension errors?
- Can TOU pricing information be presented in a way that makes consumers more price-sensitive, and therefore more likely to shift and/or reduce their consumption?
- What types of non-financial motivations are most impactful in this domain (i.e. social norms, group competition, social pressure, self-concept maintenance, reinforcements, etc.)?

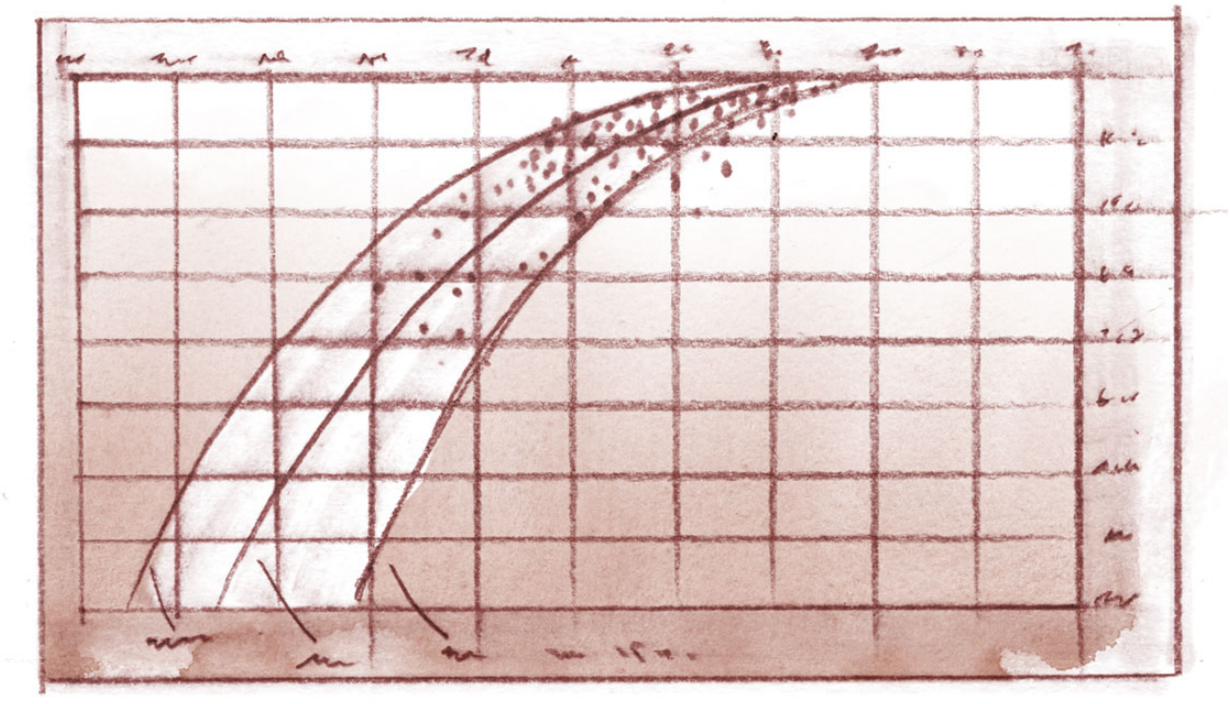
Simply asking people about their motivations can be misleading. Previous studies have found that 96% of people say they "want to reduce their energy usage," and 92% feel that "reducing energy usage is important."[50] but this is not reflected in their actual energy consumption behavior. Our experimental approach is designed to understand why these intentions and normative judgments, as well as straightforward financial incentives, do not translate into meaningful and consistent behavioural change, and what can be done about it.

[50] Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is under detected. *Personality and social psychology bulletin*, *34*(7), 913-923.

Behavioural Intervention Point	Key Findings
1) Unit of Price Display the price per kWh in a unit that is easiest to recall and consistent across all presentations of TOU price information.	• Overall, TOU rates displayed in cents (¢), are easier to process. • When consumers were shown rates in cents (¢) vs. dollars ($), they were significantly better in recalling the rate amount. Across the three TOU periods, when participants were shown rates in dollars ($), they recalled incorrect rates that were 3 times greater than the correct TOU rate.
2) Naming Schema More powerful intuitive names may make it easier for consumers to understand and comply with TOU pricing.	• Participants in the Price Focused naming schema conditions were significantly better at recalling the period names. Only 17% of people were able to correctly recall the current names of each TOU period (on-peak, mid-peak, off-peak) whereas >55% were able to remember schemas that included a financial underpinning (e.g. Peak Price, High Price, Standard Price).
3) TOU Visual Simpler and more intuitive visuals that explain TOU schedules would make it easier for consumers to understand and comply with demand management targets.	• Participants in the control condition had greater difficultly recalling the exact times of the on-peak periods relative to those in the experimental BE conditions. • Participants in the Linear off-peak condition (86% correct) were better able to comprehend the TOU visual, relative to the control visual (80% correct), and indicate the correct start and end times for each TOU period.
4) Price Clarity Simplified price presentation and framing can help Ontarians better understand the costs and value associated with TOU pricing.	• Displaying fixed charges in a table with a glossary, without a subtotal breakdown, led to an overall improvement in comprehension scores. • This bill format also led to greater motivations to conserve off-peak energy.
5) Longitudinal Consumption Visual Providing feedback about overall electricity consumption will lead to an increased understanding of consumption behaviours.	• Participants in all of the BE treatment conditions significantly outperformed the controls wrt recall of consumption details. • Participants exposed to the Year over Year consumption visuals indicated that they found the visual to be significantly easier to understand than the control group.

6) TOU Period Consumption Visual Visuals illustrating a consumer's on-peak, mid-peak, and off-peak consumption over time can be leveraged to motivate the individual to shift usage to off-peak periods.	• Participants found conditions where the consumption bar graphs displayed only one TOU period (e.g. on-peak only) to be easier to understand. • Participants' comprehension of how 1) on-peak and 2) off-peak energy consumption changed between two periods increased when they were provided with consumption visuals that represented all three TOU periods.
7) Consumption Benchmarks People may modify their current consumption behaviour based on their goals and past behaviour. Relative usage compared to others both proximal (e.g. neighbors) and distal (groups of people) can influence behavioral changes.	• When consumption was framed negatively, participants responded more favourably to the "historically-oriented" benchmark, indicating that they were willing to conserve more on-peak energy relative to participants in the control. • When consumption was framed negatively, participants felt the guiltiest when exposed to the "goal oriented" benchmark.
8) TOU Pledge Making a pledge can serve as a "first commitment" to improve and an open request for information about how to fulfill that commitment.	• Participants were more motivated to sign the pledge (i.e. 76% signed) when there were multiple calls-to-action presented, relative to conditions where participants were only presented with a single energy conserving option. • Particiants who signed the pledge (vs. those who did not) were significantly more likely to indicate that they wanted to enroll in the PeaksaverPLUS program. We found that the environmental message that accompanied the pledge were the least effective in influencing enrollment in PeaksaverPlus.
9) Pricing Extremes Consumer awareness and compliance of TOU may or may not change as a result of changes to the cost of electricity.	• Participants were more likely to recognize that they had consumed too much on-peak energy in response to a 5:1 Peak:Off-Peak TOU pricing ratio. • Participants also reported greater sense of control over their spending on electricity in response to a 5:1 Peak:Off-Peak TOU pricing ratio.

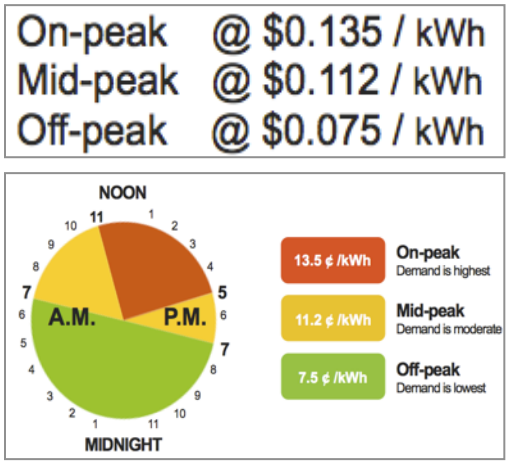
10) PeaksaverPLUS offer Strategic positioning of this offer, while strengthening awareness, comprehension, and motivation, can help drive enrolment.	• Irrespective of the offer they saw (e.g. loss aversion messaging), Ontarians were undecided about their participation in the PeaksaverPLUS program. Participants were not significantly more willing to learn about the program or join the program than participants in the control. • The top three reasons for participants indecision and/or not wanting to enroll in the program were: 1) not wanting to lose control of their appliances, 2) requiring more information prior to enrollment, and 3) the disbelief that the program will have an impact on their electricity bills.



2.1 Unit of Price

The Unit of Price experiment was designed to explore how peoples' perception of cost are impacted by the presentation of the pricing unit. Currently, the price per kWh is presented in either dollars or cents depending on where it is displayed. For example, most bills tend to display the cost of energy in dollars per kWh (e.g. $0.135), whereas marketing materials and online informational content typically display the price per kWh in cents (e.g. 13.5¢). Given the important role that consistency plays on memory, learning, and liking of stimuli, we propose that the information of kWh be presented in a consistent unit across all communications.

Figure 1. Example of incongruent price presentations on bills and in TOU Visuals



The following experiment was designed to determine whether dollars or cents are the optimal unit of price in terms of subsequent comprehension and recall of TOU pricing. Prior research indicates that subtly manipulating the visual salience of an unfamiliar monetary unit by enlarging the font of that unit relative to the font of the number prompts recognition of the unit's unfamiliarity (novelty) and reduces magnitude sensitivity. Based on this research we included two variations of the font size in which the price unit was displayed. This was aimed at understanding whether a larger font size increased or decreased peoples' sensitivity to the cost of electricity.

The rationale and hypotheses for the manipulations that were tested in the Unit of Price Nudge Panel Experiment were:

Unit: presenting rates in dollars or in cents

The way prices are displayed has been shown to attract attention in different ways. When a very low price (such as a rate for kWh of electricity) is displayed in a dollar value, all relevant numbers are preceded by a period and at least one zero. The same is not the case when the cost is displayed in cents, as few prices presented in the real-world are in tiny fractions of a cent. Evidence shows that people in Western countries tend to make judgments about the magnitude of a number as they read it from left to right.[51] Furthermore, as the reader moves towards the right most digits of a price, the task of memorization becomes more difficult leading to poorer recall of rightmost digits. For example, if shown a price of $3.39 cents you are likely to recall that number as around $3 and have poorer recollection of the 39 cents that followed.

Given these findings, we expected the unit of price per kWh ($ or ¢) to influence consumer perceptions about the costs of electricity as well as their recall of the pricing information. More

[51] Poltrock, Steven E., and David R. Schwartz. "Comparative judgments of multidigit numbers." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 10.1 (1984): 32.

specifically, we hypothesized that seeing the price in dollars would lead to weaker recall than when it was presented in cents. This is because when a zero is presented as the first digit in an electricity rate (as it is when displayed in dollars), consumers may pay lesser attention to the differences in rates between on-peak, mid-peak, and off-peak periods, leading to poorer comprehension and less motivation to shift. Conversely, if a relevant number is placed at the leftmost side of a rate (as it is when displayed in cents), consumers may better attend to that number, perceive greater differences between period rates, and consequently feel more motivated to shift their usage in order to save money.

Size: The $ or ¢ symbol is either larger or smaller than the value

Inspiration for the currency size manipulation was derived from research by Luxi Shen and Oleg Urminksy.[52] They found that by increasing the saliency of an unfamiliar pricing unit (either making it darker or larger), people became less sensitive to the value shown next to it. In other words, by simply drawing participants' attention to the currency unit, researchers were able to alter participants' perceived magnitude of the accompanying price. There is an opportunity to apply this insight to how TOU electricity rates are presented to Ontarians. If it is possible to influence consumers' perceptions of electricity rates through this simple manipulation, perhaps it could be used to nudge them towards greater awareness of costs associated with electricity consumption, potentially resulting in increased TOU compliance.

The Unit of Price experiment was designed to answer the following questions:

- How does the pricing unit (dollars vs. cents) impact recall?
- How are perceptions of the magnitude of differences between rates affected by the following two factors: (i) the unit in which the price is presented ($ vs cents) and (ii) the size of the pricing unit compared to the numeric price?
- Does the size of the pricing unit and the dollar versus cents manipulation impact motivation to shift consumption to less expensive periods of the day?

[52] Shen, Luxi, and Oleg Urminsky. "Making Sense of Nonsense The Visual Salience of Units Determines Sensitivity to Magnitude." *Psychological science*24.3 (2013): 297-304.

Experiment 1: Design

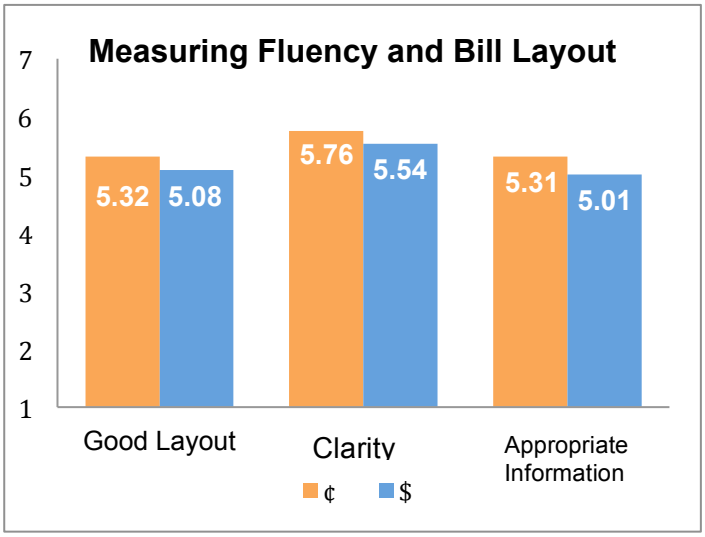
The first experiment employed a 2 (Representation: Dollars vs. Cents) X 2 (Symbol Size: Bigger than normal vs. Smaller than normal) between-subject factorial design, with two control conditions (i.e. one showing kWh usage in cents with the normal font size and the other in dollars, with a normal font size). To answer the above questions, participants were presented with various visual stimuli displaying one of the six conditions:

		Representation	
		$	¢
	Control	$ 0.135	13.5 ¢
Symbol Size Treatments	Unit – Big (1.3:1)	$ 0.135	13.5 ¢
	Unit – Small (1:1.3)	$ 0.135	13.5 ¢

530 participants completed the online survey, where there were approximately 90 participants per group. Summary demographics can be found in Table 17 of Appendix C.

Main Findings

Figure 2. Unit of Price is most fluent when displayed in cents

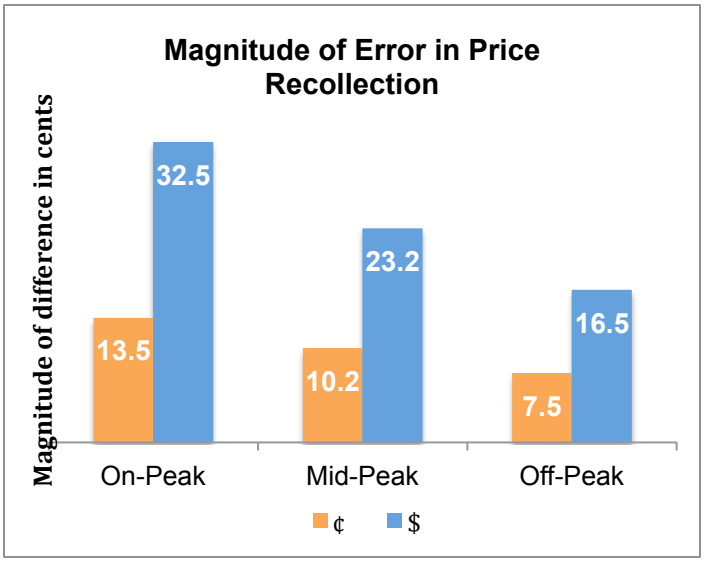


Measures:
Good Layout: The electricity company should continue to layout their bills this way
Clarity: Electricity costs are presented clearly
Information Overload: There is too much information on the bill (*Reverse Coded)*
Graph plots mean scores on a 7pt-scale, where 1 is Strongly *Disagree and 7 is Strongly Agree.*
Significant differences at *p <.05*

Bill Fluency/Layout

- **Overall, rates displayed in cents (¢) are easier to process.** Across three related measures, participants indicated that it was easier for them to process TOU rates when they were represented in cents rather than in dollars, regardless of the font size of the pricing symbol ($p < .05$ across all three dependent variables). *Information Overload* was reverse-coded for ease of interpretation relative to the other measures. Accordingly, a higher mean signals a more appropriate amount of information as is the case when information is presented in cent format. The means shown in Figure 2 are an average of the participants' scores on a 7-point likert scale, with 1 being "Strongly Disagree" and 7 being "Strongly Agree".

Figure 3. Recall is more accurate when prices are displayed in cents



Measure:
Using the slider bar below, please recall the rate for each period.
(Participants saw a slider bar next to each TOU period which started at 0 and went to either 100cents or $1 depending on the condition)
Significant differences at $p < .05$

TOU Price Recall

When consumers were shown rates in cents (¢), they were significantly better able to recall the rate amount. Overall, participants had weak recall of the price irrespective of the condition they were in. However, participants shown the cost of a kWh in cents performed significantly better than those shown the same information in dollars (p <.05). Figure 3 plots the magnitude of error on pricing (i.e., the difference between the actual price and the price recalled). As the graph indicates, participants shown the cost in cents were closer to recalling the actual price than those shown the cost in dollars. Additionally, estimates in the cent condition were approximately double the actual rates, whereas the estimates in the dollar conditions were almost three times greater than the actual rate. In short, participants were off in both conditions, but they were significantly further off in the dollar condition.

Implications and Recommendations

Display all prices consistently and in cents. The Unit of Price experiment illustrates how the same price can be perceived remarkably differently if it's presented in dollars or cents. There is strong evidence highlighting the significant impact the unit of price has on recall. While it is unclear whether this subsequently influences conservation and demand shift behaviour, it is evident that displaying peak kWh prices in cents is easier to recall for most people. These results hold further implications for subsequent RPP price changes. While all kWh prices benefit from being shown in this matter, it may be *especially beneficial when prices have increased; the same price displayed is recalled as being lower when it is displayed in cents than when it is displayed in dollars*. This study provides further evidence of the role of presentation on peoples' judgments. While the price is equal, its representation in the mind is not. We note that the phenomena we have identified here could be particularly true when prices are in the low to medium range. In contrast, if prices were in the range of thousands of dollars, we might expect that dollars would be more effective than cents in terms of generating recall.

The findings from this study hold further implications for any new pricing schema launched by the OEB. Given the important role that consistency plays on memory, learning, and liking of stimuli, we believe that the current inconsistent presentation format of cost information could be associated with reduced recall and comprehension among TOU consumers in Ontario.

2.2 Naming Schema

Emotional, familiar, or intuitively instructive stimuli are more likely to be recalled accurately than stimuli that lack these features. The naming schema used for TOU periods today may be ineffective due to the lack of a clear association between the name and the required behaviour.

In neuroscience, "embodied cognition" is the idea that our behaviour emerges from real-time interactions of resources distributed across our brains, bodies and environments, and our ability to perceive and act on those affordances. Inherent in this theory is the idea that representations used by the perception and action system are *necessary* for understanding higher-level cognitive processes[53,54], and there are automatic connections between perceptions and motor movements[55]. For example, previous research has indicated that pulling movements of the arm are more easily associated with approaching desired objects and that pushing movements of the arm are more associated with the avoidance of undesired objects[56,57]. Within this context, the interplay of perceptual and motor behaviour also becomes relevant for complex judgments and memory such as the kind associated with comprehension and recall of Peak and off-peak periods of electricity pricing within the TOU. Under the current naming schema, "on-peak" periods are ones in which consumers are suggested to turn electrical appliances "off" where as "off-peak" periods are ones in which they are suggested to turn electrical appliances "on", creating a dissonance between perception and required motor action.

The goal of this experiment was to test the current TOU time period naming schema (on-peak, mid-peak, off-peak) against a selection of alternatives that were strategically designed to increase comprehension, recall, and load-shifting behaviours. We proposed and tested the use of names that are rewarding or punitive in nature and that convey intrinsic social norms. This can be accomplished by modifying the naming schema to incorporate the socially negative impact of overconsumption of on-peak energy, similar to Health Canada's messages that are displayed on cigarette packs ("smoking causes yellow teeth and bad breath").[58] We hypothesize that this strategy may be effective in nudging consumers away from consumption during peak hours. Second, we tested whether implementing naming schemas that trigger familiar responses such as a traffic light system, which has been shown to be effective for nutrition labels[59], would implicitly suggest the appropriate behaviour, making it a useful technique for discouraging on-peak consumption. Lastly, to test the hypothesis that increasing the congruence between behaviour and financial consequences can reduce cognitive strain and draw attention to the financial incentive for shifting behaviour, we examined the effect of combining the period name with its associated cost.

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[53] Gibson, J. J. (1966). The senses considered as perceptual systems.
[54] Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review*, *9*(4), 625-636.
[55] Dijksterhuis, A., & Bargh, J. A. (2001). The perception-behaviour expressway: Automatic effects of social perception on social behaviour. *Advances in experimental social psychology*, *33*, 1-40.
[56] Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of personality and social psychology*, *65*(1), 5.
[57] Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioural predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin*, *25*(2), 215-224.
[58] Strahan, Erin J., et al. "Enhancing the effectiveness of tobacco package warning labels: a social psychological perspective." Tobacco control 11.3 (2002): 183-190.
[59] Sonnenberg, Lillian, et al. "A traffic light food labelling intervention increases consumer awareness of health and healthy choices at the point-of-purchase."*Preventive medicine* 57.4 (2013): 253-257.

Figure 4. Selection of naming conditions tested against the current schema

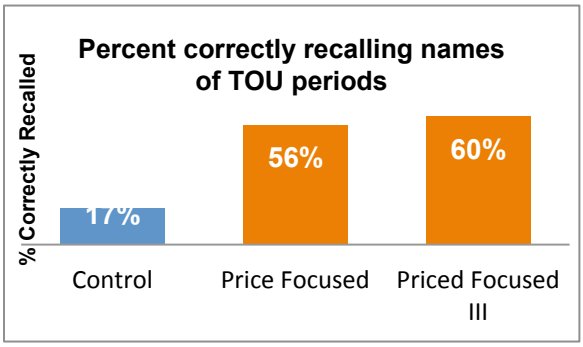
Social Norms Conveys socially punitive or rewarding feedback	Dirty Electricity	Clean Electricity	Green Electricity
Familiarity Consistent with concepts we come across regularly	Red Hours	Orange Hours	Green Hours
Price Focused Provides economic decision aids	Most Expensive	Average	Least Expensive

Experiment Design

After completing a comprehension section that introduced TOU pricing (without mentioning Ontario's current naming structure) participants were exposed to the condition-specific stimuli and asked to answer a series of questions related to the naming schema(s) they had seen. This experiment employed a between-subjects design, composed of 9 different treatment conditions that contained variations of the names of the different TOU periods (e.g. Peak Price, High Price, Standard Price), and 1 control condition (On-peak, Mid peak, Off peak). Participants were randomly assigned to one of 10 conditions. Across each condition, participants were evaluated on several questions testing the effectiveness of the labels, their motivation to conserve electricity as a result of the labels, and their recall of different naming schemes. These dependent variables are described briefly below but please refer to Table 21 of Appendix C, for question details. 842 participants completed the online survey, where there were approximately 90 participants per group. Summary demographics can be found in Table 20 of Appendix C.

Main Findings

Figure 5. Price Focused BE Conditions outperform current controls on recall,



Measure: Please recall the names of the three Time-Of-Use periods used in the question that you answered previously in this survey.
Significant differences at $p < .05$

Recall

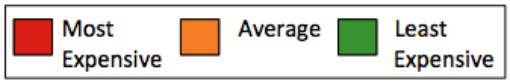
- Participants in the Price Focused BE conditions were better able to recall the names of the TOU periods relative to the control condition. Specifically, we tested three price focused conditions in total and found that overall, participants recalled the correct TOU names over 55% of the time compared to 17% of those in the control condition. While all price focused conditions performed well, we focused on the top two in particular. The first labelled the periods as Most Expensive, Average, and Least Expensive and the second used Peak Price, High Price, and Standard Price as its labels.

- Further, we found that these price-focused conditions generally outperformed other BE conditions on perceptions of name effectiveness, as well as motivation to conserve electricity. However, the price-focused conditions did not significantly outperform the control on these questions.

Top 2 BE Conditions

Figure 6. Price Focused

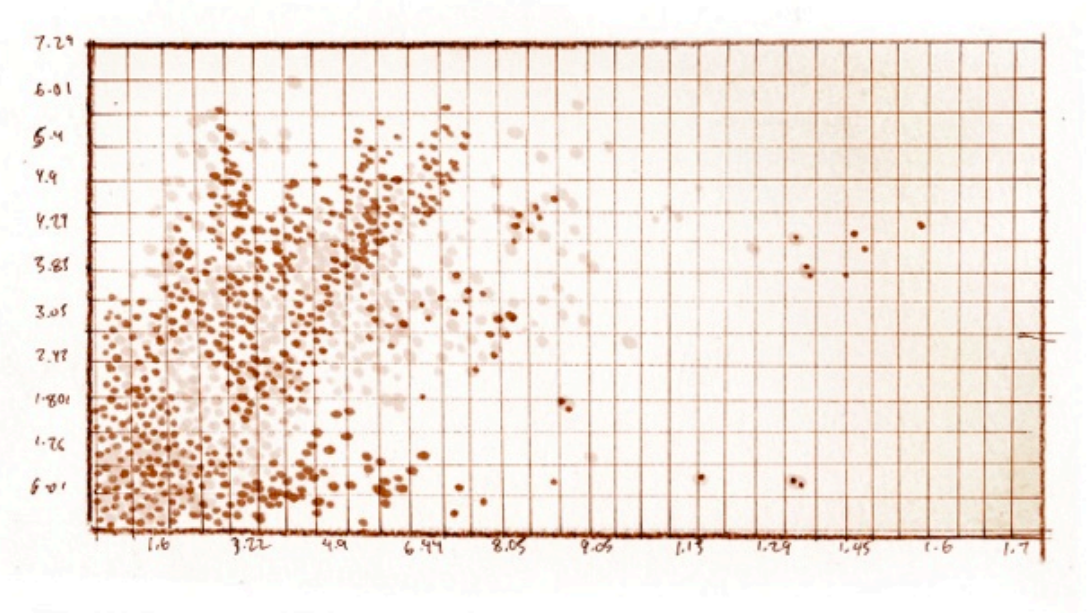
Figure 7. Price Focused III



Implications and Recommendations

Overall, we found that participants were more adept at recalling the correct TOU names in the BE conditions, especially when the names entailed some form of a financial association (i.e. focused on the price of each TOU period).

- **"Money Talks" in the names of the TOU periods.** Participants were significantly better at recalling the correct TOU names in the price-focused BE conditions than those in the control condition. It appears that tailoring a financial association to the TOU period names increases their saliency and improves participants' memory of them at a later time.



2.3 TOU Visual

In order to encourage load-shifting behaviour, consumers must be provided with relevant information and the appropriate tools. One tool used by Ontarians in their attempts to adhere to TOU schedules is the visual representation of the pricing schedule. The results from the *Electricity Consumer Survey* found that although the majority of Ontarians claimed to understand the TOU clocks currently distributed in the province (online survey: 77%, on-the-street survey: 61%), far fewer of them were able to use the image to answer hypothetical questions about when one should run high energy consuming appliances like a dishwasher (only 23% of participants were able to use the visuals correctly).

Given the gap between what people think they know and their inability to interpret the TOU clock correctly, it was important to test alternate versions of the TOU visual. This experiment tested modifications to the TOU clock as well as entirely new linear visuals in an effort to increase the speed and ease of interpreting peak timing information. We hypothesized that by making the visuals more intuitive and easier to process, Ontarians' would be able to make better decisions about when to engage and disengage in energy consuming behaviours.

