SUMMARY

The Impact of Real-Time Feedback on Residential Electricity Consumption: The Hydro One Pilot

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Study Overview

A pilot study[1] was undertaken by Hydro One to determine whether provision of a real-time feedback device is sufficient to empower residential customers with the information needed to reduce their electricity consumption. The pilot was intended to establish whether use of such a device can help customers save money and be an aid in promoting a "conservation friendly" culture. The objective of the pilot was to assess whether real-time feedback is effective and to determine, from change in usage data, if behaviour of the participants could be quantified as energy savings. In this study, we have established a quantitative level of energy savings at the household level that can be linked to the provision of a real-time feedback monitoring device in the home.

In the summer of 2004, participants in Hydro One's Real Time Monitoring Pilot began using real-time feedback monitors. The monitor provided direct instantaneous feedback on a household's electricity consumption. In comparison to previous pilots and demonstration projects regarding feedback provided by real-time monitors, the sample size of the Hydro One pilot is very large. Over four hundred pilot participants and control customers were followed over a 2.5 year period. The participants were chosen from five regions in Hydro One's service territory (Barrie, Brampton, Lincoln, Peterborough and Timmins) that covered a wide variation in geography and weather. Within the sample there is also a rich diversity representing a great variety of configurations in space heating, cooling, water heating, appliance configurations, household income, educational levels and other demographic characteristics.

The pilot is unique in that only the impact of feedback on consumption information was being tested. A panel based econometric methodology was used to control for factors such as weather, appliance stock and demographic factors that could influence the level electricity consumption in a household. The impact of the real-time feedback monitor was quantified by comparing electricity usage (kWh) against the prior year.

The Technology

Direct instantaneous feedback is shown as a visual display by the PowerCost Monitor™ manufactured by Blue Line Innovations Inc. This monitor has many features designed to provide the homeowner with information regarding their electricity consumption and the cost of that consumption. The monitor that was used in this pilot displayed consumption in dollars per hour, total dollars and predicted dollars. Consumption was also displayed in current kWh, total kWh and predicted kWh. In addition to these features, the user was also able to view the current carbon-dioxide emissions, total carbon-dioxide emissions and predicted emissions, as well as the outside temperature. A key feature of the monitor is complete portability within the home and gives the user the option to view energy consumption from any room in a house.

The PowerCost Monitor™ comprises a visual monitor that receives a signal from a transmitter attached to the meter outside the house. The transmitter is attached to an existing electro-mechanical utility meter with a ring clamp that can be self-installed by a home-owner without requiring the services of a qualified electrician. The transmitter tracks the electricity consumed

[1] The study was conducted by Professor Dean Mountain, McMaster Institute for Energy Studies & DeGroote School of Business, McMaster University, Ontario

by counting the turns of the meter disk and it continuously sends a wireless signal to the in-home visual display showing electricity consumption and cost in real-time.

Pilot Study Evaluation

In order to quantify the impact with a desired level of statistical accuracy at the 95% confidence level, a stratified random sample was designed to cover the geographic territory of Hydro One's service territory and to capture a wide variety of consumption patterns. Within each region, six kWh strata were chosen. The original sample, comprising 