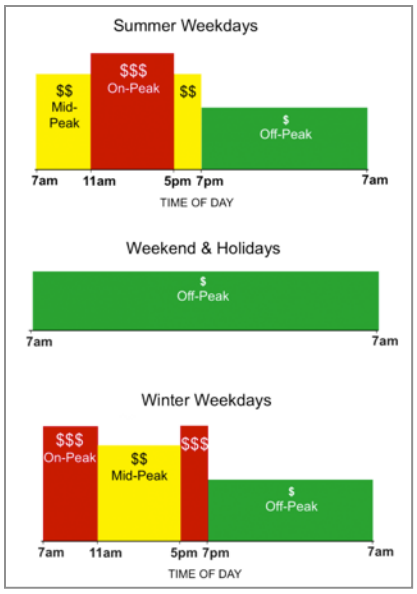
As discussed in section 1.1, improving the fluency of a stimulus - that is making it easier to process the information quickly and accurately - will improve people's recall of the information, and the likelihood they will use it to make actionable changes. Several manipulations to the current TOU visuals were designed to achieve this aim.

The rationale and hypotheses for the manipulations that were tested in the TOU visuals Nudge Panel Experiment were:

Display Type – Clock visual or linear time based

One of the most significant changes made to the TOU visual was displaying it in a linear format rather than as a 24-hour clock. The linear conditions were designed to align with peoples' mental representation of time. Numerous studies[60] have shown that the spatial representation of time moves from left to right. Given this evidence, the TOU periods were displayed horizontally, starting and ending at 7am. Displaying the information in this fashion also allowed the visual to convey the variance in prices throughout the day. Like a bar graph, the linear presentation of information not only informed participants of the peak times throughout a day, but it also displayed the relative price of each period by increasing in magnitude for Mid and on-peak times of day relative to off-peak periods. Another benefit of this visualization was its ability to take advantage of the

Figure 8. Linear TOU Clock

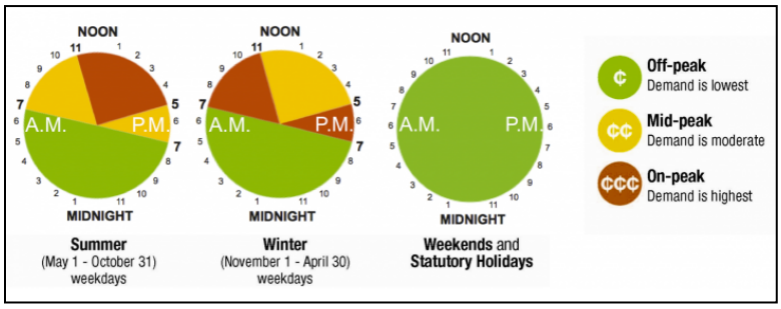


[60] Ulrich, R., & Maienborn, C. (2010). Left–right coding of past and future in language: The mental timeline during sentence processing. *Cognition*, *117*(2), 126-138.

dominant reading direction in Western countries.[61] By starting the time of this linear clock at 7am, a Mid or on-peak period depending on the season, we hoped to direct peoples' attention to costlier times of the day rather than off-peak periods.

A subtle fluency manipulation was also made to the TOU clock currently in circulation. The existing clock displays "noon" on the bottom and "midnight" on the top. Due to the possibility that the 24-hour clock is misinterpreted when displayed in this fashion and inverted the positioning of the periods by placing "noon" at the top of the clock and "midnight" on the bottom. We hypothesized that this inversion would result in greater fluency because on-peak and mid-peaks times occur during weekday mornings and afternoons. At this time, people are reading 12-hour clocks and watches with the 12 o'clock hand denoting noon rather than midnight.

Figure 9. Inverted Circular TOU Clock



Salience Manipulations – Highlighting critical time points, simplifying information, and using vibrant, high contrast colours

There is ample evidence to show that visuals can be designed to draw peoples' attention and impact future judgments and behaviours. Because attention is limited, the TOU visuals need to be able to convey the most important information quickly. If there's one thing people need to get out of this visual it is that electricity is most expensive between the hours of 7am and 7pm, no matter what the season. By highlighting the start and end times of the on-peak periods or the off-peak periods, we hoped to draw peoples' attention to these critical time points. This was achieved by either colour coding on-peak hours of the day in red, or off-peak times of the day in green. A further, more simplified condition was also created which only focused on the on-peak and mid-peak time points. The intention with this manipulation was to draw attention to the core time points between 7am and 7pm.

The BE conditions also removed any direct reference to the names of each period. More specifically, they used dollar symbols to denote each of the three TOU periods. For example, on-peak was replaced with $$$, mid-peak was replaced with $$, and off-peak was replaced with $. The purpose of making these replacements was to denote magnitude without requiring people to read the specific names of each period. Finally, the BE manipulated visuals used higher contrast colours for red, yellow, and green. These colours were selected for their

[61] Chan, T. T., & Bergen, B. (2005). Writing direction influences spatial cognition. In *Proceedings of the 27th annual conference of the cognitive science society*(pp. 412-417). Lawrence Erlbaum: Mahwah, NJ, USA.

similarity to traffic signals. Results from other studies have shown that colour coding based on traffic light signals helps to reduce decision complexity.[62,63] Because of their universal familiarity and meaning, these signals have been used to stop people from engaging in a number of behaviours both on and off the road. Our intention was to increase the perceptual fluency of the TOU visuals by using colours that more closely resemble those seen in peoples' day-to-day environment.

For a full overview of the visuals please refer to Figure 28 in Appendix C.

Experiment Design

The experiment employed a between-subjects design, composed of 10 different treatment conditions and one control, for a total of 11 conditions. The conditions differed by varying: 1) the layout of the visuals for the TOU periods (i.e. a circular vs. a linear design), 2) the labels on the visuals (e.g. on-peak vs. $$$), and 3) highlighting specific TOU times (e.g. noting the off-peak time by bolding the related times). Participants were randomly assigned to one of the 11 conditions. Across conditions, participants were evaluated on several questions testing whether they generally understood the visuals, as well as whether they were able to comprehend specific aspects of the visual (e.g. the times frames for each of the TOU periods), that they were motivated to change behaviour, and their recall of information presented on the visual (please refer to Table 24 in Appendix C, for question details. 1,060 participants participated in the online experiment, where there were approximately 90 participants per group. Summary demographics can be found in Table 23 of Appendix C)

Main Findings

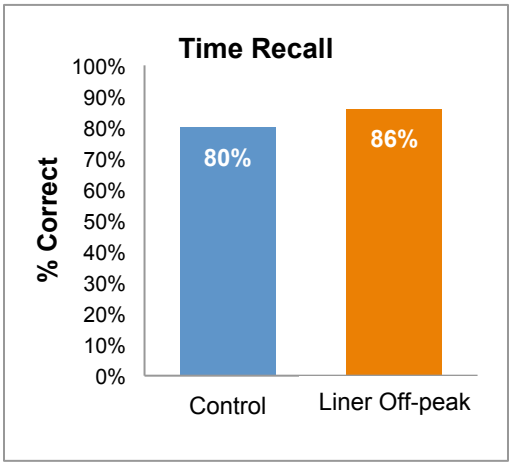
Recall

- Participants in the control condition had greater difficultly recalling the exact times of the on-peak periods relative to those in the experimental BE conditions. Additionally, participants in the BE conditions were significantly better at recalling the correct TOU start and end times. On average, over 65% of participants in the experimental conditions identified the correct on-peak time periods, compared to only 49% of participants in the control condition (p<.05).

Understandability & Comprehension

- **Participants exposed to linear visuals outperformed those exposed to circular ones.** Overall, we found that participants in the linear

Figure 10. Recall of the time period is significantly improved with Linear Off-Peak



Question: Using the slider below, please select the start times and end times for each Time-of-Use period during a Summer Weekday.
Significant differences at p=.06 *corrected*.

[62] Hieke, S., & Wilczynski, P. (2012). Colour Me In–an empirical study on consumer responses to the traffic light signposting system in nutrition labelling. *Public health nutrition*, *15*(05), 773-782.
[63] Choices, P. H. F. (2014). Traffic-Light Labels and Choice Architecture. *Am J Prev Med*, *46*(2), 143-149.

BE conditions performed better on comprehension tasks than those exposed to circular visuals. Two linear visuals in particular were found to be relatively more fluent than other treatment conditions as well as the control. When prompted to indicate how easily participants thought their peers would be able to understand the visual, the linear visual that highlighted the on-peak times performed significantly better than the control (*p<.05 uncorrected)*. When participants were asked to indicate the correct start and end times for each of the TOU periods, the linear visual that highlighted the off-peak times led to a significantly greater number of correct responses relative to the control, 86% vs. 80%, respectively (*p=.06 corrected)*.

Top 2 BE Conditions

Figure 11. Linear TOU off-peak Focused

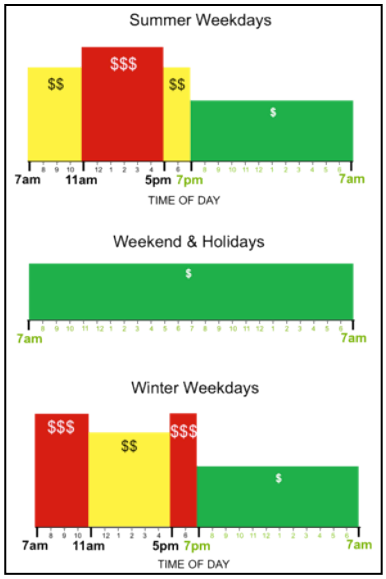
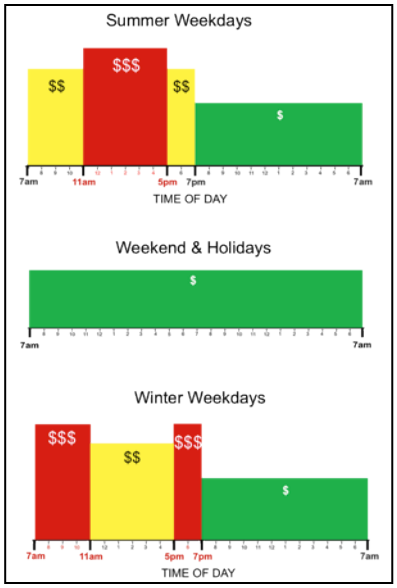


Figure 12. Linear TOU on-peak Focused



Implications and Recommendations

Overall, we found that participants in the linear visual conditions were better able to understand the information and recall the times of each period. Two conditions in particular out-performed the others: the linear with on-peak highlighted and the one with off-peak highlighted.

Use a linear TOU visual to improve peoples' ability to interpret TOU time related information. A linear TOU visual appears to create a more fluent reading experience for the reader. This resulted in higher recall and comprehension over the control. It appears that replacing the visuals with either one of the linear versions yields greater awareness of the start and end times of each period. Improvements in this domain should result in a lowered shift in consumption during on-peak times. However, this has yet to be tested in a randomized field experiment.

2.4 Price Clarity

Findings from our primary research suggest that there is an opportunity to improve the way TOU information is displayed on common electricity bills. When Ontarians in the *Bill Click Tracking Study* were presented with an electricity bill resembling a Toronto Hydro or a Hydro One statement, the majority of them overlooked their TOU usage breakdown and the rates that correspond to each period. Furthermore, when these participants were asked to recall TOU rates in the *Electricity Consumer Survey*, less than 65% were able to answer correctly. Both these findings suggest that many TOU consumers aren't paying attention to these details on their bills. We suggest two possible explanations for this disengagement. One is the complex and undifferentiated presentation of TOU consumption information on current bills. The other may be a general lack of understanding surrounding some of these charges, including the fixed monthly charges. People may feel discouraged by the significant proportion of their bill that is comprised of these delivery, regulatory, and debt retirement charges, which they have no ability to control.

The rationale and hypotheses for the manipulations that were tested in the Price Clarity Nudge Panel Experiment were:

TOU Salience: the visual representation of TOU usage, rates, and charges

Currently, fixed charges are displayed in relatively the same format as TOU usage and pricing. Significant cognitive effort must be expended in order to parse out the portion of charges consumers can control through their usage decisions. This added effort acts as a barrier to engagement and comprehension. Furthermore, analysis of the *Bill Click Tracking Study* found that when a participant attended to an area of a bill, their recall of the information contained within that area was significantly better than those who didn't look at that particular item (71% vs. 33% respectively). It was also found that the most-viewed area on an electricity bill is the one pertaining to an individual's total amount owing (with over 70% of clicks in this region). These insights suggest that an effective method for enhancing awareness, comprehension, and uptake of TOU is to increase the visibility of content related to it, visually distinguish it from fixed charges, and to clearly link these elements to one's total charge. For this reason, the TOU presentations in the BE conditions were made

Figure 13. BE Condition with Block presentation of TOU

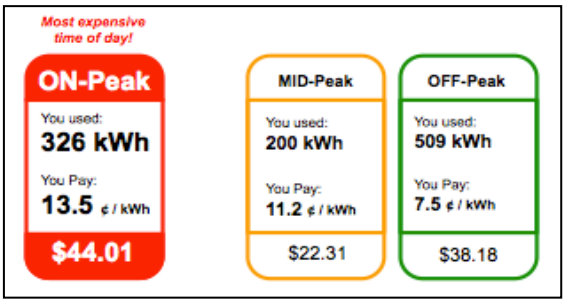
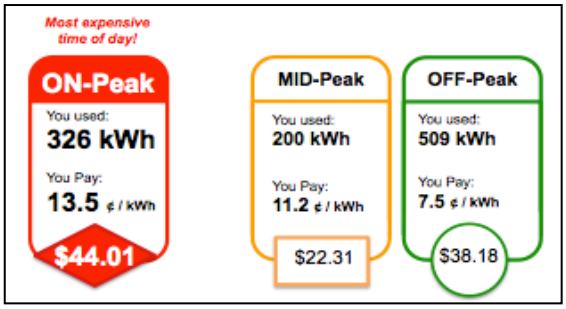


Figure 14. BE Condition with Shapes presentation of TOU



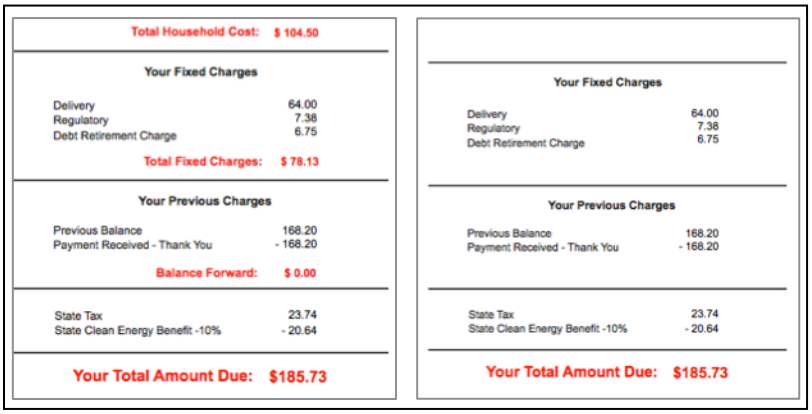
more salient by including coloured borders, a larger font, and surrounding the associated costs with additional white space. As part of the test, a message was included above the on-peak breakdown indicating that it was the most expensive time of day.

In addition to increasing the saliency of the TOU information, we hypothesized that by better distinguishing between periods we could enhance comprehension and increase motivation. This was accomplished in two ways. Firstly, colour coding was introduced. This not only enhanced the differences between periods, but also provided the reader with implicit information by simulating familiar stop/go traffic light imagery. As discussed in the section above, support for the effectiveness of this method can be found in other domains such as health and nutrition.[64] Secondly, a condition was created where the price was displayed in a different shape (diamond, square, or circle) depending on the period. It was hypothesized that participants' comprehension and recall of TOU rates would be enhanced by adding this extra differentiator. Furthermore, these shapes can be used to create consistency throughout all TOU communications, not just the bill. Finally, we created a slightly more simplified version of Toronto Hydro's bill as our second control. The kWh's consumed per month were rounded to the nearest whole number. For example, a typical Toronto Hydro bill (control 1) displays consumption as 326.419 kWh, whereas our modified Toronto Hydro bill (control 2) displayed this as 326 kWh. Given that people are largely unfamiliar with kWh, we hypothesized that the extremely exact presentation of consumption to the third decimal place was more detrimental than it was transparent. There were no other changes between the two control conditions.

Fixed Charges: Location of fixed charges, definitions, and the presence of subtotals

Ontarians may be discouraged by the savings potential of TOU schedules because of the high proportion of fixed charges which they have no control over. These fixed charges represent the cost of delivering the electricity, regulatory fees, and debt retirement charges.

Figure 15. BE Conditions Subtotals versus No subtotals

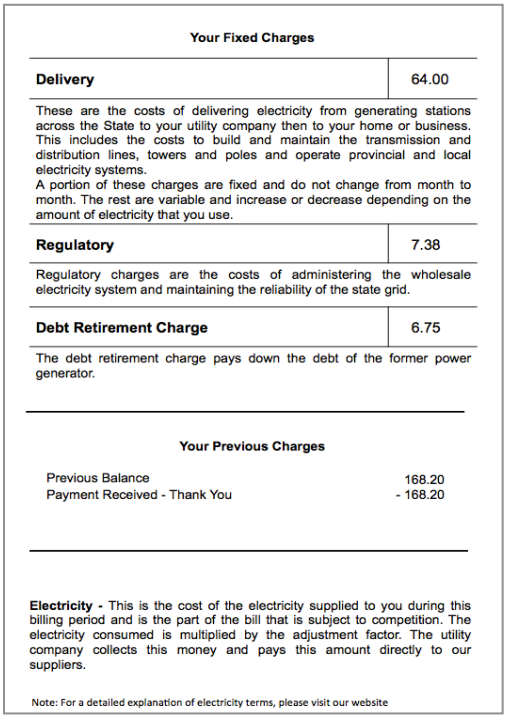


This sentiment was found in research conducted by the Gandalf Group on behalf of the OEB in 2009. The Gandalf Group reported that focus group participants frequently communicated their displeasure at the magnitude of the costs associated with items such as Delivery or Regulation. These consumers felt that they received relatively little information about these charges on their electricity bills and had difficulty articulating what they got in return for paying for this portion of the bill. These findings suggest that there is an information gap that could be leading to an overall customer dissatisfaction and disengagement in regards to TOU.

[64] Borgmeier, Ingrid, and Joachim Westenhoefer. "Impact of different food label formats on healthiness evaluation and food choice of consumers: a randomized-controlled study." *BMC Public Health* 9.1 (2009): 184.

To test the extent to which consumers are de-motivated by fixed charges and how alternate presentations may effect motivation and comprehension, we created two variations of our BE presentation. We tested this manipulation across all BE conditions. One version included subtotals for electricity consumption charges as well as fixed charges, while a different version displayed only a total charge.

Figure 16. BE Condition with fixed charges in tabular format on the back of a bill



Your Fixed Charges

Delivery	64.00
These are the costs of delivering electricity from generating stations across the State to your utility company then to your home or business. This includes the costs to build and maintain the transmission and distribution lines, towers and poles and operate provincial and local electricity systems. A portion of these charges are fixed and do not change from month to month. The rest are variable and increase or decrease depending on the amount of electricity that you use.	
Regulatory	7.38
Regulatory charges are the costs of administering the wholesale electricity system and maintaining the reliability of the state grid.	
Debt Retirement Charge	6.75
The debt retirement charge pays down the debt of the former power generator.	

Your Previous Charges

Previous Balance	168.20
Payment Received - Thank You	- 168.20

Electricity - This is the cost of the electricity supplied to you during this billing period and is the part of the bill that is subject to competition. The electricity consumed is multiplied by the adjustment factor. The utility company collects this money and pays this amount directly to our suppliers.

Note: For a detailed explanation of electricity terms, please visit our website

To address the lack of transparency many customers felt in regards to fixed charges, we manipulated the presentation of these charges and then tested participants' feelings of fairness, motivation, and comprehension. The first manipulation involved presenting the fixed charges on either the front or the back of the bill. Participants in the fixed front condition saw charges for Delivery, Regulatory, and Debt Retirement underneath their electricity total, which were presented on the front. Those in the fixed back condition were shown just their total charge with instructions to view the back of the bill for further details on their fixed charges. In both the fixed front and fixed back conditions, a glossary of terms was included on the back that defined each charge separately.

The second manipulation involved placing the fixed charges in table format and presenting definitions directly next to the name of the charge and its associated price. This design was inspired by the feedback discussed above. If consumers are provided with greater clarity in regards to the fixed charges that appear on their bill, our hypothesis is they will feel less frustrated by these costs and be more likely to see the benefits of aligning with TOU schedules.

Experiment Design

The experiment employed a 2 (TOU Design: block vs. shapes) X 2 (Bill Subtotals: breakdown vs. no breakdown) X 3 (Fixed Charges: Front vs. Back vs. Table) between-subjects factorial design. It was composed of 12 treatment conditions and two control conditions. We varied the stimuli across three factors; the first factor in the treatment conditions varied the presentation of the TOU periods and related costs/prices, where certain participants saw a block design that outlined the TOU periods, while others saw a shape design. The second factor varied whether participants were provided with a subtotal breakdown of their fixed charges or not. Finally, the third factor varied whether the fixed charges were displayed on the front of the bill, the back of the bill, or the back of the bill in a tabular format. With respect to the two control conditions, the first was a replica of an existing Toronto Hydro bill with all branding and personally identifiable information removed. The second was a slightly simplified version of the same Toronto Hydro

bill will one small change, the amount of kWh consumed were rounded to the nearest whole number (i.e. there were no decimals).

Across each condition, participants were asked to imagine receiving the following electricity bill and were shown an image of one of the conditions described above. They were then asked several questions that were designed to measure their comprehension of the information presented (and TOU in particular), their motivation to conserve electricity, how fair they believed the prices to be, and whether or not the information was presented clearly on the bill. They were then asked several demographic questions which were followed by a recall question which asked them to select the total dollar charge for on-peak electricity in the bill they saw earlier. Please refer to Table 27 in Appendix C, for question details. A total of 619 participants completed the online survey, with approximately 40 participants per group. Summary of demographics can be found in Table 26 of Appendix C.

Main Findings

Comprehension

- Displaying fixed charges in a table with a glossary and no subtotal breakdown led to an overall improvement in comprehension scores. Participants in conditions that did not tally the TOU and fixed charges in subtotals outperformed the control conditions on measures of recall and comprehension. Specifically, these people were better able to recall and comprehend specific details about the bill. Furthermore, when the fixed charges were displayed in a glossary table (again without subtotals), people performed even better on comprehension tasks relative to controls. These findings hold irrespective of the visual design of the bill. We did not find any significant differences between the TOU block or shapes presentation, however these two conditions did outperform both controls. Specifically, on an aggregate score across 5 questions, participants exposed to the TOU layout in the block design (M = 3.29) and shapes design (M = 3.09) significantly outperformed the control 1 (M = 2.34) and control 2 (M = 2.36); $p < .05$.

- Participants in the Control conditions struggled to recall the exact price of each of the TOU periods. They also had difficulty approximating how much electricity was consumed during on-peak Hours. When asked to identify the prices of each of the TOU periods, only 26% of the participants in control 1 were able to identify the correct response, while only 17% of those in control 2 (simplified kWh) answered correctly. These participants also had greater difficulty identifying how much on-peak electricity was consumed on the bill: only 17% of participants in control 1 and 31% of those in control 2 could answer this correctly.

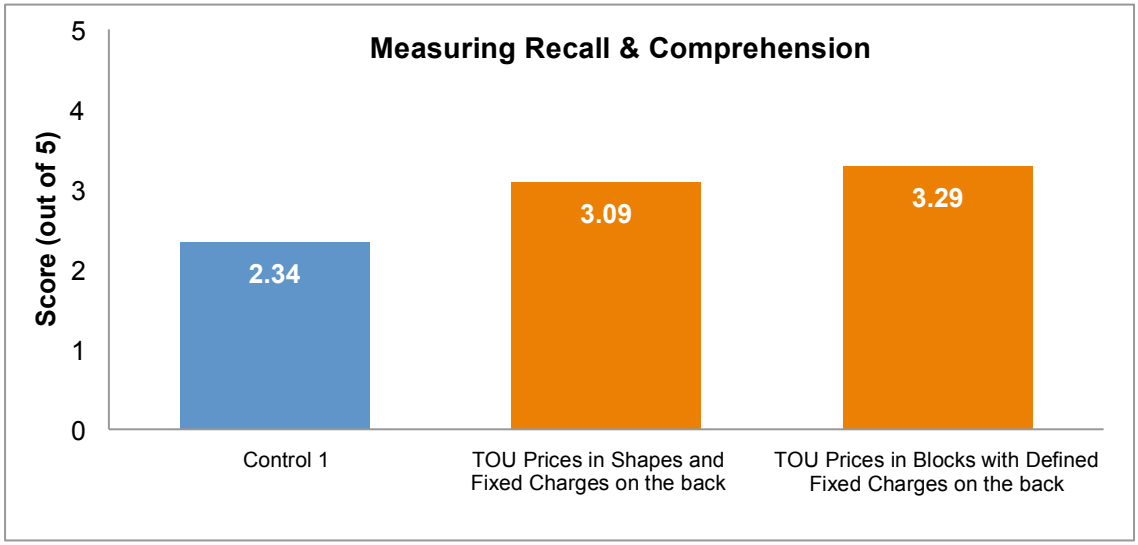
Motivation

- People were more motivated to conserve electricity when they saw the TOU charges displayed in a block design with fixed charges displayed in a glossary table on the back of the bill with no subtotal breakdowns. Participants were asked a series of questions regarding their motivation to engage in different behaviours. We asked questions to determine how motivated they were to conserve on-peak electricity, to share the bill with others in the household, whether the cost savings would be worth the effort to shift electricity

consuming activities to off-peak times of day, and their motivation to shift to off-peak hours. Respondents answered on a 7-point Likert scale with 1 being "Strongly Disagree" and 7 being "Strongly Agree". For the analysis, we created an aggregate score across these 5 highly correlated motivation questions, and found that participants in the block condition with fixed charges in the tabular format were significantly more motivated to conserve (M = 5.79) than in control 1 (M = 5.43) and control 2 simplified kWh (M = 5.42); $p < .06$. In addition, this specific condition outperformed many of the other BE treatment conditions (e.g. ones that included a subtotal breakdown as well as ones that displayed fixed charges on the back).

Implications and Recommendations

Figure 17. Overall recall of billing information outperformed controls



Measures:

1. In the bill you just saw, what was the price of each of the three Time-of-Use periods?
2. On the bill you just saw, what was the current total amount owing?
3. According to the bill you just saw, you consumed the most amount (kWh) of electricity during:
4. According to the bill you just saw, you were charged ($) the most for electricity consumed during which period?
5. According to the bill you just saw, approximately how much electricity did you consume during On-Peak hours?

The graph plots the number of correct answers provided for each of the 5 questions per condition.
Significant differences at $p < .05$.

This experiment sheds light on the influence of information presentation on motivation and recall. The exact same price, cost, and consumption information was presented in different ways and often led to significantly different outcomes. With this experiment we were able to shed light on findings from OEB's focus groups with consumers. Indeed, people are demotivated to conserve when the fixed charges for delivery, debt retirement, and regulatory charges are tallied into a subtotal. Furthermore, the results of this study show that fixed

charges, which are largely misunderstood, should be displayed next to their definitions. Further experiments could test different manipulations of this, perhaps using a more simplified definition of the fixed charge rather than the detailed one as was included in our experiment. Finally, participants displayed equal preference for the design of the TOU prices (blocks or shapes). In future bill designs, we suggest "chunking" the information in ways that make the important elements of TOU more salient. .

- **Do not bundle the costs of fixed charges with consumption costs.** Across the measures, it was apparent that participants did not respond favourably to the fixed charges being broken down into subtotals on the front of the bill. The conditions without the TOU and fixed cost subtotals broken down led to increased comprehension, motivation to change ones behaviour, and reduced feelings of being overloaded with information.

- **Simplify the layout of the fixed charges using a table on the back of the bill.** Participants who saw their fixed charges displayed in a table format with the corresponding definitions (but without the subtotal) were better able to comprehend the information and were more motivated to conserve electricity. They also had better recall of the three rates across the TOU periods as well as their charges, and were more motivated to conserve on-peak electricity.

Top 2 BE Conditions

Figure 18. TOU Prices in block presentation with fixed charges defined in a table on the back and no subtotal breakdown

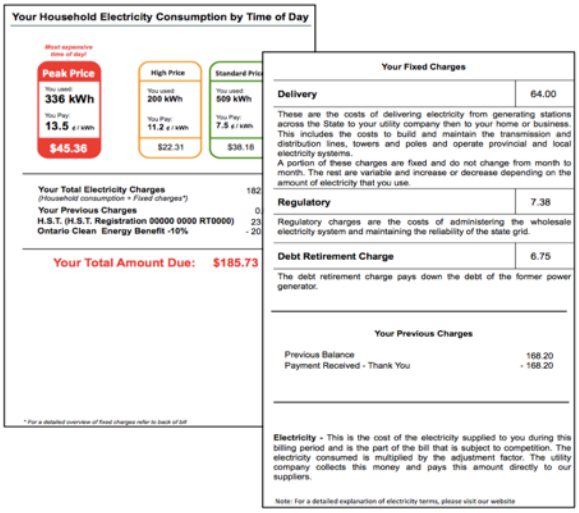
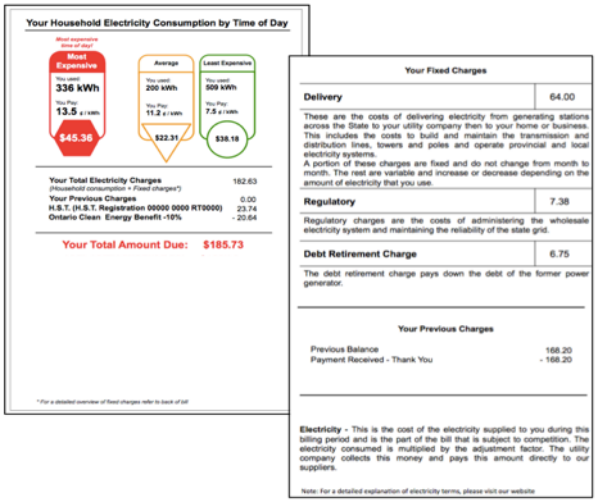


Figure 19. TOU Prices in shape presentation with fixed charges defined In a table on the back and no subtotal breakdown

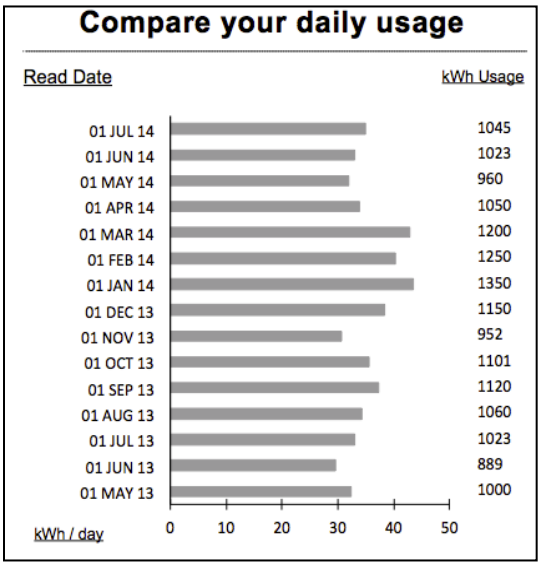


2.5 Longitudinal Consumption Visual

There is significant opportunity to optimize the graphical visuals presented on electricity bills. The bill evaluation revealed that some utilities show month-over-month consumption information either graphically or in table format whereas others do not provide historical usage information at all.

Findings from behavioural research on fluency and cognitive overload suggest that the way information is presented to consumers will influence their judgment and subsequent conservation behaviours. It is therefore important to determine which format of presenting historical consumption information drives respondents to shift their electricity usage to off-peak periods.

Figure 20. Existing Toronto Hydro Overall Consumption Graph



This experiment focused on optimizing the visuals used in Toronto Hydro's bills. Toronto Hydro is the largest municipal electricity distribution company in Canada. The company reaches approximately 730,000 households in the City of Toronto.[65] They are also one of the few utility companies in the province to display consumption information in a graphic format.

The rationale and hypotheses for the manipulations that were tested in the longitudinal consumption visuals Nudge Panel Experiment were:

Fluency: Alpha-numeric versus graphic display of consumption information

Information that is presented in an alpha-numeric text format requires deeper cognitive processing, and more mental effort, than the same information in a visual graphic format.[66] Information in a text format also limits the amount of information that can be processed quickly and retained in memory.[67] Well-structured visual representations reduce readers' cognitive strain and search-time costs. In other words, the visual representation of text-based information makes it easier for people to identify what they should be attending to. Infographics present complex information quickly and clearly. They improve a readers' fluency by displaying information in a way that enhances the visual system's ability to see patterns and trends.[68] That said, even graphic representations of information need to be designed in a way that makes the relevant and important information easy to find and understand. Variations in colour, size, and

[65] Toronto Hydro-Electric System Financial Report (2013).
[66] An alpha-numeric display consists of information presented to consumers through the use of numbers/ statistics or verbal descriptions. The term graphic or graphs are used to interchangeably refer to Cartesian graphs, pie charts, bar charts, and iconic charts.
[67] Wise, J. A., Thomas, J. J., Pennock, K., Lantrip, D., Pottier, M., Schur, A., & Crow, V. (1995, October). Visualizing the non-visual: spatial analysis and interaction with information from text documents. In *Information Visualization, 1995. Proceedings.* (pp. 51-58). IEEE.
[68] Card, S (2009). Information visualization. In A. Sears & J. A. Jacko (Eds.), Human-Computer Interaction: Design Issues, Solutions, and Applications (pp. 510-543). Boca Raton, FL: CRC Press.

form greatly impact the visual processing speed of information.[69] These visual design elements influence perceptions of what is 'worthy' of attention. Given the evaluation of the current visuals as in the *BE Bill Audit* above, there is room to improve the existing graphic visuals which lack clarity about what information the reader should be paying attention to.

The results of the *Bill Click Tracking Study* point to the potential of improvements to the consumption visuals. According to those results, people were more likely to look at their monthly consumption information when it was presented in a graphical format (Toronto Hydro) than when it was shown in a text format (Hydro One).

More importantly, people who attended to the TOU-specific information had better recall of that information at a later time. Research has indicated that the way information is acquired and coded in memory has important consequences for judgment and decision-making.[70] For example, information that attracts attention holds greater weight and influence over a subsequent decision. We hypothesized that electricity consumption visuals that highlight comparisons between previous and current usage – in a simplified and easy-to-understand way -- would help households better understand their usage. This greater level of awareness may motivate households to reduce their electricity usage, especially in cases where their current usage is higher than it was in prior months, or current usage is higher when compared to their historic seasonal averages for the same time of the year.

To increase the fluency of the existing Toronto Hydro Consumption visual, monthly usage information was displayed vertically rather than horizontally. Placing time in months along the x-axis was predicted to increase processing fluency. Research on the mental representation of time provides evidence for peoples' preferences to associate the past with the left and the future with the right.[71] These associations hold for the sequencing of months, years, and days of the week.[72] By laying out the information in a manner that is congruent with the way people conceptually think about time, we expect to increase the ease and understanding of the consumption information. Furthermore, the visual is also simplified by only providing exact consumption data for 2 months rather than all 12 months.

Time frame: Comparing month-over-month usage versus year-over-year usage

Shifts in temperature, seasons, and holidays make comparing the current month to the previous month (month-over-month), as well as the same month last year (year-over-year), useful. We tested which type of consumption feedback was most useful to consumers by highlighting either the month-over-month comparison or the year-over-year comparison. After discussion with members of the OEB, we found that annual comparisons more capture fluctuations in usage accurately than month-over-month comparisons. Given this hypothesis, we tested peoples'

[69] Wolfe, J. M., Cave, K. R., & Franzel, S. L. (1989). Guided search: an alternative to the feature integration model for visual search. *Journal of Experimental Psychology: Human perception and performance*, *15*(3), 419.
[70] Hastie, R., & Park, B. (1986). The relationship between memory and judgment depends on whether the judgment task is memory-based or on-line. *Psychological review*, *93*(3), 258.
[71] Bonato, M., Zorzi, M., & Umiltà, C. (2012). When time is space: evidence for a mental time line. *Neuroscience & Biobehavioural Reviews*, *36*(10), 2257-2273.
[72] Gevers, W., Reynvoet, B., & Fias, W. (2003). The mental representation of ordinal sequences is spatially organized. *Cognition*, *87*(3), B87-B95.

responsiveness to, and comprehension of, consumption visuals presented in one of the two feedback formats.

Unit: Graphic representation of average monthly consumption in kWh or total $ amounts

When it comes to providing households with consumption feedback there are two predominant units of measurement. People can either receive consumption feedback in kWh consumed or total dollar amounts spent. To our knowledge, most bills in Ontario display historical consumption information in kWh. For example, Hydro One displays their chart in average daily kWh consumed over each month. Toronto Hydro, in contrast, shows overall monthly consumption as well as average daily values (although the latter isn't displayed very clearly and needs to be extrapolated from the graph).

The *Bill Click Tracking Study* revealed that people were more likely to seek out and click on dollar charges as opposed to usage information on their bills. Therefore it was imperative to test consumers' response to consumption visuals in kWh as well as the equivalent total monthly charges. Furthermore, because people have a greater understanding of charges in dollar amounts, rather than in kWh, they may become more sensitive to the monetary consequences of their consumption.

Magnitude: Small versus large differences in consumption feedback

The final manipulation for this experiment was whether or not the differences across time points were large or small (8% versus 2% respectively). We hypothesized that consumers would be more sensitive to large gaps between the current usage and prior usage. However, what's more important, is whether or not this information motivates conservation across months where reductions in usage are small. This latter scenario is more likely to be the case according to several studies on the impact of energy conservation nudges.[73,74] Therefore the test also measured the impact of the consumption visuals when the differences were relatively small.

By testing variations of Toronto Hydro's existing consumption visuals, this experiment explored the following questions:

- How effective is Toronto Hydro's overall consumption visual at helping customers (i) accurately understand their current month's electricity usage and (ii) compare the current month's electricity usage to their previous month's usage, or that of the same month last year?

- Does modifying the Toronto Hydro's consumption visual by positioning the monthly consumption bars horizontally rather than vertically improve comprehension and recall of prior electricity usage and motivation to conserve electricity?

[73] Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*(9), 1082-1095.
[74] Navigant (2013). Time of Use Rates in Ontario. Part 1: Impact Analysis. Seasonal Conservation Estimates, Residential Conventional Impact

- Does presenting monthly usage in terms of total costs in dollars, rather than in consumption units (kWh) have an impact on recall, visual comprehension, and motivation to shift usage to off-peak times of day?

- Does this consumption visual motivate consumers even when there are small differences in usage (2%) rather than large differences in consumption (14%)?

Experiment Design

A total of 10 conditions were included in the test: Two control conditions, and 8 BE conditions which varied by which *time frame* was made salient, either current month to previous month (henceforth referred to as MoM) or current month compared to same month last year (henceforth referred to as YoY); whether graphical *units* were presented in kWh or $Cost; and whether the *magnitude* of difference in consumption across the comparison points was "big" or "small". This led to an experimental design that was a 2 (time frame) X 2 (unit) X 2 (magnitude) between-subjects factorial design with two control conditions, (i) existing Toronto Hydro graph and (ii) HydroOne current usage table (please refer to Figure 30 in Appendix C).

Figure 21. BE Condition with YoY comparison, large difference across compared months, and units in kWh

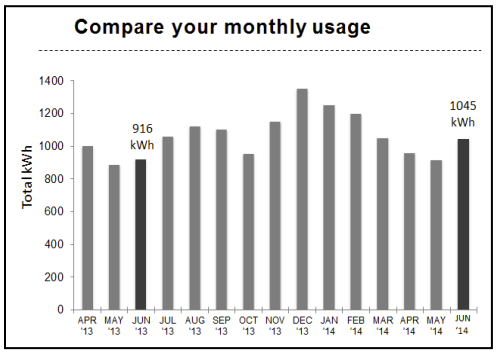
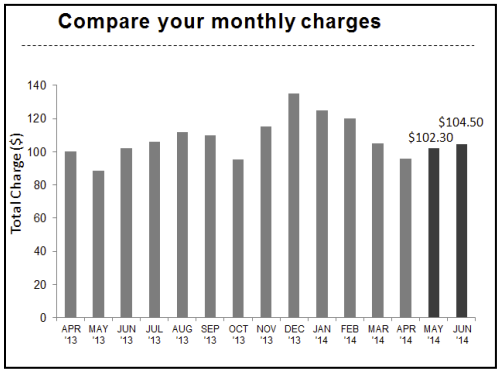


Figure 22. BE Condition with MoM comparison, small difference across compared months, and units in $Cost



The monthly usage for the previous month and the same month in the previous year were always the exact same amount. Within these groups, half of the participants were presented usage amounts in kWh, while the other half saw $Cost. Finally, the magnitude of difference between the compared months was varied across groups. Half the participants saw a big difference (14%), while the other half saw a small difference (2%). Respondents in the control conditions also saw graphs with the same magnitude of difference as in the experimental conditions. All participants in the new BE conditions saw consumption bar graphs that were positioned vertically rather than horizontally.

To determine the effectiveness of the different consumption visuals, participants were shown the graphs and subsequently asked a series of questions testing their comprehension of the information, recall, and motivation to change behaviour – see Table 30 in Appendix C for questions details. 896 participants completed the online study, with approximately 90 participants per group. Summary demographics can be found in Table 29 of Appendix C.

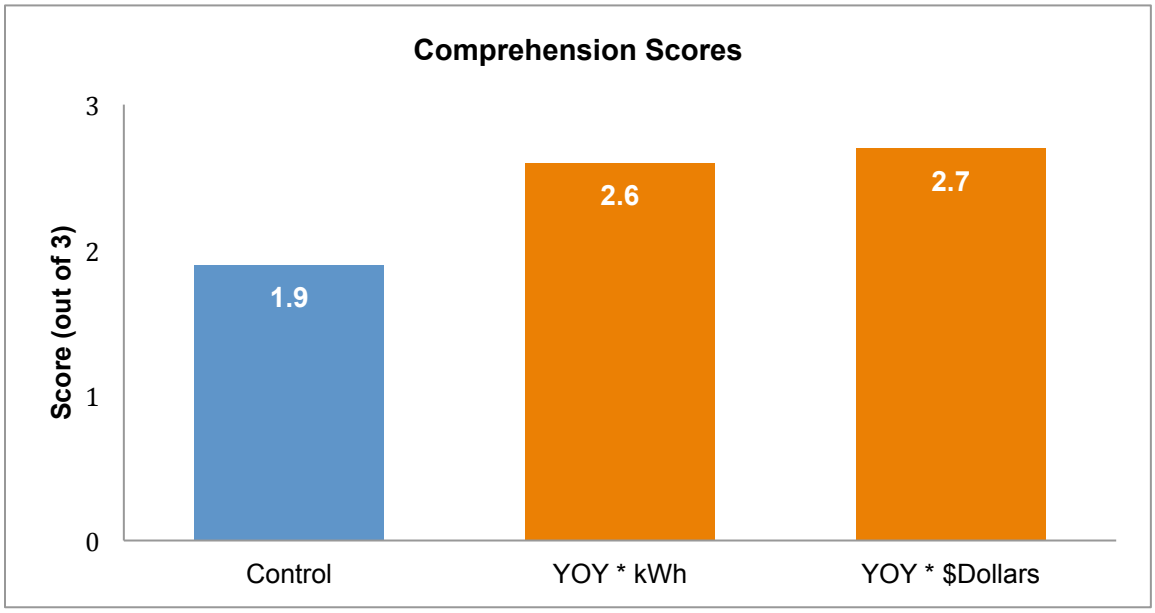
Main Findings

Comprehension: To measure comprehension, participants were asked three questions that required them to identify shifts in electricity usage between the current month and the previous month, as well as the current month compared to the same month last year.

- Consumption visuals displaying longitudinal data should highlight Year over Year (YoY) comparisons rather than Month over Month (MoM) comparisons. When the YoY difference was small, participants in the MoM condition had difficulty identifying the directional shift in usage between the current year and the same month last year (25% of participants answered the question correctly). In contrast, those in the YoY condition who saw small differences in usage were still able to accurately identify the directional shifts between the current month and previous month. This may be a result of MoM comparisons being much easier to make as the bars are in close proximity to one another. Respondents can easily make comparative judgments even without the labels provided. This is more difficult to do for YoY comparisons, especially when the differences are small. Since yearly comparisons provide a better cue for over consumption than monthly comparisons, this information should be made salient on the bill.

- Presenting the bar graphs vertically (time on the x-axis) and highlighting YOY consumption improved participants' comprehension of the graph as well as the speed at which the information was processed. Participants were able to identify directional changes in the MoM comparisons better when the graph was displayed vertically rather than horizontally. We also found that visuals highlighting YoY consumption led to higher reading/comprehension speeds than controls as measured by reaction time. Participants were faster at interpreting the graphs regardless of whether the differences across the comparison months were small or big. For example, participants who were asked to compare their usage in the current month to that of the same month last year (small differences in magnitude) did so in an average of 39.44 seconds, whereas it took those in the control condition (small differences), 56.87 seconds to do so ($p<.05$). The same significant finding exists for those who saw the graphs with big differences across the compared months. Participants making YoY comparisons with big differences did so significantly faster than controls, taking 47.38 seconds versus 69.70 seconds in the equivalent control ($p<.05$). In other words, participants who saw information presented vertically, and with YoY highlighted were quicker to process the information correctly. These improvements can also be seen in Figure 23 below across three comprehension measures.

Figure 23. Comprehension Improvements when graph makes it easy to compare YoY usage



Comprehension Measures:

- How many kilowatt-hours did you consume in June 2014?
- Your consumption in the most recently billed month is _____ your consumption in the month prior
- Based on the graph, what was your total charge for the month of June 2014?

The graph plots the number of correct answers provided for each of the 3 questions per condition.
Significant differences at $p < .05$

- The existing consumptions visuals tend to confuse readers by making them think the meter-read date month is actually the month that is being measured. A significantly large number of people in the control conditions (56%) were unable to correctly answer the question "how many kilowatt hours (kWh) did you consume in June 2014?". They misinterpreted the meter-read date for the consumption month. On the other hand, 94% of respondents in the BE visual conditions answered this question correctly. *p<0.05.*

Recall

- **Overall, participants' recall of information was improved when the consumption graph was perceptually fluent.** Reducing the amount of information presented on the graph, as well as displaying it vertically instead of horizontally, resulted in significant improvements in recall of the unit presented (irrespective of whether it was in $ amounts or kWh). Participants in all of the new BE conditions had significantly better recall of the precise consumption information on the most recently billed month (93% correct) compared to participants in the control conditions (64% correct). *p<0.001.*

Motivation To Change Behaviour

- **YoY comparisons were easier to understand.** Participants were asked to rate ease of understanding of presented information on a 7 point likert scale, with 1 being "Very Difficult" to 7 being "Very Easy"). Participants in the small differences YoY conditions stated that they found the information easier (*M* = 6.29) to understand compared to those in the control group which also displayed small differences (*M* = 5.70); *p<0.05.* Similarly, participants in the big differences YoY conditions stated that they found the information easier (*M* = 6.28) to understand compared to the big differences control group (*M* = 5.56), p<0.05. For the MoM conditions, only participant in the big differences condition found the information easier (*M* = 6.27) from big control, p<0.05.

- Consumption visuals that are presented vertically and that display units in dollars are rated as being the easiest to understand for the general population. Participants were also asked how easy they thought others would find the information to understand (same scale as in the previous Ease question). The consumption visual that presented the information vertically and highlighted usage in dollars was rated as the easiest for the average person (*M* = 5.44) to understand relative to any of the other conditions tested (Control: 4.89, kWh: 5.21) *(p<0.05 for each).*

- **Participants felt graphs displaying consumption in dollar amounts would drive others to conserve.** Despite feeling that the new concept designs would not change their own behaviours, participants felt that displaying units in dollar amounts (*M* = 5.54) rather than kWh, would drive others to reduce their electricity bill (*M* = 5.21), p<0.05. Participants answered this question on a 7-point likert scale with 1 being "Strongly disagree" and 7 being "Strongly agree".

- Consumption measured in kWh rather than dollars made participants slightly more likely to select off-peak times to run their appliances. Participants were asked the times that they would run three major household appliances (dishwasher, washing machine, and dryer). A Motivation to Change Behaviour score, described further at the beginning of Appendix C, was created that reflected how often a participant selected off-peak period times, i.e. the higher the score, the more likely that times during off-peak period periods were selected

- . In contrast to the findings above, participants were marginally more likely to say they would run their appliances during off-peak periods when information was presented vertically and in kWh (*M* = 0.97) rather than $ (*M* = 0.96). This score was also significantly better than the control condition (*M* =0.96), *p*<0.05.

Implications and Recommendations

Our *Bill Click Tracking Study* showed that people are more likely to look at information when the electricity bill is presented as a graphic (such as the Toronto Hydro Bill) versus the same information presented in tabular form (such as the Hydro One Bill). The goal of this experiment was to enhance the current graphic to improve peoples' comprehension and recall of their longitudinal usage data in order to influence them to reduce or shift their consumption behaviours..

- Present longitudinal information in a vertical bar graph. It improves participants' comprehension of the information, as well as the speed at which they process sit relative to the horizontal format. Because people don't generally spend much time reviewing details on their bill, it is imperative that TOU-relevant information be presented in a quickly and easily digestible manner. Our findings suggest that processing fluency is improved when information is displayed in a way that is consistent with peoples' mental representation of time.

Top 2 BE Conditions

Figure 24. Top BE Condition – YoY comparison, small difference across compared months, units in $Cost

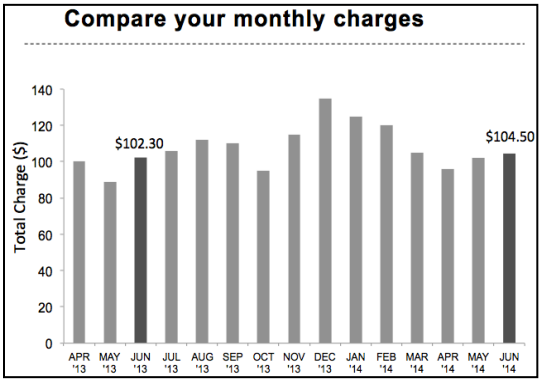
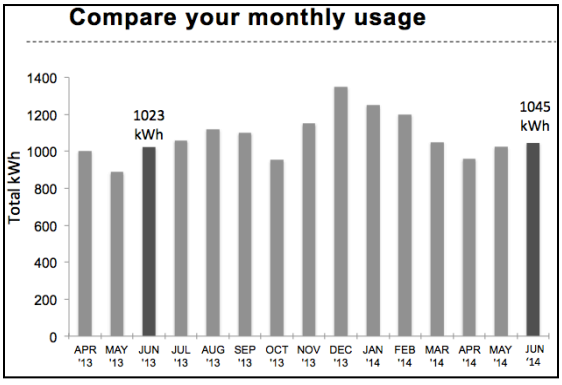


Figure 25. Top BE Condition – YoY comparison, small difference across compared months, units in kWh



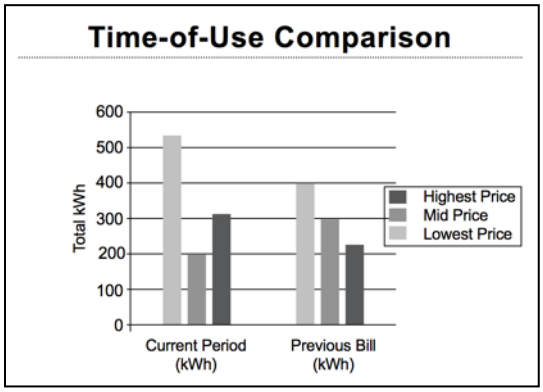
- It is important to deliberately direct peoples' attention to the most important information, in this case YoY usage comparisons. Removing all other values reduces search time costs and increases the likelihood the information will be paid attention to. Presenting too much information can lead to information overload or distract users from the comparisons that are most important. It takes people over a minute to compare the appropriate data points on the graphs currently presented in Toronto Hydro's bill. This is time that most people likely aren't willing to spend on their bill. Shortening the time it takes to make such comparisons will help people better track and understand their usage over time. Simplifying this information is also important because it improves peoples' recall of their usage information, even if it is simply directional in nature (greater than or less than last year). We hypothesize that improvements to recall will increase consumers' likelihood of shifting their electricity usage.

- **It is unclear whether information is better displayed in dollar amounts or kWh.** Generally, we found few significant differences across the unit presentation manipulation, with the exception of a marginally directional difference in people saying they would run their appliances during off-peak hours after having seen information in kWh. On the other hand, people believed that others were more likely to reduce energy usage when it was presented in $ versus kWh. This may stem from the ability to make a direct link between energy utilization and monetary repercussions when consumption information is presented in terms of cost. Data from the *Electricity Consumer Survey* also found that consumers have great difficulty defining a kWh. However, this difficulty defining kWh may have a positive impact on intentions to reduce usage. Because the nominal difference between consumption in kWh is generally greater than the difference in savings in dollar amounts, a kWh visual may seem larger in magnitude and thus lead to ultimate reductions in electricity consumption. This hypothesis is further tested in the *Bill Statement Experiment* and should be explored in a real-world experiment.

2.6 TOU Period Consumption Visual

Along with longitudinal electricity consumption, another important piece of information contained on an electricity bill is a breakdown of how much electricity is consumed during each of the three peak periods in the last billed month. Previous research has indicated that visual representation of data outperforms semantic ones (as is the case with Hydro One's current bill)[75]. Additionally our *Bill Click Tracking Study* found that consumers were more likely to click on the visual TOU comparison in the Toronto Hydro bill, as opposed to the Hydro One chart depicting the same information. Nonetheless, the *BE Bill Audit* of Toronto Hydro's bills revealed potential areas of confusion for consumers, such as difficulty in making the connection between the labels used in the visual with on-peak, mid-peak, and off-peak consumption.

Figure 26. Toronto Hydro Time-of-Use Comparison



The purpose of the TOU Period Consumption Visual study was to test alternate ways of displaying consumption information across peak periods. The aim was to make it easier for people to compare their usage across peak periods, as well as improve their recall of this information using more salient visuals. In order to change consumption behaviours, communications must first capture the audiences' attention and then facilitate the quick and accurate interpretation of the information. It has been documented that the more tailored the feedback communications are, the greater the impact on conservation.[76] Optimizing the TOU Period Consumption Visual using BE becomes another way to nudge conservation and demand management goals. This experiment sets out to determine which visual would best achieve this aim.

The rationale and hypotheses for the manipulations that were tested in the TOU Period consumption visuals Nudge Panel Experiment were:

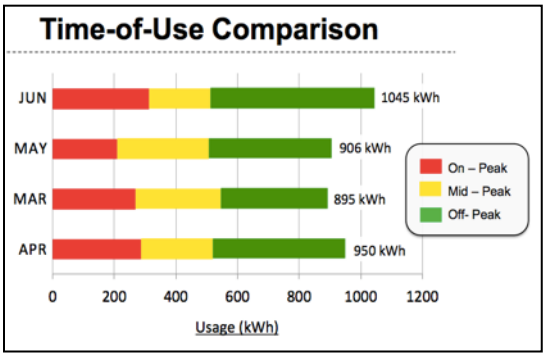
Salience Manipulation: Making each of the TOU periods easier to discern

In order to increase the persuasiveness of the presented information, the TOU Period graphs were modified to increase their chances of capturing consumer attention. Some of the most effective ways to do this is to present information that is vivid, concrete and personalized.[77] This is important because salient information stands out, and is therefore more likely to be encoded in memory and lead to changes in behaviour.[78] Failing to address the role that memory plays in

[75] Wise, J. A., Thomas, J. J., Pennock, K., Lantrip, D., Pottier, M., Schur, A., & Crow, V. (1995, October). Visualizing the non-visual: spatial analysis and interaction with information from text documents. In *Information Visualization, 1995. Proceedings.* (pp. 51-58). IEEE.
[76] Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of environmental psychology*, *25*(3), 273-291.
[77] Borgida, E., & Nisbett, R. E. (1977). The Differential Impact of Abstract vs. Concrete Information on Decisions1. *Journal of Applied Social Psychology*,*7*(3), 258-271.
[78] Costanzo, M., Archer, D., Aronson, E., & Pettigrew, T. (1986). Energy conservation behaviour: The difficult path from information to action. *American psychologist*, *41*(5), 521.

dynamic pricing schemes can harm the success of the initiative. The vividness of the visuals was enhanced using colours that aligned to each of the three TOU periods. Like the traffic light colours used throughout all our manipulations, on-peak was coloured red, mid-peak was yellow, and off-peak was green. As discussed in section 2.5 above, fluency manipulations such as increasing contrast, colour coding, and consistency all aid consumers by making the information easier to understand and therefore remember.

Figure 27. All-peak Visual in kWh units



Additionally, in order to make the information more concrete and easier to interpret, all BE manipulated graphs made it easier for consumers to compare their peak usage from the current billing period to the last billing period. This was achieved either by using stacked bar graphs representing a consumer's consumption across the three periods, or by creating visuals that were focused on one particular period only, such as on-peak or off-peak.

In the stacked bar graph conditions, people saw their total monthly consumption for the past 4 months broken down by period. In particular, since the aim is to shift usage away from on-peak TOU periods, on-peak usage was always displayed on the left of the graph to make it easier for people to compare their on-peak consumption across the displayed months of usage.

In the on-peak-only condition, people were shown a TOU visual that displayed only their on-peak usage this month versus the last. As was noted in the *BE Bill Audit*, a potential for misinterpretation of specific TOU period consumption exists because on average, peoples' off-peak consumption is greater than their on-peak consumption. Within the context of strained information processing given limited resources of time and attention, visualizing this information with the bars stacked next to each other could create the impression that a consumer is already a "green" and doing everything he/she can to conserve energy. In order to correct for this, we focused on specific comparisons between on-peak consumption, removing mid-peak and off-peak visualizations altogether. This approach underscored on-peak consumption, with a specific focus on shifting consumption away from that period through highlighting month over month consumption and associated costs. Finally, in order to control for the fact that people in the on-peak only conditions were viewing a far more simplified visual than the controls, an off-peak only condition was also created.

Unit of Measure: Graph units in kWh or dollars

Consistent with the longitudinal Consumption Visual Study, the TOU Period Consumption Visual Study also tested the graphs in both kWh and Dollars. Research indicates that consumers are price sensitive and dollar amounts gather attention.[79] However, because evaluations of Ontario's TOU model have shown that the current consumer savings are fairly modest, it is possible that the financial impact of adhering to TOU schedules may not be a sufficient

[79] Shen, L., & Urminsky, O. (2013). Making Sense of Nonsense The Visual Salience of Units Determines Sensitivity to Magnitude. *Psychological science*,*24*(3), 297-304.

motivator. According to Navigant's (2013)[80] impact analysis, Ontarians save an average of $7 during on-peak times, and $12 per year overall by shifting their electricity consumption to less expensive times of the day. Another evaluation concluded that 98.2% of customers see a total cost difference of 5% relative to a traditional flat rate model.[81] However, even with these small potential savings, peoples' familiarity with dollar amounts may still result in greater comprehension and recall of the provided information.

Figure 28. on-peak Only Visual in kWh units and $ on y-axis

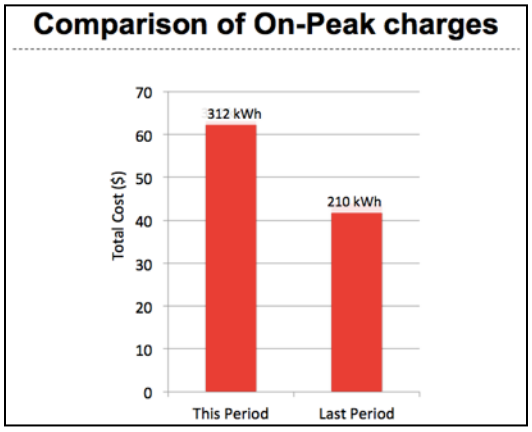
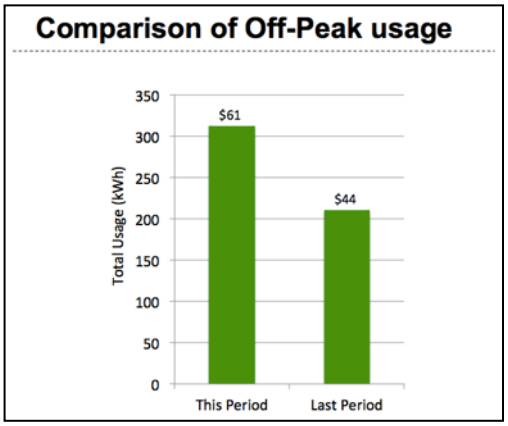


Figure 29. off-peak Only Visual in $ units and kWh on y-axis



Kilowatt hours, while less understood by the general population, may still be a worthy point of comparison. This misunderstanding of kWh could be beneficial if an increase in energy consumption is perceived as being greater in magnitude when shown in this unit. For example, do consumers feel like they've consumed too much on-peak electricity when they see a visual comparing 312 kWh to 210 kWh as opposed to the equivalent comparison in dollars? Findings from other studies suggest that decisions involving unfamiliar units, such as kWh, horsepower, or foreign currencies, are highly prone to deliberational blindness.[5] That is, people have a tendency to ignore the unit and make magnitude judgments based on the numerical amounts shown. In this case, people's unfamiliarity with kWh may be ironically beneficial.

Experiment Design

A total of 15 conditions were tested in this experiment. The experiment employed a 3 (TOU Periods: All-Peaks vs. on-peak Only vs. off-peak Only) X 2 (Axis: kWh vs. Dollars) X 2 (Data Units: kWh vs. Dollars) between-subjects factorial design, composed of 12 treatment conditions and 3 control conditions. Participants were asked to imagine receiving an electricity bill that included one of the graphs in the experiment.

The first factor in the treatment conditions varied the presentation of the TOU periods, where participants either: 1) saw an energy consumption bar graph representing their consumption

[80] Navigant (2013). Time of Use Rates in Ontario. Part 1: Impact Analysis. Seasonal Conservation Estimates, Residential Conventional Impact.
[81] Rowlands, I. H., & Furst, I. M. (2011). The cost impacts of a mandatory move to time-of-use pricing on residential customers: an Ontario (Canada) case-study. *Energy Efficiency*, *4*(4), 571-585.

across the three TOU periods, 2) saw an energy consumption bar graph representing their consumption for only the on-peak period, or 3) saw an energy consumption bar graph representing their consumption for only the off-peak period. The second factor varied the unit of one of the axes; participants saw graphs with an axis in kWh or in Dollars. In the On & off-peak only conditions, the y-axis was manipulated, whereas in the All-Peaks conditions, the x-axis was manipulated. The third factor varied the unit in which the information was displayed atop the consumption bar, which was in either kWh or in Dollars. The 3 controls were 1) the energy consumption bar graph that currently exists on the Toronto Hydro bill, 2) the Toronto Hydro graph with a colour scheme matching our conditions (i.e. further differentiating the three TOU periods), and 3) a consumption table such as the one that is currently used in the Hydro One bill. Across all the conditions, participants would see that they consumed more energy for a recent period relative to a previous one (e.g. comparing June vs. May).

Participants were evaluated on several questions testing whether they understood and were able to comprehend specific details of the bar graph, whether they would be willing to reduce their energy consumption as well as whether they would be motivated to conserve more energy after viewing the graph, and recall - please refer to Table 33 in Appendix C for question details. 866 participants completed the online survey, with approximately 60 participants per group. Summary demographics can be found in Table 32 of Appendix C.

Main Findings

Understanding

- Overall, participants found conditions where the consumption bar graphs displayed only 1 TOU period (i.e. on-peak only or off-peak) to be easier to understand. Generally, participants in the on-peak only conditions found the consumption bar graphs easier to understand and believed that others would also find it easier to understand. Specifically, participants favoured the on-peak only consumption bar graph when the y-axis was represented in kWh and the data units were also represented in kWh (M = 6.17). They found the visual significantly easier to understand relative to the visual from the Hydro One control (M = 5.45; p < 0.01) and moderately easier than the Toronto Hydro control (M = 5.66; p = *0.79)*. The means are an average of the participants' scores on a 7-point likert scale, with 1 being "Strongly Disagree" and 7 being "Strongly Agree".

Reducing Consumption

- Consumers indicated that they would be willing to reduce their consumption after viewing the on-peak only conditions and believed that others would do the same. Across the four on-peak only visual conditions that were tested ($M_{\text{On-Peak average}}$ = ~ 5.23), participants indicated that they would be more likely to reduce their consumption in the future relative to participants exposed to the Toronto Hydro control (M = 4.67); p < .05. There was no significant difference compared to HydroOne. When asked how others would react to the visuals, participants exposed to the on-peak only conditions ($M_{\text{On-Peak average}}$ = ~ 4.91) indicated that others would also be likely to reduce their consumption. This was significantly higher than participants who viewed the either of the controls – i.e. Toronto Hydro (M = 4.24) and Hydro One (M = 4.30) visuals; p < .05.

Comprehension

- Participants' comprehension of how much their 1) on-peak and 2) off-peak energy consumption changed between two periods increased when they were provided with consumption visuals that represented all three TOU periods. Overall, participants were better able to recognize that both their on-peak as well as off-peak energy consumption had increased relative to the prior month when they were provided with the BE All-peak visual. Subjects answered two questions, one about whether or not their on-peak consumption changed relative to the prior period, and another identical question about changes to their off-peak consumption. Their responses were measured on an 8-point likert scale, where 1 was "Much Less", 7 was "Much More", and 8 was "Information not provided". Anyone selecting either "somewhat more", "More", or "Much more" for each question was given a score of 1, with the opportunity to earn a perfect score of 2 across both questions. Specifically, we found that those participants who saw the All-peak consumption visual with the x-axis and monthly consumption labels both in kWh, had a near perfect score of 1.91 (Figure 31). This score was similar to those who saw the same graph but with the x-axis in kWh and the monthly consumption labels in dollar amounts (M = 1.89). Both of these conditions performed significantly better than the Toronto Hydro consumption visual (M = 1.53); $p < 0.01$. While it's difficult to determine whether it's the vertical presentation of the information, or the colour coded bars that led to this enhancement, it is apparent that this graphical display makes it easier for people to interpret their consumption accurately

Top 2 BE Conditions

Figure 30. on-peak Visual in $ units and $ on y-axis

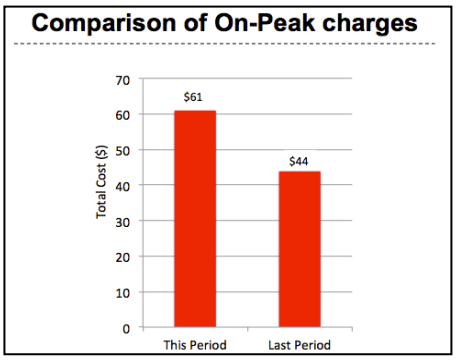
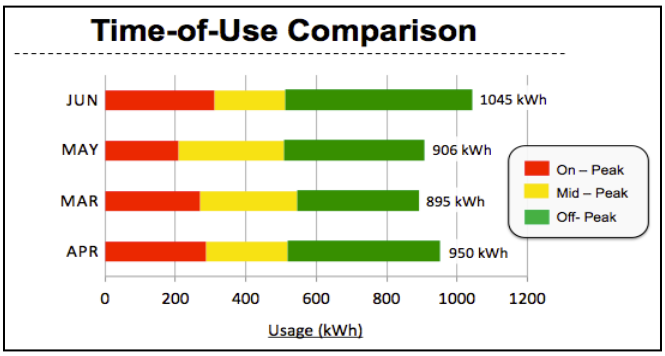


Figure 31. All-peak Visual in kWh units and kWh on y-axis

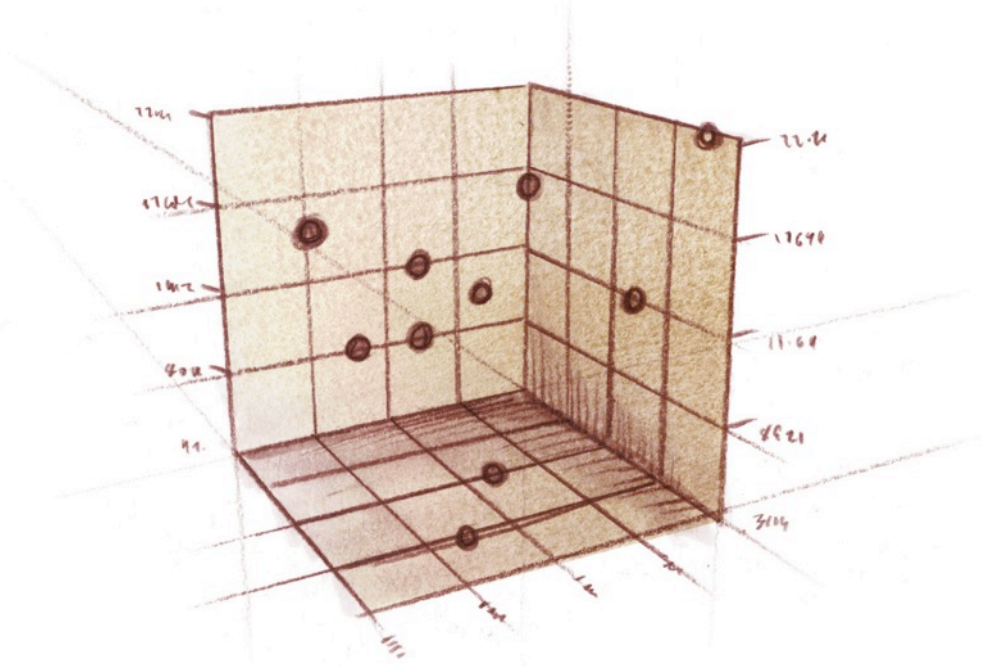


Implications and Recommendations

Overall, when people were provided with a simplified electricity consumption visual, such as displaying one's on-peak energy consumption only, they found the visual easy to understand, and were more likely to say they would reduce their electricity consumption. Furthermore, consumers appeared to find visuals that had congruent axis and data units (e.g. kWh with kWh) easier to process than when the axis and data units were incongruent (e.g. Dollars with kWh)..

- Focus consumption visuals on a single period, such as on-peak consumption. Doing so appears to increase peoples' understanding of their consumption and leads to a greater willingness to reduce consumption in the future. As the findings illustrate, providing consumers with on-peak only consumption visuals will help 1) focus their attention of their on-peak consumption, and 2) increase their willingness to use less on-peak electricity in the future.

- **Ensure that the unit of the axis and the consumption data are congruent (e.g. kWh with kWh or Dollars with Dollars).** A consistent finding across the reported measures is that people preferred consumption visuals that used matching axis and consumption units. While displaying incongruent information provides more information, it may require more time and mental energy to interpret. Congruent measures are likely to make the information easier to process.



2.7 Consumption Benchmarks

Results from the *Electricity Consumer Survey* showed that Ontarians have trouble understanding how electricity is priced. With over 700 people surveyed, less than half (48%) were able to correctly define a kilowatt-hour and of those who could, a sizable portion (45%) was not confident with their response. We also found that people were significantly more accurate at estimating their total monthly usage when they had their bill at hand, but that this did not hold for the totally monthly charges i.e. recall of total monthly charges was more accurate than recall of total monthly consumption in kWh. When asked about their monthly consumption, those who lived in detached homes and received monthly bills revealed their consumption was 1244 kWh when they reported having their bills on hand to answer the question. Conversely, those who said they did not have their bills on hand, and had to guess their consumption, reported it to be 508 kWh. These findings represent significantly large differences across the same demographic group ($p<0.01$). However, these differences disappeared when they were subsequently asked to provide the total billed amount for the same period. Those who had their bills said it was an average of $161 and those guessed reported it being around $162. There is other evidence to show that the consumption of energy is unlike most other commonly consumed goods. Electricity as a measurable, consumable good is abstract and intangible. Feedback about electricity consumption is provided in a unit that is difficult for people to understand which is why consumers have a tendency to focus on the most digestible piece of information on the bills today – the total amount due. Given the high degree of miscomprehension about electricity use, there is an opportunity to use consumption feedback through the electricity bill to change future rates of consumption.

One possible explanation for peoples' tendency to overlook their kilowatt-hour consumption is that this metric seems meaningless without appropriate context. We frequently interact with money and consequently have little trouble judging our consumption by this metric. But in our day-to-day lives, kilowatt-hours are seen only on a monthly or bimonthly basis, on our electricity bills. Along with the findings from the *Electricity Consumer Survey*, other researchers have also found that consumers typically perceive home energy consumption in dollars rather than kWh.[82] One method of combating this misalignment is to provide additional context where needed. While it may not be necessary for people to know the exact definition of a kWh, they should be given feedback as to whether or not the amount they have consumed is an excess of a particular benchmark.

The purpose of the benchmark experiment is determine which feedback type is most likely to shift consumer demand for energy from on-peak to off-peak times of day. Feedback regulates behaviour by allowing a person to make comparisons to goals, standards, or norms.[83] Feedback provides a basic mechanism by which to monitor and compare behaviour, and allows an individual to better evaluate their performance. More specifically, it plays an important role in learning - when information is attributable to specific actions; in habit formation – when routine behaviours are reinforced; in the internalization of behaviour – when energy-conscious attitudes are formed; and in motivation – when feedback acts as a reward for the achievement of a

[82] Kempton, W., & Montgomery, L. (1982). Folk quantification of energy. *Energy*,*7*(10), 817-827.
[83] Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological bulletin*, *119*(2), 254.

conservation goal.[84] Studies evaluating various forms of feedback have found an overall reduction in subsequent electricity consumption ranging from a 2%[85] to 15% decline.[86,87] The following Consumption Benchmarks study evaluates the impact of various forms of feedback in the context of Ontario's TOU pricing scheme.

The rationale and hypotheses for the manipulations that were tested in the Benchmarks Nudge Panel Experiment were:

Feedback Type: the point of reference being either one's historical consumption, households "like yours," or a goal set by the province

Historical Feedback
Historical benchmarking, or presenting an individual's consumption relative to prior months, is currently the method of comparison used by many utility companies in Ontario. Residents and small business owners receiving bills from both Toronto Hydro and Hydro One see their historical consumption information. In an era marked by various forms of the "quantified self" consumers are becoming accustomed to tracking their behaviours over time.[88] Given this increasingly growing trend, and other research to support the influence of this tactic[89,90], we tested the impact of historical feedback on conservation. Respondents in this condition were told that they had either consumed 5% more (or less) electricity compared to their seasonal average.

Social Norms Feedback
The previously cited *Electricity Consumer Survey* found that Ontarians were overconfident in their judgment of their electricity consumption relative to similar others. Eighty-three percent of participants believed that they consumed about the same amount, or less, than other households of a comparable size. This is highly implausible. The majority of people cannot conserve less electricity than the majority of other people who are just like them. This finding is not surprising given that many people are overly optimistic and overconfident when it comes to their own behaviours, relative to others.[91]

Another reason for this inflated sense of environmentalism may be due to peoples' beliefs that they're already doing everything they can to reduce their electricity consumption. However, current conservation efforts may not be enough to substantially impact the province's conservation and demand reduction goals. The *Electricity Consumer Survey* corroborated

[84] Van Houwelingen, J. H., & Van Raaij, W. F. (1989). The effect of goal-setting and daily electronic feedback on in-home energy use. *Journal of consumer research*, 98-105.
[85] Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*(9), 1082-1095.
[86] Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of environmental psychology*, *25*(3), 273-291.
[87] Van Houwelingen, J. H., & Van Raaij, W. F. (1989). The effect of goal-setting and daily electronic feedback on in-home energy use. *Journal of consumer research*, 98-105.
[88] Singer, E. (2011). The measured life. *Technology Review*, *114*(4), 38-45.
[89] Midden, C. J., Meter, J. F., Weenig, M. H., & Zieverink, H. J. (1983). Using feedback, reinforcement and information to reduce energy consumption in households: A field-experiment. *Journal of Economic Psychology*, *3*(1), 65-86.
[90] Wilhite, Harold, A. Hoivik, and Johan-Gjemre Olsen. "Advances in the use of consumption feedback information in energy billing: the experiences of a Norwegian energy utility." *Proceedings, European Council for an Energy-Efficient Economy*. 1999.
[91] Hatfield, J., & Soames Job, R. F. (2001). Optimism bias about environmental degradation: The role of the range of impact of precautions. *Journal of environmental Psychology*, *21*(1), 17-30.

findings from other studies[92], which showed that people are more likely to engage in energy curtailment behaviours that result in small savings in energy (such as switching off the lights when leaving the room) rather than efficiency behaviours (installing storm windows) which are more impactful. Furthermore, when asked to select the single most effective thing that people could do to conserve energy in their lives, almost 20% selected "turn off the lights" (the top answer), over "changing thermometer settings" (6.3%), or "use efficient appliances" (3.2%)[93]. People appear to be engaging in conservation behaviours, but they are not always the most efficient ones. This may be leading to the inflated view of oneself as "green" consumer. People seem to be generally well intentioned, but largely misinformed.

The misperception of behaviour can be corrected with various types of feedback, including social norms based feedback. As discussed in section 1.1, Opower has shown repeated success in their efforts to promote conservation by displaying a household's consumption relative to their neighbors. It works by leveraging the human tendency to conform to social norms, a technique that is particularly effective in the area of electricity usage. Where units and concepts are unfamiliar, we are more likely to rely on the opinions and actions of others to guide our decisions.[94] Respondents in this condition were told that they had either consumed 5% more (or less) electricity compared to similar households.

Goal Feedback

Utility companies and policy-makers may also implement goal-setting strategies in an effort to motivate people to reduce their consumption. Research suggests that consumers typically respond well to goal feedback resulting in increased conservation. For example, in a field study of residential energy use, 40 families were asked to set a goal to reduce their electricity consumption by 20% and were provided with feedback three times per week. These households achieved an average of a 13.0-15.1% reduction in consumption. Similarly, consumers who self-set a conservation goal and received feedback reduced their consumption by almost 22% in a simulated washing machine experiment.[95] Respondents in this condition were told that they had either consumed 5% more (or less) electricity compared to a goal set by the state.

Visual: Comparing the effect of different visuals

The results from the *Bill Click Tracking Study* show that people are more likely to pay attention to their usage information when it is displayed graphically, rather than when it is displayed numerically in a table. Research supporting this finding has been discussed in greater detail in section 1.1 and 2.5. Images are not only more attractive to readers, but also have the ability to communicate information faster and in ways that require less mental effort to process, compared to text. For this reason, images were added next to each feedback message that was tested.

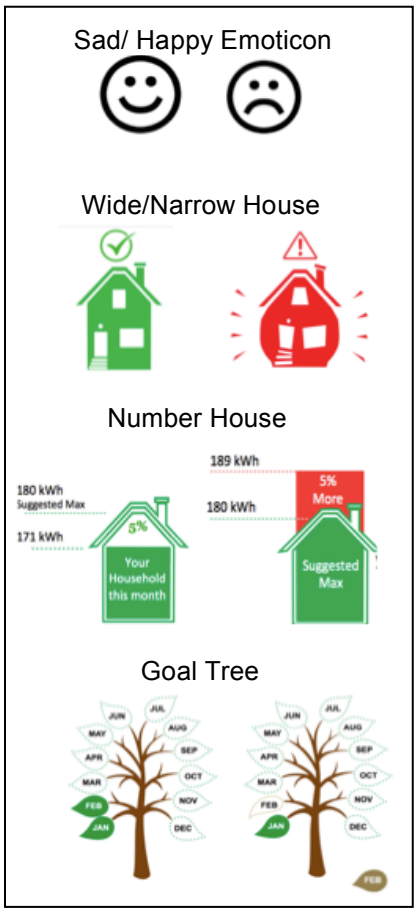
[92] Gardner, G. T., & Stern, P. C. (2008). The short list: The most effective actions US households can take to curb climate change. *Environment: science and policy for sustainable development*, *50*(5), 12-25.
[93] Attari, S. Z., DeKay, M. L., Davidson, C. I., & de Bruin, W. B. (2010). Public perceptions of energy consumption and savings. *Proceedings of the National Academy of Sciences*, *107*(37), 16054-16059.
[94] White, Katherine, and Bonnie Simpson. "When Do (and Don't) Normative Appeals Influence Sustainable Consumer Behaviours?." *Journal of Marketing*77.2 (2013): 78-95.
[95] L.T. McCalley , Cees J.H. Midden. "Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation." *Journal of Economic Psychology* 23 (2002): 589–603

The benchmark visuals were designed using colours that have been shown to attract attention such as red, yellow, and green.[96] Each visual had both a negative and positive variation but the underlying image remained consistent regardless of feedback type. In total, there were four image types used. The rationale for each image type is as follows:

Sad/ Happy Emoticon

Happy faces have been used to communicate positive feedback across a number of domains. Humans have evolved to be particularly sensitive to facial expressions of happiness. Not only is this simple social stimulus easily detected by a perceiver, it is also held in memory longer than other facial expressions.[97] Further research suggests that unlike most visual stimuli, people are able to process a happy face at an automatic level even when attention is compromised.[98] In addition to the psychological affinity people have to such stimuli, happy faces have also been shown to mediate important behaviour in regards to social benchmarking and conservation as discussed in the section above. Although evidence supporting the salience of sad faces is less robust, it was tested against alternatives for the purposes of consistency and because we hypothesized that visuals suggesting strong social cues (either strongly positive or negative) were likely to motivate consumer behaviour. People are motivated to avoid being viewed negatively by their peers, therefore we hypothesized that a sad face would be more motivating than a smiling face.

Figure 32. Benchmark Visuals



Wide/Narrow House

The Wide House was designed to elicit feelings of discomfort in the viewer. By using angular lines rather than straight ones and having elements of the house appear to be cracking under pressure, the image is meant to convey a message of overconsumption and a warning. For reasons explained above, we also intentionally made the house resemble an angry and disapproving face. Just as a balloon about to pop stimulates feelings of urgency and unease, this house was designed to make the viewer feel like immediate action is required in order to return a state of normalcy. In contrast, the house visual accompanying positive feedback appears stable, happy, and comfortable.

Number House

In the Number House visual we presented consumers with an image that depicts a benchmark as an actual threshold that a consumer has either surpassed or remained below.

[96] Gelasca, Elisa Drelie, Danko Tomasic, and Touradj Ebrahimi. "Which colors best catch your eyes: a subjective study of color saliency?" *First International Workshop on Video Processing and Quality Metrics for Consumer Electronics*. 2005.
[97] Becker, D. Vaughn, and Narayanan Srinivasan. "The Vividness of the Happy Face." *Current Directions in Psychological Science* 23.3 (2014): 189-194.
[98] Srivastava, Priyanka, and Narayanan Srinivasan. "Time course of visual attention with emotional faces." *Attention, Perception, & Psychophysics* 72.2 (2010): 369-377.

Unlike the other images, the Number House visual contains numerical data embedded within the image, making the kWh consumption more salient in this condition compared to the others.

Goal Tree

The final image type that was used in the experiment was an image of a tree whose leaves were either filled in green when feedback was positive or fell to the ground when feedback was negative. There are several reasons for why this image was chosen to provide feedback. For one, it is fairly commonplace for consumers to associate "green" behaviours with images of nature. Marketing messages are often paired with visuals of leaves. The variation that was tested however was intended to motivate goal-directed behaviour. People are motivated to complete something that has already been started but feels incomplete. For instance, a study on goal frames showed that people were more likely to complete a task when their progress was displayed in a pie chart (which filled in one of five wedges as they progressed in the task), than when progress was displayed as five individual balls (which filled in one at a time as they progressed in the task). Making one's progress feel like a part of a greater whole, motivated 71% of respondents to complete the task compared to the 57% of those who saw the individual units of progress.[99] We applied these insights to the design of our tree visual, which fills in a green leaf for each positively performing month.

Valence: Whether feedback was positive or negative relative to the benchmark

The Benchmark Nudge Panel Experiment also looked at the impact of positive or negative feedback on people's motivation to conserve electricity. Research in the area of benchmarking has pointed to a possible "boomerang effect" when people are told they are doing better than their neighbors or another point of reference (for more information on this, please refer to section 1.1). It has been suggested that the beneficial effects of providing negative feedback to over-consumption may be overshadowed by an increase in consumption among under-average consumption consumers. Previous research has found that by adding a smiling face next to the benchmark message of those who consumed under the reference point, the boomerang effect could be mitigated.[100] There is also ample evidence to show that people are more sensitive to losses than to equivalent gains. Based on this research, we hypothesize that subjects will be more sensitive to the benchmarks when they are providing negative feedback than when it is displaying positive feedback (even though the magnitude of the feedback is always 5%). In this study we aimed to examine this response by testing both positive and negative feedback for each of the messages and visuals.

Experiment Design

A 2 (Frame: Positive vs. Negative) X 3 (Benchmark Feedback: Historical vs. Social vs. Goal) X 4 (Visual Stimuli: House vs. Social smiley vs. Number House vs. Goal Tree) between-subject factorial design was employed, entailing 24 different combinations of feedback on their

[99] Barasz, K.N.; John, L.K.; and Norton, M.I. (2013, November). Greater than the Sum of Its Parts: How Whole Unit Framing Increases Effort. Paper presented at the Society for Judgment and Decision Making Annual Conference, Toronto, Canada. Abstract retrieved from http://www.sjdm.org/programs/2013-program.pdf

[100] Schultz, P. Wesley, et al. "The constructive, destructive, and reconstructive power of social norms." *Psychological science* 18.5 (2007): 429-434.

consumption. In addition, there were also 2 control conditions (i.e. a positive frame and a negative frame), creating a total of 26 conditions. Accordingly, the first factor was *feedback type* which was either historical, social norms, or goal oriented feedback. The second factor was *visual stimuli*, which manipulated the image that was paired with the feedback. Participants would either see a visual image of a house, a face, a variation of the house visual, or a tree. The final factor was *valence,* which was either positive or negative. In all conditions, participants were told that they had either consumed 5% more or 5% less than the benchmark.

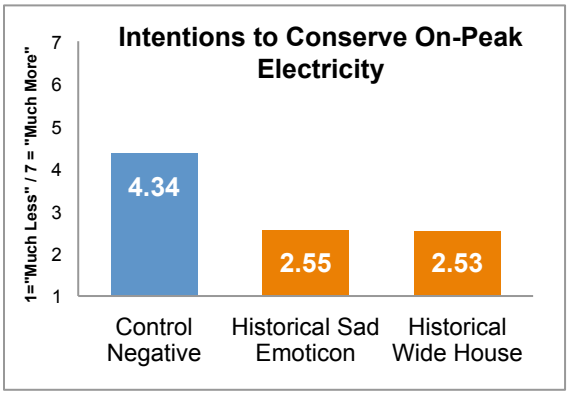
Like many of the other nudge panel experiments, participants were told to imagine having received the electricity bill displayed on the screen. They were then asked several questions to evaluate how easy the visual was to understand, whether they would change their consumption behaviours after seeing the visual, how offensive the visual was or how guilty it made them feel, how useful the visuals were in helping them understand their consumption, and finally, whether or not the visual should be included on future electricity bills. After answering a number of demographic questions, participants were then asked to recall the exact percentage of over/ under consumption stated in the benchmark they saw (always 5%). A total of 1,423 participants completed the online survey, with approximately 60 participants per condition. Summary of demographics can be found in Table 35 of Appendix C.

Main Findings

Reduction of on-peak Energy Consumption

- Participants were more likely to indicate that they would conserve on-peak electricity when they were told that they had consumed more than in the previous year. Using a 7-point likert scale, participants were asked to indicate their likelihood of consuming "Much less" (1) or "Much more" (7) on-peak electricity. On this scale, lower means are more favorable as they indicate a motivation to conserve on-peak electricity. We found that the historical comparison was strongest when paired with the wide house (*M* = 2.53) and sad emoticon visual (*M* = 2.55). Participants in these conditions differed significantly from the control (*M* = 4.34); $p < 0.05$. These particular historical benchmarks were also most favourable when it came to reporting how effective they would be at motivating others to conserve. Specifically, participants who saw the Historical benchmark with the wide house visual (*M* = 2.82) and sad emoticon visual (*M* = 2.67) indicated that they believed others would consume less energy. This was a significantly different response relative to the participants in the control condition who viewed a similarly negative consumption graph without a visual benchmark (*M* = 4.43); $p > 0.05$.

Figure 33. People are much less likely to use on-peak electricity following historical feedback paired with either a sad emoticon or wide house visual



Question: After seeing this visual on my electricity bill, I am likely to consume _____ on-peak electricity
Graph plots mean scores on a 7pt-scale, where 1 is *Much Less and 7 is Much More. (Smaller means are more favorable)*
Significant differences at $p < .05$

Guilt & "Offensiveness"

- As predicted, the negatively valenced benchmarks were more likely to induce feeling of guilt and offensiveness compared to their more positive counterparts. This was especially the case for the two historical conditions mentioned above. Participants in the study were asked to evaluate their benchmark visual on a number of different measures. Using a 7-point likert scale, with 1 being "Strongly Disagree" and 7 being "Strongly Agree", participants were asked to evaluate their agreement (or disagreement) on the following guilt and offensiveness measures – *"If I were to see this visual on my electricity bill, I would it offensive",* and *"If I were to see this visual on my electricity bill it would make me feel guilty".* Interestingly, we found that the two historical benchmark conditions that were most likely to motivate people to conserve on-peak electricity were also rated as significantly more guilt inducing than the control ($M_{SadEmoticon}$ = 4.50; $M_{WideHouse}$ = 4.22; $M_{NegativeControl}$ = 3.30; $p < 0.05$). These two conditions were also rated as being significantly more offensive than the control condition ($M_{SadEmoticon}$ = 2.95; $M_{WideHouse}$ = 3.29; $M_{NegativeControl}$ = 2.15; $p < 0.01$). The results show that visuals that are slightly offensive or that induce feelings of guilt are also more effective and more likely to drive conservation behaviours, even if they're disliked.

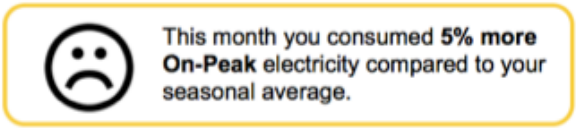
Ease of Understanding

- **The same two conditions described above were also rated as being easier to understand relative to the control.** Participants exposed to the Historical feedback, paired with either the Sad Emoticon (M = 5.86) or Wide House visual (M = 6.01), found the consumption bar graph to be significantly easier to understand than those exposed to the negatively framed control condition (M = 5.40); ps < 0.05. The means are an average of the participants' scores on a 7-point likert scale, with 1 being "Strongly Disagree" and 7 being "Strongly Agree".

Top 2 BE Conditions

Figure 34. Negative Historical Feedback with Wide House visual

Figure 35. Negative Historical Feedback with Sad Emoticon visual



Implications and Recommendations

Overall, these findings suggest that providing feedback to participants (e.g. comparing their consumption to another benchmark) helps to increase their understanding of their consumption behaviour, which will ultimately help foster a change (i.e. reducing on-peak consumption). In particular, our study found that historical feedback, or comparisons to one's own past behaviour, resulted in greater motivation to conserve and better understanding. These historical frames were widely effective when they provided negative feedback, telling people that they had used more electricity than their performance in the prior year. Finally, while these negative images were rated as being more offensive and guilt inducing, they also resulted in greater likelihood to reduce on-peak consumption.

- **Consumers should be provided with some form of benchmarking information.** This type of visual feedback is largely missing on bills today. This nudge panel experiment, as well as numerous others mentioned above, has proved the ability of benchmarks to make electricity consumption more salient.

- Historical comparisons were found to be more motivating that other types of feedback. These should be tested in a field experiment with real consumers and against social consumption feedback in particular.

- While certain visuals are considered more offensive than others, they work particularly well at increasing consumers' intention to conserve.

2.8 Pledges

This experiment tested the hypothesis that commitment devices, along with specific calls-to-actions, will lead to shifts in electricity consumption. As discussed in section 1.1 of the report, commitment devices have shown promising results in the area of electricity conservation.[101] It has been theorized that when people perceive that they have freely chosen to engage in a behaviour, their self-concept changes as well as their subsequent actions. In other words, when someone signs a commitment to conserve energy on their own free will, they reason that they must care about the cause and will continue to follow through with behaviours that are consistent with that initial trivial action.[102]

Drawing from research in this area, we tested the impact of what might happen if the OEB or a utility company were to distribute a pledge to electricity consumers asking them to commit to shifting their consumption to off-peak hours of the day. In this study, we explore consumers' perceptions of these pledges and the potential of such commitment devices to drive conservation behaviours.

Two overarching questions were investigated in the Pledges study:

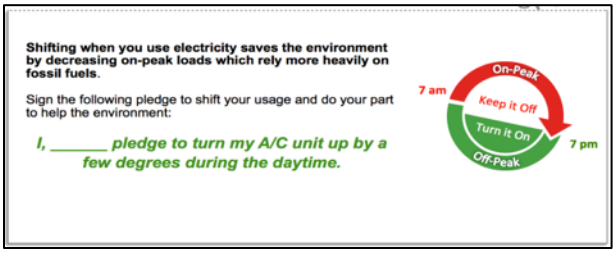
1) What is the best message to display on a pledge in order to encourage people to commit to shifting their electricity consumption to off-peak times of day?
2) Does offering people a specific call-to-action or list of actions on a pledge make it more likely that people will agree to commit, and how does this commitment subsequently affect their self-predicted behaviour?

The rationale and hypotheses for the manipulations that were tested in the Pledge Nudge Panel Experiment were:

Message: Environmental plea, social norms, financial incentives, or informational

Simply providing consumers with messages outlining the financial benefits of conserving electricity in their home is a financial plea to conservation. It assumes that people are motivated to conserve if the financial benefits to do so are large enough. Support for the effectiveness of this type of plea is limited.[103] Similarly, simply providing consumers with information about energy conservation is

Figure 36. BE Pledge with Environmental Plea messaging Reason Only



[101] Burn, S. M., & Oskamp, S. (1986). Increasing community recycling with persuasive communication and public commitment. Journal of Applied Social Psychology, 16(1), 29-41.
[102] Katzev, Richard D., and Theodore R. Johnson. "A social-psychological analysis of residential electricity consumption: The impact of minimal justification techniques." *Journal of Economic Psychology* 3.3 (1983): 267-284.
[103] Pitts, Robert E., and James L. Wittenbach. "Tax credits as a means of influencing consumer behaviour." *Journal of Consumer Research* (1981): 335-338.

typically not an effective method for driving behaviour change.[104] However, it has been found that by combining information or financial incentives with other interventions, such as a commitment strategy, it is possible to enhance conservation behaviour.[105] For example, in a field study homeowners were asked to either sign a commitment to recycle newspapers or were given tokens for recycling which could be redeemed for goods or services. A third group was given a combined approach where they were asked to commit to recycling and offered tokens in exchange for their compliance. At the end of the trial, those homeowners who were in the combined condition, meaning they received both the financial incentive in the form of tokens and were asked to sign a commitment, performed significantly better than those in the token-only condition.[106]

In order to strengthen the effectiveness of this approach, it is important to identify which messages resonate best with consumers and which are the most likely to motivate commitment. In a large field study, researchers tested a variety of conservation messages amongst a sample of Californian residents. Door hangers that included an information-only message, an environmental message, or a message communicating social responsibility, were placed on the door handles of participants. It was found that participants who received hangers displaying a descriptive social norm were more likely to reduce their consumption relative to those who received environmental, social responsibility, or financial messages. Similar results were found when the content of a message displayed to hotel guests was changed from an environmental protection one to one that included a descriptive social norm (e.g., "the majority of guests reuse their towels").[107]

Appeals for conservation and general behaviour change can take many forms. The current experiment looked at four message types: Environmental Pleas, Informational Pleas, Social Norming, and Financial Incentives. It was hypothesized that variance in the number of signed commitments would be explained by presented message type.

Figure 37. BE Pledge with Social Norms messaging and Reason Only

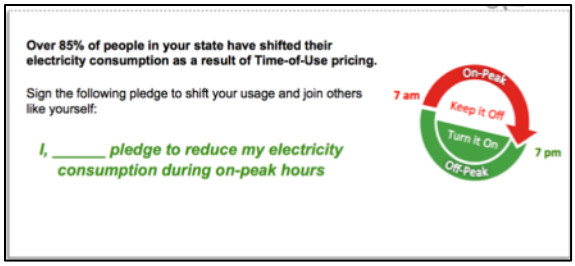


Figure 38. BE Condition with Financial Incentive messages and Multiple Call-to-Action items

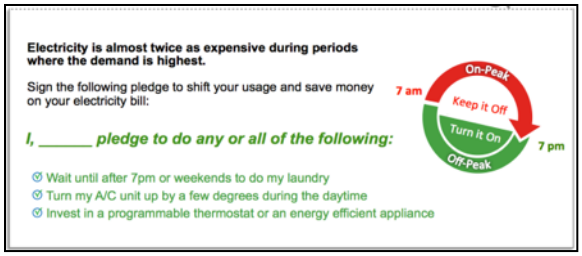
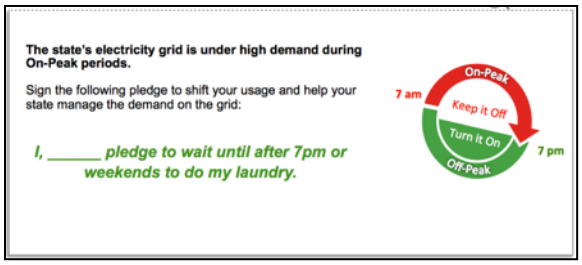


Figure 39. BE Condition with Informational Plea and one Call-to-Action Item.



[104] Geller, E. Scott. "Evaluating energy conservation programs: Is verbal report enough?." *Journal of Consumer research* (1981): 331-335.
[105] Lokhorst, A.M. (2009) Using commitment to improve environmental quality, Leiden: Kurt Lewin Instituut.
[106] Katzev, Richard D., and Anton U. Pardini. "The comparative effectiveness of reward and commitment approaches in motivating community recycling."*Journal of Environmental Systems* 17.2 (1987): 93-113.
[107] Goldstein, Noah J., Robert B. Cialdini, and Vladas Griskevicius. "A room with a viewpoint: Using social norms to motivate environmental conservation in hotels." *Journal of consumer Research* 35.3 (2008): 472-482.

Call-to-Action: providing one action item or multiple items

In addition to the effects of message type, this study also aimed to address the importance of providing consumers with details on how to comply with TOU scheduling (e.g. "Wait until after 7pm or weekends to do my laundry"). It has been found that when people have a detailed plan for how they intend to reach a goal, they are more likely to attain it.[108] Psychologists have dubbed these action plans "implementation intentions". Theories supporting the use of implementation intentions postulate that when anticipated situations are linked with a goal-directed response, people are less likely to be deterred by obstacles impeding the completion of a task. [109] For a real world example of how implementation intentions can be used, consider research conducted during the 2008 United States presidential elections. It was found that potential voters from single-eligible voter households who had developed a voting plan over a telephone call with a "Get Out The Vote" representative were significantly more likely to vote on election day than they had been in the past. These participants increased their turnout by 9.1%, which was greater than the increase in turnout for other participants who were either given the standard "Get Out The Vote" script or asked to predict whether or not they would go to the polls.[110] By providing respondents in the present study with specific load-shifting actions and the option to commit to doing them, we hope to leverage implementation intentions and nudge consumer behaviour.

Lastly, we were interested in whether there would be a difference in participants' intentions to commit to demand shifting as a result of the number of call-to-action items presented on the pledge. Two competing hypotheses address this question. Presumably, by offering consumers multiple examples of behaviours that align with TOU, we broaden the applicability of the approach. Alternatively, when only one action is suggested, the instructions become easier to remember and visualize resulting in less cognitive effort and greater compliance.

Experiment Design

The content presented on the pledge was manipulated across two factors; message type and call-to-action. For message type, participants were shown a pledge that included one of four "reasons" for why they should shift their consumption to off-peak hours of the day. These messages conveyed a social norm, a financial incentive, or an informational or environmental plea. The second factor we varied across conditions was the inclusion and presentation of a "call-to-action". In this second manipulation across conditions, we tested whether presenting a participant with a call-to-action item on the pledge, and the number of presented actions changed their likelihood to sign the pledge and/or shift behaviour. In total, we tested 20 different pledge conditions.

[108] Gollwitzer, Peter M., and Veronika Brandstätter. "Implementation intentions and effective goal pursuit." *Journal of Personality and social Psychology* 73.1 (1997): 186.
[109] Gollwitzer, Peter M. "Implementation intentions: strong effects of simple plans."*American Psychologist* 54.7 (1999): 493.
[110] Nickerson, David W., and Todd Rogers. "Do you have a voting plan? Implementation intentions, voter turnout, and organic plan making."*Psychological Science* 21.2 (2010): 194-199.

We analyzed participant's interaction with the pledge (i.e. agreeing to sign the pledge by entering the word "yes" in the text field below the pledge) and intentions to shift electricity usage to off peak periods as a proxy for its potential effectiveness in the real world. 1445 participants completed the study – summary of demographics can be found in Table 38 of Appendix C.

Main Findings

Signing the pledge

- **People were more motivated to sign when there were multiple calls-to-action presented.** Irrespective of the message type, participants were more likely to sign the pledge when they could choose among a list of potential call-to-action items.

- **When participants were presented with 3 call-to-action items on a pledge, they selected an average 1.7 of them.** The most selected item overall was to do the laundry during off-peak periods (67%). Fifty-nine percent of participants committed to turning up the temperature on their AC a few degrees during summer days, and 48% chose to commit to investing in a programmable thermostat or energy efficient appliance.

Recall

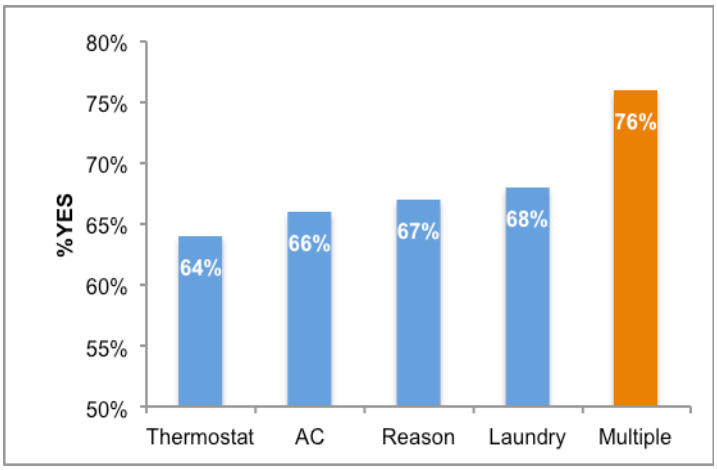
- Irrespective of the message type, participants were more likely to remember what they pledged to do when they were given the option to choose among a list of potential calls-to-action. Participants who were shown multiple load-shifting behaviours on a pledge, and committed to doing at least one of them, had better recall of the chosen behaviour than those who were just shown one behaviour.

Motivation to Change Behaviour

- Overall, participants who signed a pledge were significantly more likely to state that they would use their appliances during off peak periods than those who did not sign the pledge. The largest difference between these two groups was amongst the participants who had seen a Social Norms message. In other words, participants who signed a pledge in response to a Social Norms message were most likely to state that they would use their appliances during off-peak periods.

- Participants who signed the pledge were far more likely to be interested in signing up for the PeaksaverPLUS program.

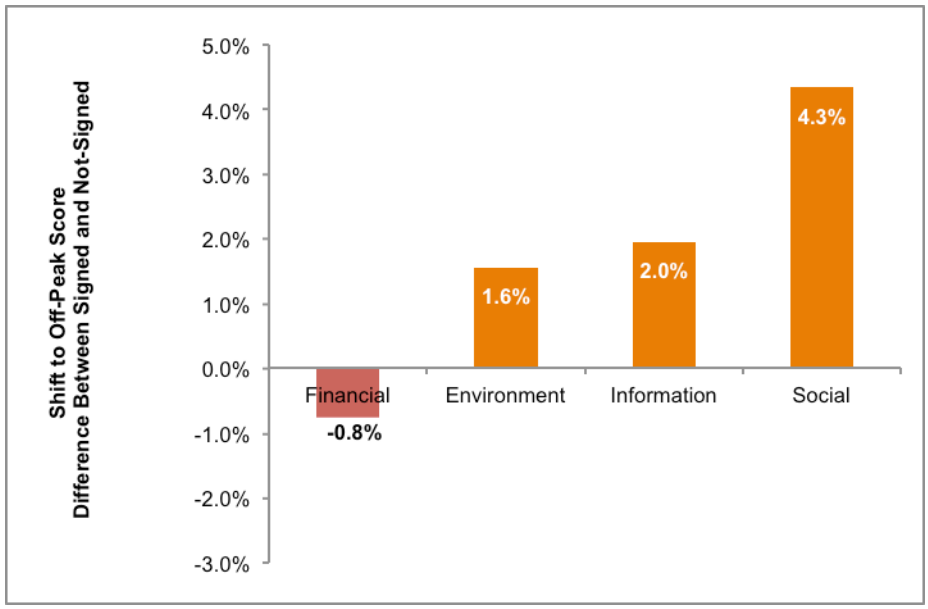
Figure 40. Multiple Call-to-Action Increases Pledge Signing



Call-to-action: To sign the pledge enter the word "Yes" in the box provided and then click "Next"
If you prefer to not sign the pledge, leave the box blank and then click "Next"

- Surprisingly, participants who saw an Environment-based message were significantly less likely to enrol in the PeaksaverPLUS program compared to other message types

Figure 41. Measuring Intentions by Pledge message type



Question: Given this pricing schedule, when would you typically run a dishwasher / washing machine / clothes dryer in the summer?

Implications and Recommendations

We found that people who signed the pledges were significantly more likely to state that they would engage in behaviours that would reduce electricity usage during off peak periods than those who did not sign the pledge. Although it is unclear whether this is a result of a self-selection bias whereby people who state they will do "good" behaviours are more likely to sign the pledge, previous research discussed above has indicated that people who sign pledges are more likely to stick to their intentions/commitments. The findings from this experiment suggest employing the following three design concepts will positively impact the likelihood that someone will sign a pledge and follow through with load-shifting behaviour.

- **The pledge should allow people to choose among a brief list of calls-to-action.** We found that people are more likely to sign and recall the pledge when they actively engage in selecting their calls-to-action. Two possible explanations for this are (1) the current state of energy conservation in a household and the feasibility to change behaviour varies from household to household (e.g., the night-shift worker versus the employee who is out of the home between 7 am and 7 pm), so having more options offers greater opportunity for a person to align to at least one call-to-action, and (2) the active process of selecting a call-to-action may increase recall of the action and endow a person to follow through and sign the pledge.

- **The pledge should highlight the % of people that are also doing the desired behaviour (Social Norms message).** We found that people who signed the pledge including a Social Norms message were more likely to shift electricity usage to off-peak periods. Social Norms messages, or messages that convey what the majority of people are doing, are effective at helping people understand how they should behave when there is uncertainty about the "correct" action. Here a social norms message in the pledge may increase the likelihood that the person sticks to their commitment as it may make them aware of their misperception and encourage them to shift their behaviour to be consistent with the majority.

- **The current presentation of the PeakSaver Plus is less appealing to those who saw a pledge with an environmental message.** Although it is hard to pinpoint the reason as to why this is the case, one possible explanation could be that people who see an environmental message are motivated to lead a simpler life (i.e., with less items), and adding a new device may not align with this vision.

Top 2 BE Conditions

Figure 42. Social Norms Message with Multiple Calls-to-Action

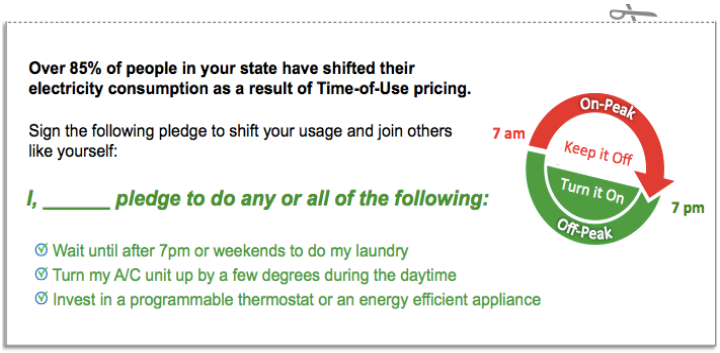
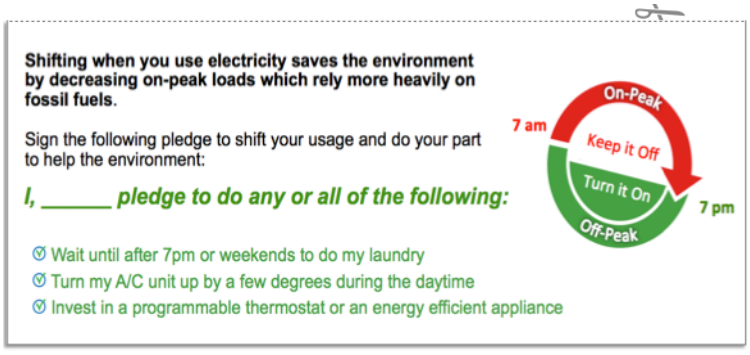


Figure 43. Informational Plea with Multiple Calls-to-Action

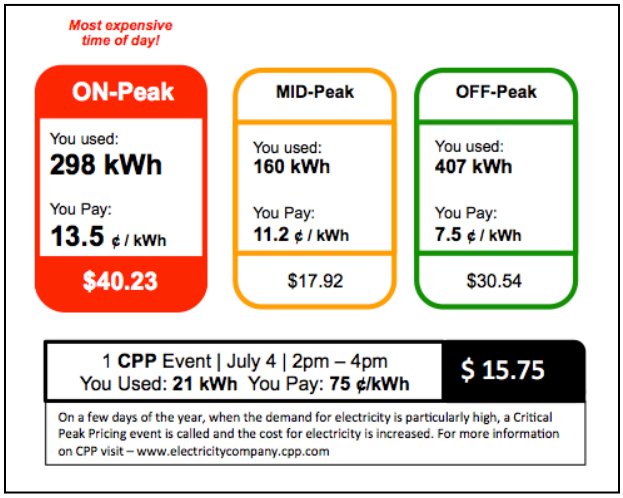


2.9 Pricing Extremes

Ontario's TOU electricity pricing model was introduced as a strategy for managing demand on the province's electricity grid. The model was implemented in order to prevent events such as power outages and to reduce costs associated with the generation of electricity. Ontarians under this plan are incentivized to consume electricity during times of the day when the demand is lowest making the overall load on the grid easier to manage and mitigating the need for capacity expansion.

Under some models of time-of-use pricing, the insignificance of the additional costs incurred by consumers during On-Peak times don't increase their motivation to shift usage. It follows that in order to obtain the required amount of shifting needed to manage grid loads, ratios between consumption periods costs should be increased until they are of considerable importance to consumers and motivate them to shift.

Figure 44. BE Condition with three period TOU and added CPP



A substantial amount of research has been done to identify the optimal price ratio required to manage electricity loads in dynamically priced systems.[111] Overall it has been found that dynamic pricing is generally effective with reductions in peak loads documented at up to 30%. This suggests that consumers are sensitive to rate differences.[112] The challenge is identifying and positioning a rate ratio that is manageable, fair, doesn't cause undue pressure to the economically less-advantaged, and is of significant magnitude in order to remain top-of-mind for consumers.

As discussed in section 1.1 of the report, an increase in off-to-on-peak ratios from 1:3 to 1:5 can be enough to stimulate significant peak load reductions of over 2%.[113] Furthermore, in a statewide pricing pilot conducted in California in 2005, a Critical Peak Period (CPP) electricity rate that was set at six times the off-peak rate was effective at reducing peak loads by 13%.[114] This research found that responsiveness varied with climate zone, the ownership of air conditioners, and customer characteristics, including socio-economic status. These results suggest that although a particular ratio may be effective in one jurisdiction, it may not be generalizable across all populations.

[111] Faruqui, Ahmad, and Jenny Palmer. "The Discovery of Price Responsiveness–A Survey of Experiments Involving Dynamic Pricing of Electricity." *Available at SSRN 2020587* (2012).
[112] Kirkeide, Loren. "Effects of Three-Hour on-peak Time-of-Use Plan on Residential Demand during Hot Phoenix Summers." *The Electricity Journal* 25.4 (2012): 48-62.
[113] Loren Kirkeide, Reducing Power Capacity Requirements Using Two-Period Time-of-Use Rates With Ten-Hour Peak Periods, Master's Thesis, Arizona State University, 1989.
[114] Faruqui, Ahmad, and Stephen George. "Quantifying customer response to dynamic pricing." *The Electricity Journal* 18.4 (2005): 53-63.

The rationale and hypotheses for the manipulations that were tested in the Pricing Extremes Nudge Panel Experiment were:

Ratios: A 5:1 or a 3:1 ratio, removing mid-peak altogether, or adding CPP

Ontario's relatively low ratio of less than two has been criticized by some for being the cause of the province's limited success with TOU rollout.[115,116,117] In the present study we examined the extent to which consumers are sensitive to TOU rate ratios with the aim of discovering a more effective pricing model. We presented participants with a hypothetical bill that included one of two price ratio manipulations reflected in a TOU model that was otherwise identical to the one currently in use in Ontario. Participants saw a three period TOU electricity usage breakdown with either a 3:1 or a 5:1 on-to-off peak price ratio. We also examined the effects of removing the mid-peak period altogether and compensated by adjusting the remaining on-peak and off-peak rates to reflect a ratio of 3:1. Lastly, we explored participants' reactions to an additional CPP charge set at rate equaling ten times that of off-peak. This CPP condition was added on top of Ontario's current TOU rates.

Using the current pricing ratio as a control, we compared the influence of these pricing models on participants' perception of the magnitude of rate differences, the affordability of electricity, the fairness of how electricity is priced, and their perceived control over their electricity charges.

Measurement Variable: Manipulating the usage or the period charges

In order to isolate the variable influencing consumers' responses to the TOU models presented in the study, we performed an additional manipulation to the three TOU period 3:1 and 5:1 conditions. All participants saw a bill that was similar to the control except for the rate and either the total charge per period or the kWh consumption (usage) per period. For example, of all the participants who were in a condition reflecting a 5:1 TOU pricing model, half saw a kWh consumption that differed from the control, and half saw a total period charge that differed from the

Figure 45. BE Condition with 3:1 On-to-Off Peak ratio and kWh usage that differs from the control

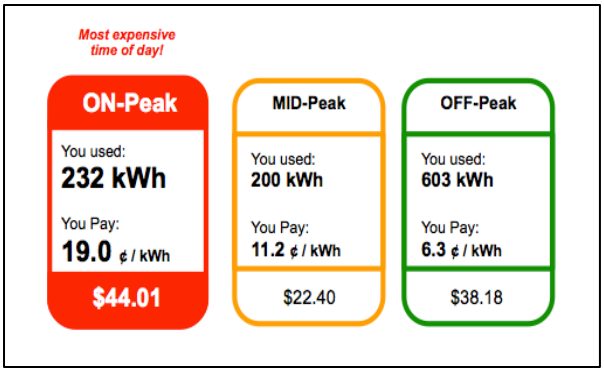
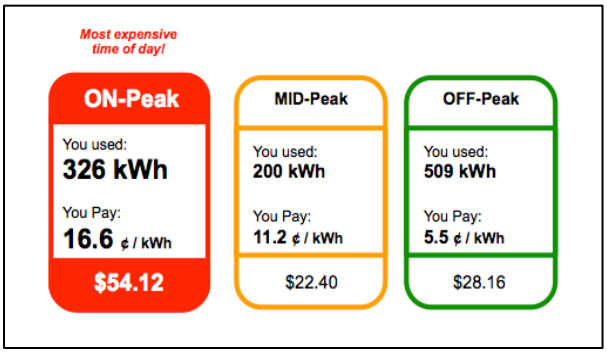


Figure 46. BE Condition with 3:1 On-to-Off Peak ratio and total period charge that differs from the control



[115] Singla, Sahil, and Srinivasan Keshav. "Demand response through a temperature set point market in Ontario." *Smart Grid Communications (SmartGridComm), 2012 IEEE Third International Conference on*. IEEE, 2012.
[116] Adepetu, Adedamola, et al. "Critiquing Time-of-Use Pricing in Ontario." *Smart Grid Communications (SmartGridComm), 2013 IEEE International Conference on*. IEEE, 2013.
[117] Faruqui, Sergici, and Lessem The Brattle Group '"Impact Evaluation of Ontario's Time-of-Use-Rates: First Year Analysis. Prepared for the Ontario Power Authority. November 26, 2013.

control. All participants across all conditions saw the same total amount owing.

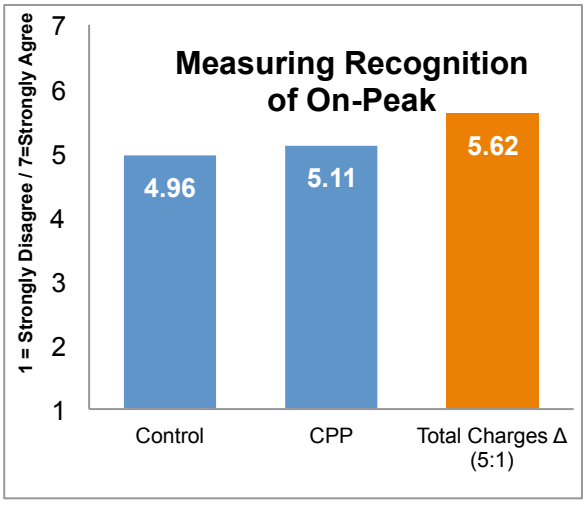
By performing this experimental manipulation we were able to determine if differences in perception were due to increases in the difference between period charges (for those who saw the same kWh consumption as the control) or simply due to the fact that people noticed the magnitude of the ratio.

Experiment Design

The experiment employed a 2 (TOU Ratio Plans: 3:1 vs. 5:1) X 2 (Measurement Variable: kWh vs. Charges) between-subjects factorial design. We also tested two additional treatment conditions: one that included a CPP element and one that had only two TOU periods (i.e. on-peak and off-peak). Including the control (i.e. the current TOU ratio plan), there was a total of seven conditions.

After reading a brief description of dynamic pricing in relation to electricity consumption, participants were shown a TOU or a TOU+CPP plan (see Figures 45 and 46 above for an example of the stimuli) and were asked to imagine that this was their own electricity bill. Following this, participants were evaluated on several criteria such as whether they understood the TOU plan they were shown, their general attitude toward the plan, and how fair they thought the plan was. They were also asked about their predicted willingness to conserve on-peak electricity if they were enrolled in such a plan and whether they believed they would have enough control over their spending if they were charged for electricity in such a manner (please refer to Table 42 in Appendix C for question details). 626 participants completed the online survey resulting in approximately 90 participants per group. Summary demographics can be found in Table 41 of Appendix C.

Figure 47. Measuring Recognition of On-Peak Consumption



Question: I have consumed too much On-Peak electricity this period
Significant differences at $p < .05$

Main Findings

Please note that for the following set of findings means represent participants' average score on a 7 point likert scale from 1=Strongly disagree to 7=Strongly agree.

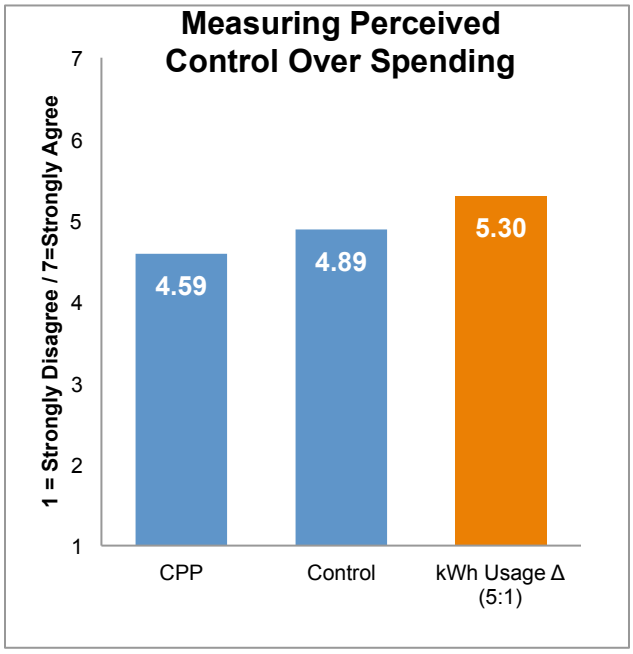
Consuming Too Much

- Relative to participants exposed to the CPP (M = 5.11) and Control (M = 4.96) conditions, those that were shown the 5:1 TOU plan (M = 5.62), specifically when kWh usage was held constant (326 kWh of on-peak usage), but the period charges were different (i.e. $62.59 versus $44.01), were more likely to agree that they have consumed too much On-Peak electricity this period; $p < 0.05$ (see Figure 47).

Perceived Control over Spending

- Participants exposed to a 5:1 TOU ratio, where the total kWh usage was identical across conditions, perceived that they would have significantly more control over their spending on electricity than those in the control and CPP conditions (M = 5.30 versus 4.59 and 4.89 respectively); $p < 0.05$ (see Figure 48).

Figure 48. Measuring Perceived Control over Spending



Question: With this plan I would have enough control over my spending on electricity
Significant differences at $p < .05$

Motivation to Conserve

- When asked whether they felt motivated to conserve on-peak energy and shift to off-peak in order to optimize cost savings, participants indicated that they felt more motivated when exposed to the 5:1 TOU plan that manipulated TOU charges (M = 6.04), relative to the CPP condition (M = 5.60); $p < 0.01$. In other words, participants exposed to the 5:1 TOU plan that displayed TOU charges that were different than the control felt that they would be significantly more likely to conserve on-peak energy than participants in the CPP condition. Given that total charges for all three periods were practically identical in these two conditions, we can infer that participants felt more motivated in the 5:1 plan due to a combination of the relatively lower off-peak rates and higher on-peak rates, as well as the corresponding charges.

Fairness & Positive Attitude

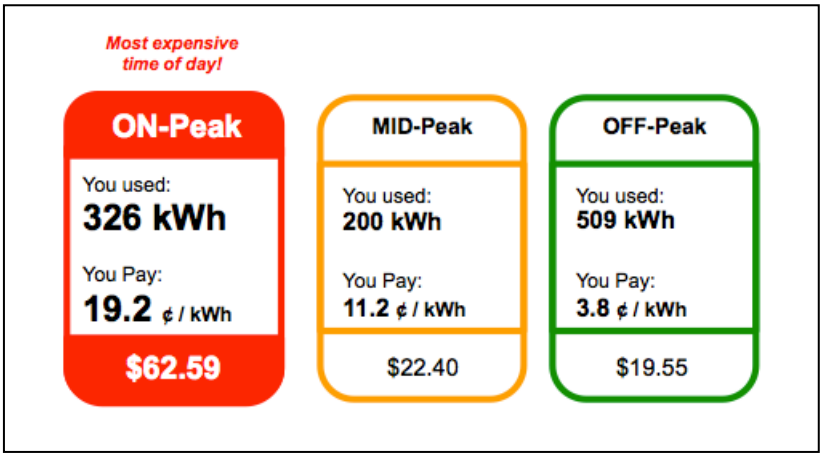
- Relative to the CPP condition, participants found the 3:1 TOU plan, which manipulated charges and kept kWh usage constant, to be fairer and they perceived this plan more favourably. When participants were asked whether they perceived the price of electricity to be fair, participants in the 3:1 TOU plan (M = 4.72) found the prices to be fairer than those exposed to the CPP condition (M = 4.15); $p < 0.05$. Furthermore, participants who saw the 3:1 TOU plan (M = 5.20) indicated that they had a significantly more positive attitude towards the plan than those in the CPP condition (M = 4.45); $p < 0.05$.

Cycling Down

- When participants were asked whether they would feel comfortable allowing their utility company to cycle down some of their major appliances during high peak times, those in the 5:1 TOU plan (M = 4.47), which manipulated kWh usage and kept charges constant, were more open to the idea than those in the CPP condition (M = 3.85); $p < 0.05$.

Top BE Condition

Figure 49. Three Period TOU with a 5:1 On-to-off-peak Ratio



Implications and Recommendations

Participants were more likely to recognize that they were consuming too much on-peak electricity when exposed to a 5:1 TOU plan than when exposed to 1.8:1 TOU plan (the control) or one that includes a CPP tier. Specifically, the greatest effect was found amongst those who were exposed to the 5:1 ratio with prices that were different than the control. These individuals were more likely to report that they felt they had over-consumed on-peak electricity, a result that is likely due to the higher charges associated with on-peak consumption. While we suggest further experimentation to build upon our findings, it appears there is merit in exploring a 5:1 TOU ratio.

2.10 PeaksaverPLUS

Ontario's PeaksaverPLUS program is designed to reduce electricity demand through an automated load control device that limits air conditioning, electric water heating, and pool pump usage. Residential and small business consumers are eligible to participate by allowing their utility company to install a one-way paging network to control either a programmable communicating thermostat or load control switch associated with one of the above appliances. As of 2012, consumers who have enrolled in the program also receive an in-home display that allows them to monitor their electricity consumption and TOU costs in real time. The in-home display was introduced by the Ontario Power Authority (OPA) as a way to encourage program enrolment and provide customers with additional information to manage energy consumption. While the program holds great promise to manage the province's electricity demand during peak times, only 180,000 devices have been installed to-date (approximately 175,000 residential and 4,300 small commercial).[118] Current estimates suggest that marketing efforts have resulted in generally low uptake rates.

A recently published report concluded that the installation of PeakaverPLUS resulted in a 17% reduction in average load relative to households who did not have their devices activated[1]. This translates to a 651 MWh in energy savings during event hours. Furthermore, 75% of respondents claim the in-home display has led to changes in their consumption behaviour. Depending on the utility company they belonged to, 49-60% of those surveyed said they do their laundry on evenings or weekends, and 36-52% run their dishwasher during this time as well[1]. While there are well-established gaps between what people say and what they ultimately do, the results of the evaluation are positive. People have a propensity to shift their energy consuming activities to off-peak times of day when they are provided with technology that facilitates the process. It is evident that increasing the adoption of the program will have a tremendous impact on the province's demand reduction and conservation goals.

From a behavioural perspective, the PeaksaverPLUS program is powerful because it automates demand reduction and doesn't rely on any form of consumer interaction. There is also strong evidence to show that coupling automated technologies with TOU results in even greater energy savings. Furthermore, in-home feedback technologies, like the new in-home display, have been shown to reduce energy use by 10-15%[119]. These savings were attributed to several dimensions of feedback associated with the device, namely the increased frequency of feedback, the granularity of data, the comprehensibility of the units of measurements, and the location of the device within the home.

Given its potential impact on electricity savings there are still several barriers to adoption. The *Electricity Consumer Survey* revealed a general lack of interest in the program, with 67% of respondents stating they would not be interested in participating in the program. The leading reasons for not wanting to join the program are that it won't make a difference on their energy bill (31%) and privacy reasons (30%). The PeaksaverPLUS experiment was designed to tackle these barriers by testing new BE communications to the increase the appeal of the program.

[118] The Ontario Power Authority. (2012). 2011 Residential and Small Commercial Peaksaver. San Francisco, CA: Berghman, D., Perry, M. of Freeman, Sullivan & Co.
[119] Froehlich, J. (2009, February). Promoting energy efficient behaviours in the home through feedback: The role of human-computer interaction. In *Proc. HCIC Workshop* (Vol. 9, pp. 0-10).

More specifically, two different messages were tested against what is current displayed on a bill.

Message framing: Loss aversion and Social norms messaging

Simple changes to the way things are communicated can have a profound impact on behaviour. Several studies that have already been discussed in this report help illustrate this fact. For example, social norms messages have been deployed to decrease energy usage with great success. The PeaksaverPLUS experiment deployed two different message conditions. One relied predominantly on social norms information, while the other was focused on loss aversion.

The way a message is framed is also a method of persuasion that has been met with great success. People are often more motivated to avoid a loss than they are to attain an equivalent gain.[120] Gain framed messages emphasize the advantages of performing recommended behaviours: "if you conserve energy you will help save the environment", whereas loss framed messages highlight the costs associated with inaction: "if you do not conserve energy, the environment will deteriorate." While both message advocate the same behaviour, one focuses on benefits of conservation and the other focuses on costs. Studies have shown that loss framed messages are more effective promoting pro-environmental behaviour.[121] Similarly, in another study, homeowners were more likely to conduct an energy retrofit when auditors used loss-framed scripts informing them of the energy or money lost via inaction rather than the energy or money saved through action. A significantly greater proportion of people who read the loss-framed script agreed to the retrofit, compared to those in the control who read the standard script.[122] Similarly, when presenting information about the monetary rewards of installing conservation equipment, showing people how much money they lose every month by *not* investing in the devices, is significantly more effective than emphasizing how much they can save by using them. Information campaigns looking to increase the adoption of energy conserving devices should focus on highlighting what people are losing by not enrolling in the program.[123] The loss aversion condition in the PeaksaverPLUS experiment is designed to highlight that people are missing out on a free device valued at $400.

The second condition led with a social norms message. When faced with a choice, consumers are more likely to rely upon the behaviours of others to make choices, particularly in situations involving a high degree of uncertainty.[124] Much of the research on social norms has been discussed in detail in the behavioural diagnostics section as well as in sections 2.7 and 2.8 of this report. Behaviours surrounding electricity conservation or automated load control device adoption may not be well understood. The current adoption numbers of PeaksaverPLUS, while quite low relative to the population may still encourage program enrolments.

[120] Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.
[121] Davis, J. J. (1995). The effects of message framing on response to environmental communications. *Journalism & Mass Communication Quarterly*,*72*(2), 285-299.
[122] Gonzales, M. H., Aronson, E. and Costanzo, M. A. (1988), Using Social Cognition and Persuasion to Promote Energy Conservation: A Quasi-Experiment. Journal of Applied Social Psychology, 18: 1049–1066.
[123] Yates, S. M. (1983). Using prospect theory to create persuasive communications about solar water heaters and insulation (Doctoral dissertation, University of California at Santa Cruz, 1982). *Dissertation Abstracts International*, *44*.
[124] Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance.

Saliency: Highlighting the persuasive message using colour

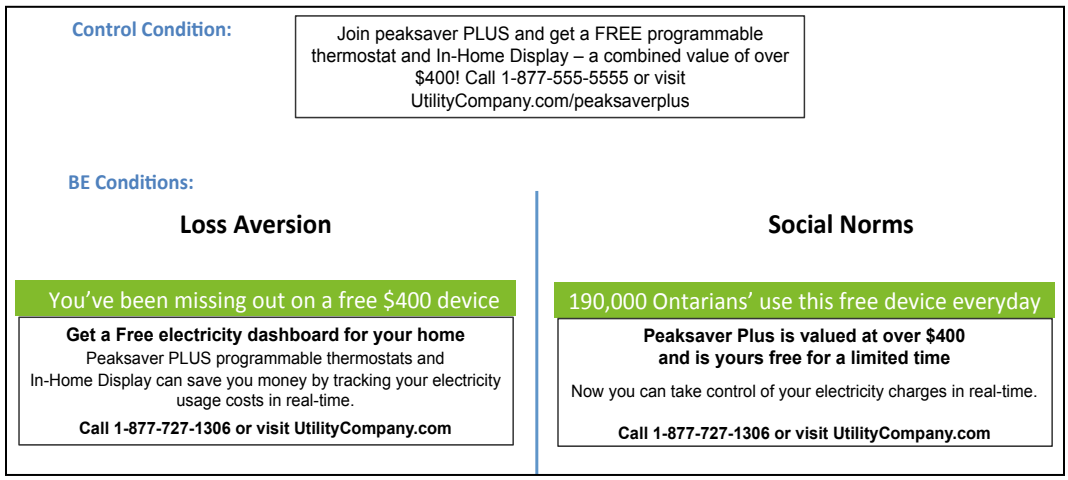
The final manipulation in the experimental conditions relative to controls is the use of colour to attract attention. The purpose of doing so is to magnify the persuasive effects of the frame by drawing peoples' attention to the message.

Experiment Design

The current PeaksaverPLUS offer, which highlights the free In-Home Energy Display and its cost, was used as a control. Two variations of the promotional message were created and tested against the current offer resulting in a total of three conditions. The newly created offers were named "Loss Aversion" and "Social Norms". These titles corresponded to the rationale used in their respective message (see Figure 50 for images of the three conditions).

All three conditions highlighted the monetary value of the programmable thermostat and In-Home Display as well as indicated that the items were free, however one condition used a salient loss aversion message in the header and provided more information about the

Figure 50. Control and Experimental Conditions for PeaksaverPLUS



PeaksaverPLUS program. In contrast, the other experimental condition used a social norms message in the header, paired with a limited time offer, and emphasized taking control over one's electricity charges.

Unlike the other nudge panel experiments which evaluated American Amazon Mechanical Turk respondents, the PeaksaverPLUS experiment was conducted amongst a sample of Ontarians. This was accomplished by adding the study to the end of the *Bill Statement Experiment* (discussed further in section 3.0). After completing the *Bill Statement Experiment*, all participants were shown one of the three offers and were required to answer a series of questions related to their perception of the program and their likelihood of enrolling. To better understand the concerns affecting participants' enrollment in the program and how these concerns vary as a function of the presented offer, participants who were undecided or stated that they were unlikely to enroll, were asked their rationale for their choice. 935 participants completed the online study, with approximately 300 participants per group. Summary of demographics can be found in Table 45 of Appendix D.

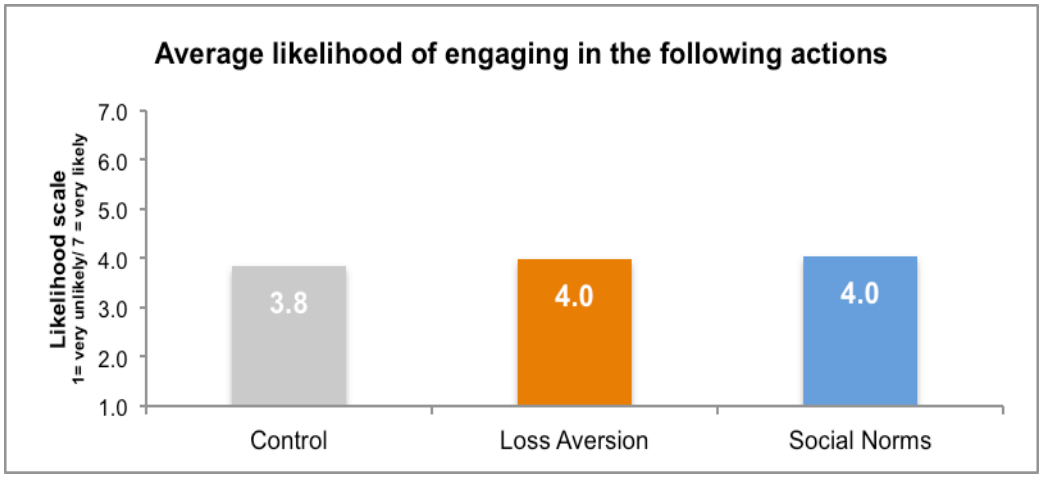
Main Findings

Enrollment Likelihood:
After seeing the offer, participants were asked how likely they would be to visit the website address provided, call the number provided, seek additional information on the program, and enroll in the program. For participants who stated that they were somewhat unlikely to very unlikely to enroll, a follow-up question was displayed asking them their reasons for their disinterest.

- Participants' responses were found to be consistent across the 5 questions. This means that a participant who said that they were likely to call were equally likely to enrol in the PeaksaverPLUS program.

- Irrespective of the offer they saw, Ontarians were undecided about their participation in the PeaksaverPLUS program. Participants in the experimental conditions were not significantly more likely to learn about the program or join the program than participants in the control condition. Additionally, the average score for each condition was near 4, suggesting that participants remained largely undecided about whether they would participate in the program. Surprisingly, even the participants in the social norms condition, who received additional details about the program, were just as undecided as participants in the other conditions who were provided with far less information.

Figure 51. There were no differences in engagement across conditions



Measure:
How likely are you to (1) Visit the website address provided (2) Call the number provided (3) Seek additional information on the program (4) Enroll in the program?
Graph plots mean scores on a 7pt-scale, where 1 is Very Unlikely and 7 is Very Likely.
No significant differences

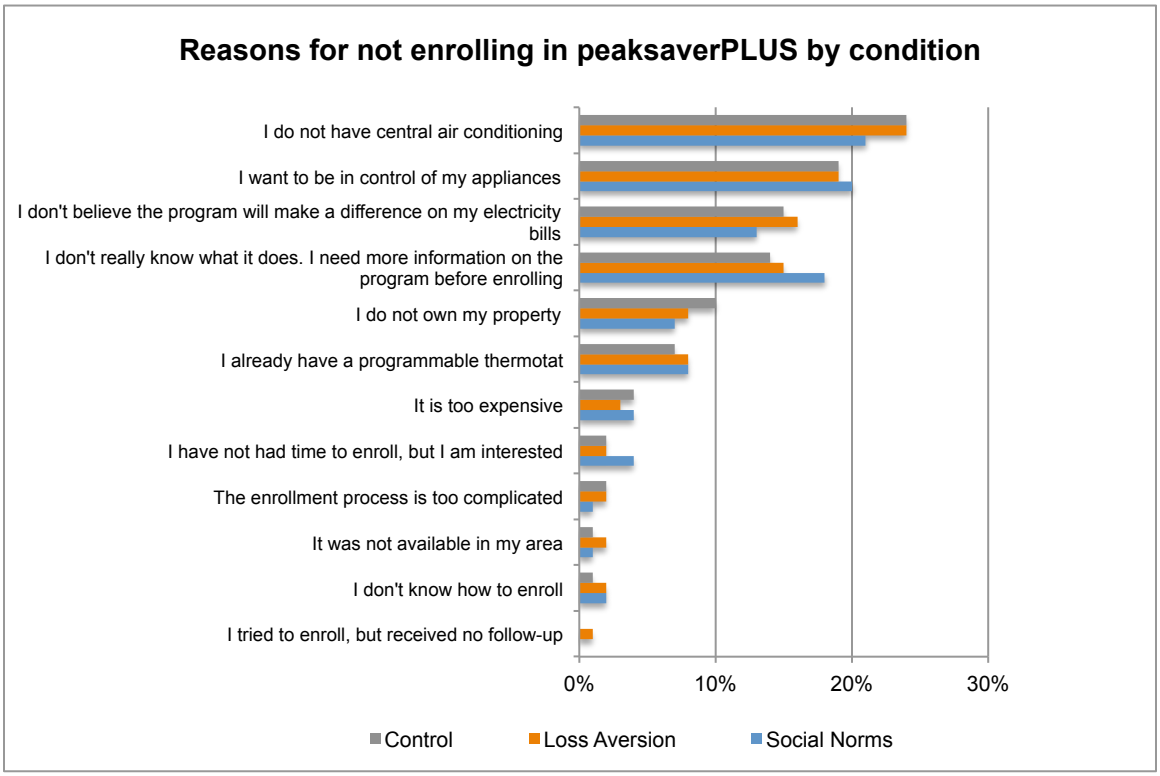
- Irrespective of the message they saw, one third of participants remain undecided about whether they would enroll in the PeaksaverPLUS program after seeing the offer. A question within the composite score explicitly asked participants their likelihood of joining the PeaksaverPLUS program. Approximately one third (35%) of participants stated that they

were unlikely to enroll in the program, and another third (31%) stated that they were undecided.

Reasons for not joining the program

- Participants who were undecided or selected that they were unlikely to join the program (n = 622), were asked to state their rationale for their decision. Excluding those respondents who did not qualified for the program because they lack an air conditioner, the top three reasons for not wanting to join the program were: (1) participants wanted to be in control of their appliances (19%), (2) they needed more information before enrolling (16%), and (3) they don't believe the program will make a difference on their electricity bills (15%). See Figure 52 for more details.

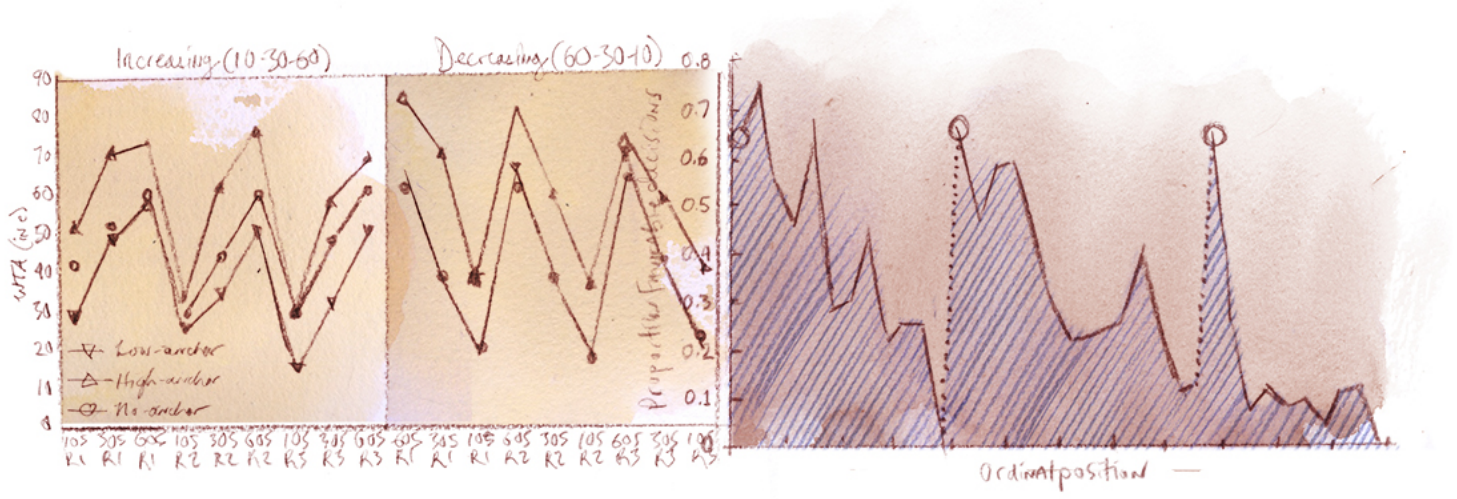
Figure 52. Wanting to be in control of appliances is cited as the top reason for not enrolling



Implications and Recommendations

- It is evident that a sense of control is the primary deterrent for not enrolling in the PeaksaverPLUS program. Although asked in the *Electricity Consumer Survey*, in the PeaksaverPLUS Nudge Panel experiment "privacy reasons" was removed as one of the options for not enrolling in the program because the word "privacy" in and of itself potentially imbues a bias. It was replaced with "I want to be in control of my appliances." Even when the social norms message explicitly mentions taking control of one's electricity charges, it

does not mitigate their concerns about control. However, since a significant impact of PeaksaverPLUS comes from consumer's granting permission to government authorities to remotely adjusting the settings on the appliances, other incentives should be introduced to encourage adoption.



Part 3 Bill Statement Experiment

As was noted in the results of the *Electricity Consumer Survey*, overall awareness of the TOU program is moderately high, but comprehension is low. *A prio*ri, it is unclear whether the failure to shift usage to off-peak periods is due to a lack of incentive, a lack of comprehension, or a different but untested hypothesis. Informed by the *Nudge Panel Experiments*, the current experiment tested different bill layouts aimed at improving ease of processing (fluency) and reducing ambiguity of the information presented on the electricity bill.

Bill statements are an ideal channel to experiment with improved fluency and clarity. First, bills can be standardized across a large group of people, limiting worries about different messaging to consumer groups in Ontario. Second, as was noted in the OEB Bill Survey, a large majority of people still receive their electricity bill via mail, and many of these people read their bill – albeit their attention appears to remain limited to the total amount due. Third, it offers an ideal format to test informational and motivational strategies such as visualized data, benchmarks, tips, and pledges. And finally, changing the bill will likely require smaller investments compared to other strategies.

This experiment provides an empirical examination of how consumers interpret and respond to bill statements, and can offer insights on how bills might be redesigned to increase load shifting from Peak periods. Conceived more broadly, this approach also sheds light on the psychological drivers of energy consumption decisions. In turn, these insights can be applied to pricing adjustments, complementary programs, and a wide array of other consumer touch points.

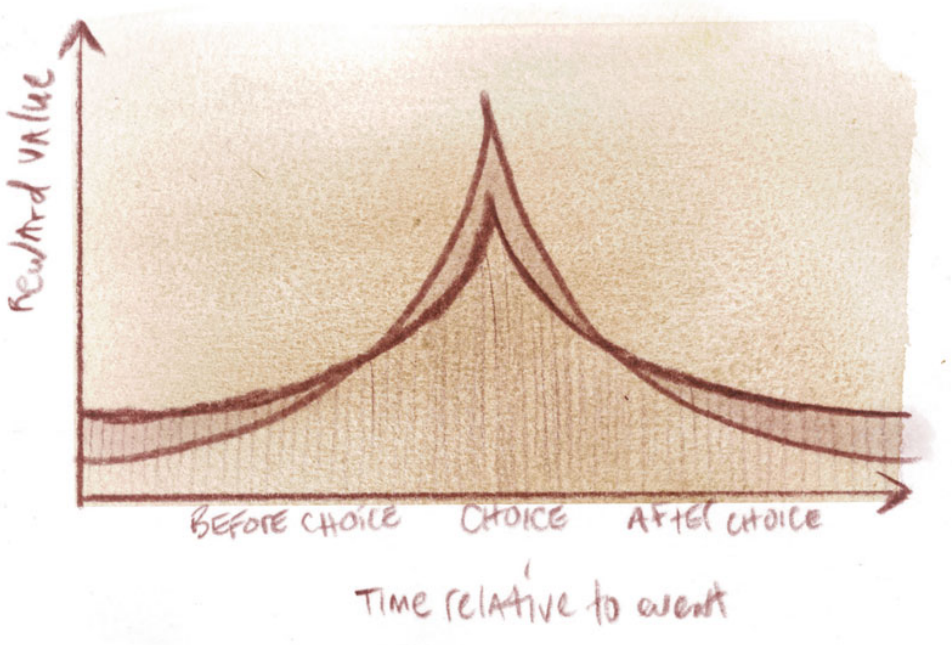
Ideally, the efficacy of a behaviourally engineered bill statement would be tested in a field study whereby real word changes in consumption of Ontarian consumers could be measured. Prior to the roll out of such a large initiative, it is imperative to ensure that the most influential bill alternatives are included in the evaluation. Findings from the current experiment could be used to design bills for use in such a trial, as well as provide the OEB with further insight into effective techniques for encouraging TOU compliance.

In the *Bill Statement Experiment*, optimized bill presentations were tested against current Toronto Hydro and Hydro One (control) statements. The content presented in the behaviourally optimized bills was determined via the *Nudge Panel Experiments* outlined in the previous section. In these ten *Nudge Panel Experiments* discussed previously in this report, individual elements of an electricity bill were tested independently in order to isolate interventions that can have positive impact on perception, comprehension, and recall of electricity usage and pricing information. In this experiment, the top performing “nudges” were combined into variations of a typical electricity bill. The experiment, which was conducted with a sample of Ontarian electricity consumers, was designed to simulate consumers’ typical interaction with their electricity bill.

We hypothesized that by combining winning "nudges" from our *Nudge Panel Experiments* into one layout, we could leverage the effectiveness of each in order to create a bill that is as powerful as the sum of its parts. Several research findings support this reasoning by showing that a combination of strategies is sometimes more effective than applying one single strategy. For example, it has been found that introducing feedback along with goal setting reduces consumption rates by over 20% (whereas feedback only conditions result in saving of around 10%), as does having people sign commitment cards in addition to receiving feedback on their recycling.[125] In the latter study it was found that those who only received feedback on their household's newspaper recycling behaviour increased the amount they recycled by 25% however, those who received feedback and were also asked to sign a public commitment increased their recycling behaviour by 40%.[126]

In testing the BE engineered bill statements, we aimed to address the following questions:

1. How does a BE engineered bill statement influence Ontarians' perception, comprehension, and recall of their usage under TOU pricing?
2. How does changing the layout and presentation of information on electricity bills in order to better align with human information processing effect *where* Ontarians' focus their attention when looking at it?
3. Do BE engineered bill statements lead to greater perception and recall of specific pricing related information vis-à-vis the TOU periods?



[125] McCalley, L. T., and Cees JH Midden. "Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation." *Journal of economic psychology* 23.5 (2002): 589-603.
[126] De Leon, Iser G., and R. Wayne Fuqua. "The effects of public commitment and group feedback on curbside recycling." *Environment and Behaviour* 27.2 (1995): 233-250.

Bill Statement Experiment: Findings

Key Findings

Overall Findings (All Bills)

- **Across all bills, there was a positive relationship between those who clicked on the bill more and intentions to shift to off-peak usage.** In particular, participants who had a higher frequency of clicks on: **1)** the TOU Break Down regions, **2)** the TOU Consumption Visual, and **3)** the TOU illustration, indicated that they were more willing to shift their electricity usage to off-peak periods, compared to participants that had a lower frequency of clicks.
    - **Insight:** A higher level of attention to the bill (captured by bill clicks) leads to higher intentions to shift electricity usage to off-peak periods.

- **Across all bills, there was a positive relationship between participants who clicked on the TOU Break Down regions and motivations to reduce their electricity consumption.**
    - **Insight:** Higher levels of attention to the TOU Break Down regions (captured by bill clicks) were associated with higher motivation to reduce electricity consumption.

Findings (Control Bills vs. Control Bills + Consumption Visual)

*Hereafter, the Hydro One bill will be referred as "HO_control", while the Toronto Hydro bill will be referred to as "TH_control".

- **Adding the consumption visual to HO_control increased the ease of understanding information on the bill.** Participants in the HO_VC condition rated their bill as easier to understand for both themselves (*M* = 5.20), and the average Canadian (*M* = 4.40), relative to the HO_control bill (M = 5.10; 4.20). Although this variance was not significantly different, the lift from the inclusion of the visual made the HO_control bill just as easy to understand as the newly designed bills (Bill 1 – 5).

- **Across both controls, changing the depiction of the consumption visual improved the layout of the bill.** Preference for the new layout was higher for participants in the HO_VC (*M* = 4.50) and TH_VC (*M* = 4.50) bill conditions compared to participants who saw the HO_control (*M* = 4.30) and TH_control (*M* = 4.40) bill conditions. Although this variance was not statistically significant, the lift resulting from the inclusion of the consumption visuals led to the manipulated control bills performing just as well as the new bill designs (Bill 1-5).

- **Participants who saw the HO_VC bill (*M* = 5.70) indicated that they felt more motivated to shift their electricity usage to off-peak periods compared to participants who saw the HO_control bill (*M* = 5.40).** However, this variance was not statistically significant.

    - **Overall Insight:** Ultimately, including a more salient and fluent consumption visual improves a viewer's understanding of the information on the bill, perception of the layout of the bill, and motivations to shift electricity usage to off-peak periods.

Findings (Newly Designed Bills: 1-5)

- **Participants who saw any of the newly designed bills [Bill 1 – 5] (*M* = 5.40) found electricity costs to be presented significantly more clearly than HO_control (*M* = 4.90); *p* < 0.06.** These bills highlighted kWh usage and associated costs for each of the TOU periods via TOU salient visuals.
    - **Recommendation:** Change the TOU breakdown region to improve price clarity.

- **Participants had better recall of the TOU prices when it was presented in cents than when it was presented in dollars.** Participants were asked to recall the TOU rates for each period using a slider bar. Analyzing the difference between the recalled amount and the actual amount, participants who saw TOU prices presented in dollars ($) [TH_control and TH_VC] had a larger magnitude of error (*M* = 45.00) than participants who saw the other 7 bills (*M* = 27.40), all of which had their TOU prices presented in cents (¢).
    - **Recommendation:** Display TOU rates in cents in order to improve consumers' ability to recall TOU rates.

- **Participants who saw a sad emoticon as the consumption benchmark (Bill 3-5) were more likely to recall the total charge for on-peak usage**. Participants who saw the bills that had a consumption benchmark that displayed a sad emoticon (*M* = 0.41) were better able to recall the total charge during the most expensive period compared to participants who saw the HO_control (*M* = 0.24).
    - **Insight:** The presence of the negatively valenced emoticon potentiates attention towards the highest cost of consumption.

- **Participants clicked more often and with a higher likelihood on the TOU Salient visual with shapes**. Participants who saw Bill 4 and 5 had a greater likelihood of clicking on the elements within the TOU Break Down region (*M* = 0.55) compared to participants that saw the HO_control bill (*M* = 0.39). In addition, Bill 4 and 5 participants also had a higher frequency of clicks (*M* = 1.41) on this same region compared to participants in the HO_control (*M* = 0.87).
    - **Insight:** Ontarians are more likely to attend to the TOU Break Down region when the prices are made salient through fluency manipulations such as colour-coding and separation by different shapes

- **Placing important information on the back of the bill (e.g., fixed costs or total amount due), near the TOU illustration, increased the likelihood that participants clicked on this region**. Participants who saw either Bills 1 - 4 (*M* = 0.29) were more likely to click on the TOU illustration than participants who saw the HO_control bill (*M* = 0.17). In addition, participants who saw either Bill 1, 2, or 4 (i = 0.50) had more clicks in the region than participants who saw the HO_control bill (*M* = 0.20).
    - **Insight:** Displaying important information on the back of the bill near the TOU illustration increases attention to the TOU visual illustration.

Top 2 Bill Findings	
Bill 1	**Bill 5**
Attention: • Compared to participants who saw the HO_control (*M* = 0.17), participants who saw Bill 1 (*M* = 0.27) were more likely to click on the TOU illustration (where Bill 1 entailed the TOU off-peak focused visual from the TOU illustration manipulation). • Similarly, compared to participants who saw the HO_control (*M* = 0.20), participants who saw Bill 1 clicked on the TOU illustration more times (*M* = 0.43).	**Attention:** • Compared to participants in the HO_control (*M* = 0.39), participants who saw Bill 5 (*M* = 0.52) were more likely to click on the TOU price breakdown region. Furthermore, Bill 5 participants (*M* = 1.40) clicked on this region more times than HO_control participants (*M* = 0.87). • Participants who saw Bill 5 (*M* = 1.08) clicked on the TOU period consumption visual more times than participants who saw the TH_control bill (*M* = 0.98).
Recall: • Compared to participants who saw the TH_control bill (*M* = 0.20), Bill 1 participants were better at recalling the correct period in which the most amount (kWh) of electricity was consumed (*M* = 0.33). • Similarly, Bill 1 participants (average magnitude of error = 28.9) were also better at recalling the correct price for each TOU period compared to participants who saw the TH_control bill (average magnitude of error = 45.7).	**Recall:** • Compared to participants who saw the HO_control (*M* = 0.20) and TH_control (*M* = 0.24) bill, Bill 5 participants (M = 0.38) were better at recalling the TOU period in which the highest amount of electricity was consumed. • Bill 5 participants (*M* = 0.47) were also better at recalling the correct total dollar charge for on-peak electricity, compared to those that saw the TH_control (*M* = 0.20) and HO_control (*M* =0.24) bill.
Fluency/Clarity: • Compared to participants who saw the HO_Control (*M* = 5.10) and TH_Control (*M* = 5.00) bill, Bill 1 participants (*M* = 5.30) perceived the bill to be significantly easier to understand. • Participants who saw Bill 1 (*M* = 5.40) perceived the electricity costs to be significantly clearer compared to those that saw the HO_control bill (*M* = 4.90). • Compared to participants who saw the TH_control bill (*M* = -3.60), participants that viewed Bill 1 perceived the bill to be significantly less cluttered (*M* = - 3.10).	**Fluency/Clarity:** • Compared to participants who saw the HO_Control (*M* = 5.10), Bill 5 participants (*M* = 5.40) perceived the bill to be significantly easier to understand. • Participants who saw Bill 5 (*M* = 5.60) perceived the electricity costs to be significantly clearer compared to those that saw the HO_control (*M* = 4.90) and TH_control (*M* = 5.1) bill. • Compared to participants who saw the TH_control bill (*M* = -3.60), participants that viewed Bill 1 perceived the bill to be significantly less cluttered (*M* = - 3.10).
Recommendation: Bills 1 and 5 should be tested in-field to measure their efficacy in leading to real world changes in electricity consumption behaviour.	

Experiment Design

935 Ontarians over the age of 18 who had received a household electricity bill in the past year participated in this study. As reward for their participation, 50% of participants received AIR MILES reward miles as a reward and 50% received the equivalent value in points towards a retail gift card. Participants who had participated in our previous studies were excluded from this experiment.

Treatments

The experiment employed a between-subjects design, with 7 treatment bills and 2 control bills, totaling 9 conditions. Participants were randomly assigned to 1 of the 9 conditions. Prices for each period, $ total charges, and usage were identical across all bills. Additionally, all the bills were negatively framed, i.e. participants were shown bills where their energy consumption in the current month had increased by 5% relative to the previous month. Please refer to Appendix D (Figures 37, 39, 31, 43, 45, 47, 49, 51, & 53) for images of the tested Bill conditions.

Participants in the control conditions either saw a Toronto Hydro bill (hereafter referred to as TH_control) or a Hydro One bill (hereafter referred to as HO_control). The general belief in the electricity space in Ontario is that the Toronto Hydro bill is considered "best of breed", having taken large strides to improve how information is presented on the electricity bill. In contrast, the Hydro One bill is representative of a standard layout electricity bill that is circulated across Ontario.

Tactics that facilitated an increased understanding of consumption and TOU costs over time were found to be an important motivator of behavior in our *Nudge Panel Experiments*. Consequently, two variations of the controls were created, in which the content and the layout were the same, except the visual energy consumption bar graphs that currently exist on each of the control bills were replaced by a consumption visual graph that emerged as a better depiction of this information in our nudge panel. Hereafter, these two treatments will be referred to as TH_VC (Toronto Hydro_Visual Consumption) and HO_VC (Hydro One_Visual Consumption), respectively. The manipulated visual for the TH_VC condition consisted of horizontal consumption bars that were segmented, where the segments varied in colour in order to represent specific TOU period consumption (i.e. off-peak, mid-peak, on-peak). The x-axis represented kWh usage, while the y-axis provided consumption bars for the months, providing participants with a year-over-year (YoY) view of their consumption (i.e. June 2013-2014). Data labels (in dollars) were provided for the first and last month, which allowed participants to make a direct YoY comparison of their last month's usage. The visual in the HO_VC condition followed a comparable layout (Figure 43 in Appendix D).

The remaining five treatment bills incorporate the "top 2" elements from each of the *Nudge Panel Experiments*. Accordingly, each bill contained:

1. **Price Clarity**: The two price clarity manipulations that were most effective in increasing comprehension and recall were the TOU salient visuals, and the TOU salient visuals with shapes design, both with fixed charges on the back. Bills 1, 2, and 3 contained the former, while TOU Bills 4 and 5 contained the latter.

2. **Consumption Benchmarks:** Our benchmarks nudge panel revealed that the historical benchmark with a house visual, and the goal benchmark with the face visual, both in the negative affective frame, outperformed other visual and benchmark combinations. Bills 1 and 2 contained the house visual (hereafter referred to as "wide house"), while bills 3,4, and 5 contained a goal benchmark with a face visual (hereafter referred to as "sad emoticon").

3. **TOU Period Consumption Visuals:** Our TOU Period consumption visuals experiment indicated that consumption visuals that were specific to on-peak usage led to better performance on measures pertaining to understanding and motivations to reduce consumption, while the All-peak visuals performed better on comprehension measures. In both cases, the effect was strongest specifically when the metric of the axis was congruent with the data points highlighting overall consumption amount (e.g. $ with $ or kWh with kWh). Accordingly, Bills 1, 2, and 3 displayed a consumption bar graph that showed usage amounts across all-peaks (off-peak, mid-peak, and on-peak) with usage presented in kWh (hereafter referred to as all-peak_kWh), while Bills 4 and 5 displayed only on peak usage, with consumption amounts referenced via price in dollars (hereafter referred to as on-peak_ $).

4. **Longitudinal Consumption:** Consumption visuals that provided a year-over-year (YoY) comparison of consumption with vertical consumption bars, outperformed visuals displaying a month-over-month (MoM) comparison, on measures relating to comprehension, recall, and motivations to change behaviour. Thus all experimental bills i.e. bills 1, 2, 3, 4, and 5 presented longitudinal usage information in vertical bars and highlighted the YoY comparison. Bills 1, 2, and 3 presented the YoY comparison in kWh (hereafter referred to as YoY in kWh). Bills 4 and 5 presented the YoY comparison dollars (hereafter referred to as YoY in $).

5. **TOU Illustration Visuals:** Overall, linear visuals tended to marginally outperform circular visuals, wherein linear visuals highlighting the on-peak and off-peak start and end times were preferred over today's TOU visuals in terms of understanding and comprehension. Bills 1, 2, and 3 contained a linear TOU Off-Peak focused visual. Bills 4 and 5 contained a linear TOU On-Peak focused visual.

6. **Naming Schema:** Relative to the control TOU period names, naming schema that were price- focused resulted in a more accurate recall of the correct TOU names. Bills 1, 2, and 3 re-named the three periods as "Peak Price" for the on-peak period, "High Price" for the mid-peak period, and "Standard Price" for the off-peak period (hereafter referred to as Price Focused I). Bill 4 and 5 renamed the three periods as "Most Expensive" for the on-peak period, "Average" for the mid-peak period, and "Least Expensive" for the off-peak period (hereafter referred as Price Focused II).

7. **Pledges:** Our pledge study revealed that participants were more likely to sign the pledge and indicate intentions to change their behaviour when they were exposed to the multiple calls-to-action conditions especially when paired with informational messaging or social messaging. Bills 1, 2, 3, 4, and 5 had a multi-attribute pledge that gave participants the flexibility to pledge up to 3 different activities. Bills 1, 2, and 3 were paired with a pledge that contained an informational message. Bills 4 and 5 were paired with a pledge that contained a social message.

In addition, two new elements were tested:

8. Bill 1 and 2 were exactly the same, except Bill 2 placed the "Total Amount Due" on the back of the bill. This was based on our finding from our click tracking study that placing the total due on the back of the bill increases attendance to the back.

9. Bill 4 and 5 were identical, except for the addition of a picture of a child with a sad facial expression displayed the top right-hand corner of the page in Bill 5 (Figure 53 in Appendix D). The rationale for this condition comes from research on donation behaviour in response to charity advertisements. Empirical analyses of advertisements for charities that employ images of the victims who would benefit from giving to the cause are shown to increase the likelihood and amount of donations. Through a process of emotional contagion, these negatively valenced advertisements are capable of eliciting feelings of sadness in the viewer, resulting in increased sympathy and a desire to help.[127] Interestingly, the effects of emotional contagion on behaviour are not limited to the domain of charitable giving. The affect-as-information model states that decisions are highly influenced by someone's subjective emotional experiences.[128] On occasion, the misattribution of these emotional experiences can impact behaviour in surprising ways. Even when the attribute causing the emotional response is unrelated to the decision at hand, one's bodily experience informs the decision on a subconscious level. These findings are applicable to the present research in the following manner: by presenting the face of a sad child on electricity bills, we hypothesize that it will elicit feelings of sadness for the reader and the reader will misattribute these feelings of sadness to their electricity consumption. To repair their mood, they will feel increasingly motivated to conserve in the future.

Measures

To determine the effectiveness of the bills, the following metrics were examined:

- **Attention:** Similar to the *Bill Click Tracking Study*, participants were asked to click on areas of the bill that they would typically attend to. Clicks served as a proxy for what participants attended to and would read on the bill. Unlike the click-tracking experiment, in which participants could make an unlimited number of clicks, participants could only make up to

[127] Small, Deborah A., and Nicole M. Verrochi. "The face of need: Facial emotion expression on charity advertisements." *Journal of Marketing Research* 46.6 (2009): 777-787.
[128] Schwarz, Norbert, and Gerald L. Clore. "Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states." *Journal of personality and social psychology* 45.3 (1983): 513.

ten clicks for each side of the bill i.e. a participant could only make up to ten clicks on the front of the bill, and up to ten clicks on the back of the bill.

- **Fluency:** Fluency was measured on two dimensions - (1) ease of understanding the information on the bill (conceptual fluency) and (2) clarity of the information on the bill (perceptual fluency). To measure the former, participants were asked to rate the ease of understanding of information contained in the bill (7-point likert scale: 1 = very difficult / 7 = very easy), as well as how easy they believed the average Canadian would find it. To measure clarity, participants were asked to rate their agreement with three statements that pertained to how the bill the presented (7 point likert scale: 1 = Strongly Disagree / 7 = Strongly Agree): (1) Electricity costs are presented clearly, (2) There is too much information on the bill, and (3) I prefer this bill layout compared to the one I currently receive from my electricity provider.

- **Recall:** To measure recall, participants were asked to recall four pieces of information that were considered important for shifting electricity usage to off-peak periods: (1) price for each TOU period ($/kWh), (2) total charge for on-peak usage, (3) the start and end time of the most expensive TOU period, and (4) the name of the most expensive period.

- **Electricity Conservation:** Participants were asked to indicate on a 7-pt scale (1 – "Very Unlikely" to 7 – "Very Likely") how likely they would be to do 5 specific energy conserving actions: (1) Wait until after 7 pm to run your dishwasher, (2) Unplug silent electricity consumers when not in use (TV, computers, coffee machine, etc.), (3) Turn off lights in a room when it is not occupied, (4) Wash your dishes by hand instead of running the dishwasher, and (5) Invest in energy efficient appliances or lightbulbs.

- **Shift Electricity Usage to off-peak Periods:** Participants were presented with three statements that served as potential indicators of motivation to switch usage to off-peak periods. Participants rated their agreement on a 7-pt scale (1 – "Strongly Disagree" to 7 – "Strongly Agree").

- **Emotions:** To assay for differences in negative feelings such as guilt and offensiveness in response to increased electricity usage in the new bill layouts, we asked participants to rate their agreement with two statements, 1) "If I were to receive this electricity bill I would feel guilty about using too much Peak Price electricity" and 2) "If I were to receive this electricity bill I would find it offensive". Both scales were a 7-pt likert scale, (1 – "Strongly Disagree" to 7 – "Strongly Agree").

- **Environmental Consciousness:** To measure environmental consciousness, participants were asked to rate their agreement with the following statement: "This bill makes me want to be more environmentally conscious" (7 point likert scale: 1 = Strongly Disagree / 7 = Strongly Agree).

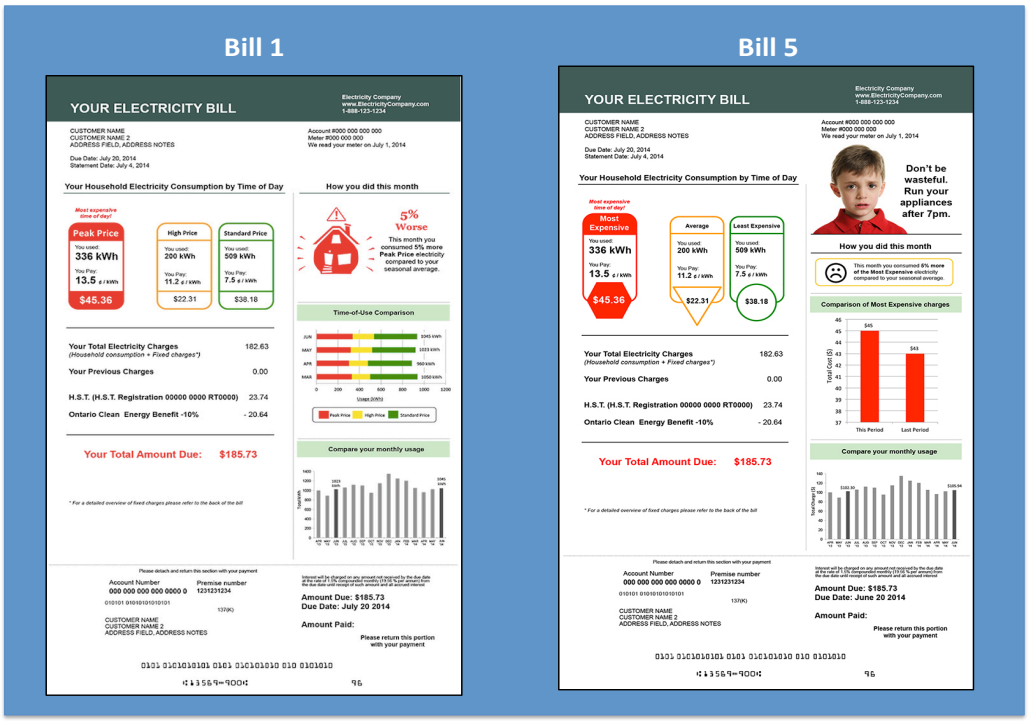
- **Pledge Actions:** Participants who saw the pledge were asked to indicate what they would do with the pledge by selecting one of the following options: sign it, read it, throw it away, or post it.

Main Findings

The main findings have been split into three parts. The first part looks at the (top) two bills that performed the best across key metrics, which were Bills 1 and 5. The second part looks at specific features across all the bills that outperformed others along the key measures. The last part discusses key questions explored in this experiment.

1. Bill 1 and Bill 5 outperformed the current utility bills on measures of fluency and recall.

Figure 53. Bill 1 and 5



Bill 1: Bill 1 was found to have higher levels of fluency and clarity compared to the controls. Participants who saw Bill 1 rated their bill higher on ease of understanding and preferred this layout to the one they receive from their electricity provider, relative to both controls. Additionally, compared to HO_control, the average Canadian found the information on Bill 1 easier to understand. Bill 1 was also rated as presenting electricity costs more clearly, relative to HO_control, and was perceived to be less cluttered than the TH_control. Participants who saw Bill 1 had higher recall of the period in which the most amount (kWh) of electricity was consumed and had higher recall of the price in $/kWh for each TOU period compared to those who saw the TH_control.

Bill 5: Similar to Bill 1, the presentation of information and layout of Bill 5 was found to increase fluency and clarity. Compared to those who saw HO_control, participants who saw Bill 5 rated

their bill higher on ease of understanding and believed that the average Canadian would too. Bill 5 was also found to present electricity costs more clearly than both control bills. As with Bill 1, improvements in fluency led to improvements in recall. Compared to those who saw the control bills, participants who saw Bill 5 had higher recall of the TOU period in which the highest amount (kWh) of electricity was consumed, and of the price in $/kWh for each TOU period over those who saw TH_control. Additionally, participants in the Bill 5 condition also displayed higher recall of the total dollar charge for on-peak electricity, which like in the Bill 1 condition, was saliently presented in the price clarity visual, but also contained an on-peak TOU consumption visual that was not present in Bill 1.

Click Tracking

Compared to HO_control, participants who saw Bill 1 were more likely to click (greater number of participants clicked) and clicked more (mean number of clicks per participant were higher) on the TOU illustration ($p < 0.05$ for both measures). Across all conditions, there was a positive relationship between clicking this region and recall of start and end times of the most expensive period, ($p < 0.001$).

Compared to the HO_control, participants who saw Bill 5 were more likely to click on, and clicked more on the TOU price breakdown region (price clarity manipulation),($p < 0.05$ for both measure). Across all conditions, frequency of clicks into this regions, improved recall of $/kWh for each TOU period ($\beta = -1.33$, $p = 0.01$) and total charge for the on-peak price ($\beta = 0.02$, $p = 0.03$). Additionally, clicking into ($\beta = 0.24$, $p < 0.001$) and clicking more ($\beta = 0.07$, $p < 0.001$) into this region increased motivation to shift electricity consumption to off-peak periods. Additionally, we found that compared to TH_control, participants who saw Bill 5 paid greater attention (assayed by number of clicks) to the TOU period consumption visual, but this effect did not achieve significance.

Recommendation: Based on these findings, we recommend that Bills 1 and 5 be tested in-field to measure their efficacy in leading to real world changes in electricity consumption behavior

2. Specific Bill Features that improved fluency and recall in specific Bills.

- **Changes to the TOU breakdown region to improve price clarity were successful across the board.** Bills 1 – 5 highlighted usage and costs for each TOU period via the TOU salient visuals and the TOU salient visuals with shapes. These designs used larger fonts, used additional white space around the associated costs, used traffic colours to colour-code each period, placed the costs in discreet boxes so as to make the information easier to parse visually, and highlighted the most expensive period by including a message above the on-peak breakdown indicating that it was the most expensive time of day. Participants who saw any of the newly designed bills (Bill 1 – 5) found electricity costs to be presented

significantly more clearly than HO_control ($p < 0.05$ for all comparisons between any of Bills 1 - 5 and HO_control).

- **Participants had better recall of the TOU prices when it was presented in cents than when it was presented in dollars.** Participants were asked to recall the TOU rates for each period using a slider scale. This allowed us to analyse the difference between the recalled amount and the actual amount. Within this analysis, the smaller the absolute difference (magnitude of error), the better the recall. Participants who saw TOU prices presented in $dollars (TH_control and TH_VC) had a larger magnitude of error than all the other bills (including HO and HO_TC), all of which had their TOU prices in cents ($p < 0.05$ for all comparisons between any of the bills that presented the rates in cents and TH_control and TO_VC).

- Participants who saw a sad emoticon as the consumption benchmark were more likely recall the total charge for on-peak usage, compared to HO_control. Participants in bill conditions 3, 4, and 5, in which the consumption benchmark was a sad emoticon, had a much higher level of recall of the total charge during the most expensive period than those who saw HO_control ($p < 0.05$ for comparisons between any of Bills 3,4,5 and HO_control). Thus it appears that the presence of the negatively valenced emoticon potentiates attention towards the highest cost of consumption.

- **Participants clicked more often, and with higher likelihood, on the TOU Salient visual with shapes**. First, as is highlighted in part 1 of the main findings, there was a positive relationship between likelihood to click and number of clicks on the TOU price break down region, and recall of the TOU prices, as well as total charges for the most expensive period. Participants in conditions Bill 4 and 5 were more likely to click on (average number of participants who clicked) and clicked more on (average number of click per participant) elements within this region than HO_control ($p < 0.05$ for both comparisons). This suggested that Ontarians are more likely to attend to the TOU Break Down region when the prices are separated by different shapes.

- Placing important information on the back of the bill (e.g., fixed costs or total amount due) near the TOU illustration increased likelihood to click on the region. For all bills, the TOU illustration was placed on the back of the bill. Participants who saw Bill 1, 2, 3, and 4 were more likely to click on the region than HO_control ($p < 0.05$ for comparisons between any of Bills 1,2,3 and 4 to HO_control), which presents the same information in a table form. Additionally Bill 1, 2, and 4 had more clicks in the region than the HO_control. This finding suggests that having important information on the back of the bill near the TOU illustration increases the likelihood that a person will attend to the image ($p < 0.05$ for comparisons between any of Bills 1,2 and 4 to HO_control).

- Placing the total amount due on the back of the bill and underneath the TOU illustration reduced recall of the start and end time of the most expensive period. Surprisingly, compared to all the newly designed bills (Bills 1 – 5), participants who saw Bill 2 were the only group who did not improved their recall of start and end times of the most expensive period over TH ($p>0.05$). This may be a result of the Total Amount Due shifting attention

away from TOU illustration, as this was the only difference between Bill 1 and 2 and likelihood to click into this region and number of the clicks was the same for both bills.

- **Labelling the most expensive period as "Most Expensive" reduced recall of the name.** Participants who saw either Bill 4 or 5 (wherein Peak periods were labelled as "most expensive) had the lowest level of recall of the name of the period with the highest electricity price, and this was significantly different from both controls ($p < 0.05$ for comparisons of either Bill 4 or 5 to TH_control or HO_control). Notably, looking at the option that participants selected instead of the right answer, two thirds of participants who saw either Bill 4 or Bill 5 chose the option "High Peak Price", which, of the answer options, was closest to "On-Peak" or "Peak" pricing – the currently used names in Ontario. Given that Bill 4 and 5 have the highest number of clicks in TOU price break down regions, i.e. this region received a significant amount of attention, this suggests that participants likely chose the most "probable" answer (based on their knowledge of the current period name in Ontario). Nonetheless, the results of our Nudge Panel Experiment concerning naming schema indicated that price focussed names such as "most expensive" led to greater recall. Thus we would recommend testing this further as there may be a habituation period wherein consumers would get acclimatized to a new name, but that after this period, greater recall of a price-focussed may translate into greater desire to conserve/greater shifts to less expensive periods of electricity consumption

- Participants who saw Bill 1, 2, and 3 were less motivated to shift their electricity usage to off-peak periods than those who saw the TH_control. Bills 1, 2, and 3 were identical, except Bill 3 had a different consumption benchmark (sad emoticon instead of a wide house) and Bill 2 positioned the total amount due on the back of the bill instead of the front ($p<0.05$ for comparisons between any of Bills 1, 2, and 3 to TH_control). We have to be cautious when interpreting these findings as stated intentions may not reflect real world behavior. For example, DVD-rental records reveal that people tend to rent 'highbrow' films first (documentaries, art films, etc.) but postpone watching them in favor of 'lowbrow' action and comedy films rented later.[129] In another study, shoppers using an online grocery store tended to order healthier foods when ordering several days in advance compared to when they ordered for the next day.[130] Consequently, although participants may state that they feel less motivated to shift their recall, improvements in fluency and recall of pricing and TOU information may be significant forces in driving real-world behaviour.

3. Answering Additional Specific Questions

Did changing the consumption visuals (TH_VC and HO_VC Bill conditions) alone have any effect on the key measures?

[129] Milkman, K. L., Rogers, T., & Bazerman, M. H. (2009). Highbrow films gather dust: Time-inconsistent preferences and online DVD rentals. Management Science, 55(6), 1047-1059.
[130] Milkman, K. L., Rogers, T., & Bazerman, M. H. (2010). I'll have the ice cream soon and the vegetables later: A study of online grocery purchases and order lead time. Marketing Letters, 21(1), 17-35.

- **Adding the consumption visual to HO_control increased the ease of understanding information on the bill.** On average, participants in the HO_VC condition rated their bill as easier to understand for both themselves and the average Canadian relative to the HO_control bill, but the differences were not significant. However, as a result of this lift, HO_VC was found to be just as easy to understand as the new designed bills (Bill 1 – 5) ($p>0.05$ for comparison between any of Bills 1 – 5 and HO_VC).

- **Across both controls, changing the depiction of visual consumption improved the layout of the bill.** Preference for the new layout versus what is currently received in the mail was higher for participants in the HO_VC and TH_VC bill conditions. Although this difference did not achieve significance in statistical testing ($p = 0.25$), the lift again resulted in the HO_VC and TH_VC performing just as well as the new designs ($p > 0.05$ for comparison between any of Bills 1 – 5 and HO_VC or TH_VC).

- **Adding a consumption visual to the Toronto Hydro Bill made the bill more offensive.** Participants who saw the TO_VC bill found the bill to be 20% more offensive than those who saw the TO_control ($p = 0.01$).

Did using a sad face emoticon instead of a wide house influence how people responded to the bill?

- When usage is framed negatively (i.e. current month's consumption is greater than the previous months) using a wide house instead of a sad face emoticon improved participant's preferences for the bill. Bill 1 was the exact same as Bill 3 except for a different consumption benchmark (wide house instead of a sad emoticon). Compared to the current bill they receive from their electricity provider, Bill 1 was found to be preferred over both controls ($p<0.05$ for both comparisons), whereas Bill 3 was not significantly different from TH_control or HO_control.

Did placing the Total Amount Due on the back of the bill increase the number of people who attended to the back?

- Participants who saw Bill 2 were more likely to turn to the back compared to TH_control, but not significantly differently than the other bills ($p>0.05$ for all comparisons). It appears that having fixed charges on the back of the bill (Bills 1- 5) was motivating enough to get people to look at the back of the bill.

- **Placing the Total Amount Due on the back of the Bill increased the perception of clutter on the bill.** Bill 2 was rated as having too much information on the bill compared to Bill 1, even though they differed only in the Total Amount Due, that was moved to the back of the bill ($p = 0.02$).

Did adding the sad child face influence how people responded to the bill?

- Pairing a picture of a child with a sad face to a negative framed social benchmark (the sad emoticon) made the bill appear less offensive. Participants who saw Bill 4 (only sad emoticon) found the bill significantly more offensive than Bill 5 (sad emoticon + sad child's face). Interestingly, as mentioned in the previous section, Bills 4 and 5 are exactly the same, except for the picture of a child with a sad face in Bill 5, suggesting that having the picture of the sad child may have reduced the negative affect known to be associated with sad/disapproving faces ($p = 0.02$).

- **Participant's who saw a picture of a child with a sad face, did not feel more guilty.** Based on previous studies that have noted the effect that images of sad children can have in increasing charity donations, we hypothesized that an image of a sad child on the bill would increase conservation intentions, possibly driven by increased feelings of guilt. Participants in the Bill 5 did not report feeling more guilty than participants who viewed Bill 4 ($p = 0.55$). Plausible explanations for this could be that there is a negative interaction of the affective image with other elements on the bill, reducing its impact, or that increased intentions to donate or conserve are not necessarily mediated by guilt.

Do the new layouts influence how people interact with pledges?

- **Participants were less likely to sign a pledge with a social message if the bill contained an image of a sad child's face.** Bills 1, 2, and 3 were paired with a pledge that contained an informational message. Bills 4 and 5 were paired with a pledge that contained a social message. Overall, participants who saw a pledge were more likely to read it after receiving it than do any of the other options presented – throw it away, post it, or sign it. Participants who saw Bill 5 were significantly less likely to read it than participant in Bill 1 and 4 ($p < 0.05$ for both comparisons). Importantly, Bill 4 and 5 were the same except for the addition of the sad faced child, suggesting that this image may have influenced how participants perceived the pledge.

- Across all pledges, participants who signed the pledge were more motivated to shift their electricity usage to off-peak periods ($p < 0.001$).

What factors improved intentions to conserve electricity?

- Participants across all conditions were found to be less likely to engage in behaviors that required more hassle to complete, such as washing their dishes by hand instead of running the dishwasher. The stated likelihood to do any of the 5 electricity conservation behaviors did not significantly differ across conditions. For example, participants across all conditions were equally likely to wait until after 7 to run their dishwasher and turn off lights in a room when it not occupied. Similarly, across all conditions, they were less likely to state that they would follow through with unplugging silent electricity consumers when not in use and wash their dishes by hand instead of running the dishwasher.

- Across all bills, there was a positive relationship between number of clicks on the billand motivation to reduce electricity consumption. The more participants clicked on the bill, the more motivated they were to behave in ways that would reduce electricity usage.

- Across all bills, participants who clicked into the TOU Break down regions were more motivated to reduce their electricity consumption.

What factors improved intentions to shift to off peak usage?

- **Across all bills, there was a positive relationship between clicks on the bill and motivation to shift to off-peak usage** ($\beta = 0.03$, $p < 0.001$). Participants who clicked on the bill more (overall), were also more motivated to do behaviours that would reduce electricity usage. In particular:

    - Across all bills, participants who clicked on ($\beta = 0.24$, $p < 0.001$) and more ($\beta = 0.07$, $p < 0.001$) on the TOU Price breakdown regions were more motivated to shift their electricity usage to off-peak periods.
    - Across all bills, participants who clicked on the TOU Consumption Visual (β = 0.36) and clicked more (β = 0.22) were more motivated to shift their electricity usage to off-peak periods ($p < .001$ for both β's).

Implications and recommendations

The results from the current experiment demonstrate that element redesigns can increase fluency, clarity, and recall of information. Presumably, these factors can also motivate behavioral change and impact electricity usage. While recall and comprehension based measures explicitly test for changes in information processing, questions about intentions/motivations are harder to extrapolate to real world behaviors due to known say-do gaps between intentions and actions. Consequently, our over-arching recommendation is to utilize the conclusions from this experiment to inform a field study that will allow for the measurement of real world conservation behaviors.

Overall learnings from the Bill Statement Experiment include:

- Bills 1 and 5 performed the best across a number of key measures. Both bills scored high on fluency, clarity, and recall compared to controls. As both bills are different variations of the top-performing elements in each *Nudge Panel Experiment*, we recommend testing these elements in the real world to change behaviour.

- Both of our changes to the TOU breakdown region improved clarity and recall of information. Additionally, participants who saw the TOU salient image with shapes, in particular, clicked more on the region and had better recall of the information, relative to the controls. Consequently, we recommend testing the TOU salient image with shapes, along with our proposed changes to the TOU break-down region, in a in-field experiment

- Presenting TOU prices in cents rather than $ improved recall of the price. Given that price is used as the primary lever to deter on-peak usage, having better recall of the TOU prices may improve the effectiveness of this lever. We recommend presenting TOU prices in cents.

- Just as we found with the *Click-Tracking experiment,* placing important information on the back page (e.g., fixed costs or Total Amount Due) causes people to look at the back, providing more real estate that is attended on the bill. If attending to the back of the bill is a desirable behaviour, we recommend placing important information in the back.

- Although a sad emoticon can have a powerful impact on behavior, it also offends people. This experiment demonstrated that placing a picture of a sad child near this emoticon reduced how offended people felt. We recommend further tests using affective images to drive conservation behaviours while mitigating any negative repercussions caused via offensiveness.

- Pre-commitment through pledges can be an effective way to change behaviour. Participants who saw bill 5 were found to be less likely to read the pledge that contained a social message.

Conclusion

Time-of-Use pricing strategies charge differing amounts for energy depending on when it is used. The introduction of smart meters in Ontario has allowed for the deployment of TOU pricing aimed at encouraging demand-shifting behaviors through incentivizing electricity consumption to less expensive "off-peak" periods and away from more expensive "on-peak" periods. Although previous research from other jurisdictions has indicated that TOU pricing can produce a significant impact on consumer behavior, it has met with limited success in Ontario.

*A prio*ri, it is unclear whether the failure to shift usage to off-peak periods is due to a lack of incentive – indicating that alternative pricing strategies should be experimented with, or simply a lack of comprehension of TOU pricing / a failure to frame the pricing in the most motivating way – indicating that the forms in which TOU are communicated should be improved through empirical testing. The studies presented in this report are aimed at the latter consideration because it is unclear if the large investment that the province and utilities have already expended on advanced metering infrastructure has met its full potential. In order to asses this, we needed to better understand non-monetary factors affecting consumer understanding, memory and motivation. Since the electricity bill is a reliable (from the perspective of the consumer) and cost effective (from the perspective of the OEB/Utilities) communication channel, with 85% of Ontarians claiming to read their bill (83% when it's online), we decided to focus our efforts on assaying what Ontarians currently attend to on their bills, subjecting exemplar current bills to a behavioral diagnostics assessment, and empirically testing a wide range of potential redesigned bill elements as well as newly compiled bill statements.

Our initial survey assessed the current level of awareness and comprehension of TOU pricing among Ontarians. We found that while awareness of TOU pricing was relatively high, comprehension of the TOU program as a whole was low. Additionally, consumers overestimated their understanding of the program, but underestimated their own energy consumption – 83% of survey respondents believed that their household consume about the same amount of electricity or less, compared to similar households – a statistical impossibility! These inaccurate beliefs about their consumption, in conjunction with the finding that hassle costs associated with breaking current habits are rated as the most important reason for not shifting to off-peak consumption, indicate that non-pricing levers that correct these beliefs, and can reinforce new habits, could be useful drivers of shifts in utilization.

Our *Click Tracking Study* used clicks as a proxy for attention, so as to understand what regions of the bill Ontarians typically attend to, and in turn, how this attention predicts subsequent comprehension and recall behavior. As predicted, we found that consumers who paid greater attention to the bill (indexed by number of clicks or total time spent looking at the bill), subsequently had higher recall of the information presented on the bill. Also unsurprisingly, the most attended to region of the bill was the total price – indeed, presenting the total price in the back significantly increased consumers' likelihood of looking at the back of the bill. Although overall recall of both TOU and usage information was poor, bills with visual depictions of consumption information received higher attention, and consumers who saw these depictions were more likely to remember information about their monthly consumption.

Armed with this information and noted issues with current bills as detailed in our behavioral diagnostics section, we designed a series of nudge panel experiments that tested optimized versions of different bill elements on an online pool of participants. The table below provides an overview of our main findings

Figure 54. Overview of Main Findings

Behavioural Intervention Points	Experimental Results
1. Unit of Price	Cents perform better on measures of clarity
2. Naming Schema	Price focused names = ↑ recall
3. TOU Visuals	Linear TOU visuals = ↑ recall & understanding
4. Peaksaver Plus offer	No significant difference
5. Price Clarity	Salient visuals + fix charges on the back = ↑ recall + comp
6. Pricing Extremes	5:1 ratio = ↑ control + recognition of peak consumption
7. Consumption: Visual	Vertical bars with salient comparisons = ↑ comprehension
8. Consumption: Benchmarks	Historical data, negative affect = ↑ Intent to conserve
9. Pledge	Multiple options, social pledges = ↑ intent to shift to off peak

Across the board, our manipulations were aimed at improving ease of processing (fluency), and reducing ambiguity of the information presented on the electricity bill. Previous research has indicated that increasing the fluency of presented information (simplicity, clear fonts, minimal text, visual formats etc.) is associated with increased experience of subjective ease associated with completing a task. Increased fluency is also linked to more efficient information processing, marked by higher recall, higher accuracy, and low resource demands.[131] Fluently presented information is evaluated more positively and is more likely to be perceived as more truthful and credible.[132] Conversely, ambiguity aversion speaks to our tendency to avoid decisions that are associated with a high level of ambiguity.[133] Given the low current understanding of electricity consumption costs under TOU, or indeed even the unit in which usage is measured (i.e., kWh), the ambiguity surrounding these multiple unknown elements, particularly in the absence of benchmarks or specific calls to action, might prevent consumers from making desirable (conservation) choices by making the status quo of *not* shifting behavior to align with TOU pricing seem like the less stressful and easier choice. We attempted to address this issue by increasing fluency so as to reduce ambiguity, as well as provide normative and benchmarking information that participants could use to compare their usage behavior against their own past behavior, the behavior of others, or provincially set goals for electricity usage. We found that a number of our fluency manipulations lead to higher recall and comprehension, while providing participants with benchmarking information or calls to action via pledges led to increased intent

[131] Oppenheimer, D. M. (2008). The secret life of fluency. *Trends in Cognitive Science, 12*(6), 237-241.
[132] Reber, R., & Schwarz, N. (1999). Effects of perceptual fluency on judgments of truth. *Consciousness and Cognition*, 8, 338–342.
[133] Epstein, Larry G. (July 1999). "A Definition of Uncertainty Aversion". *The Review of Economic Studies* **66** (3): 579

to conserve energy/shift to off peak usage. This finding may be particularly powerful, as changing behavior is the most critical goal for TOU pricing.

Informed by the nudge panel, our final *Bill Statement Experiment* compiled 9 different full bill statements using specific elements that performed best in the nudge panel. Two particular bill statement layouts outperformed other versions on key metrics such as attention, recall and fluency (detailed in section 3.0), but a number of the manipulations also led to increased performance on these and other measures in specific instances across the redesigned bills. In particular, we found that our changes to the depiction of the TOU price breakdown that were aimed at increasing price clarity, improved both noted clarity and recall of information across the board. Second, presenting TOU prices in cents rather than dollars improved recall of price. Third, we found that placing monetary information on the back of the bill potentiated attention to this region. Last, our data suggest that using an affective manipulation (a sad emoticon or a sad child's face) may be an effective way to drive conservation behaviors, although this effect needs to be explored through further experimentation.

Overall, several strategic directions emerge from this body of work. First, the current communication of TOU pricing in Ontario is not effective in promoting comprehension. Using a behavioral lens to re-engineer communication methods demonstrably increases comprehension of TOU, as validated through the scientific method detailed in this document. The data outlined here provide exciting insights into changes that can drive the shifts in consumption that TOU was intended to motivate. These behavioral insights will also remain consequential as the province considers additional load-shifting or demand-response strategies such as CPP and CPP-R, **as well as coupling automated technologies with TOU (eg. Peaksaver Plus),** to mitigate potential long terms effects of uncurbed peak demand. Motivating consumers to stimulate increased adoption of TOU via consumer-centric communication strategies is a cost effective and manifest direction. We recommend that the insights reported here be given due consideration via a large-scale in-field test in partnership with Ontario's LDCs to further streamline and validate these and related strategies, ultimately bringing about real world changes in electricity consumption behavior.

About BEworks

Founded in 2010, BEworks specializes in applying behavioral economics to real-world challenges. It is the world's first commercial firm dedicated to the specialty practice of behavioral economics. Our team unites leading academics from the fields of cognitive and social psychology, neuroscience, and marketing with management consulting experts.

BEworks uses sound research practices to help businesses and policy-makers tackle their most pressing challenges. Our tried-and-tested methodology helps explain – and nudge – consumer decision-making. We design experiments that empirically validate our interventions, to provide organizations with a clear line of sight on ROI. As part of our implementation process, we help organizations embed "behavioral economics thinking" into the DNA of their culture and practices.

As a company, BEworks is in its own category. We are not a market research, branding, advertising, analytics, or strategic advisory firm. Rather, we are in the business of changing behavior using behavioral economics principles and experimentation. Our work can be applied to marketing, communications, workflow, specialist challenges such as fraud, or any other area where there is reliance on human decision-making. In addition to having leading behavioral economists as founders of our firm, we have extensive experience and a diverse portfolio in the application of behavioral economics, unmatched by any other firm.

BEWORKS

BEworks Inc.
317 Adelaide St West
Toronto, ON M5V 1P9
Canada
phone: (416) 920-1921
email: info@BEworks.com
Twitter @BEworksInc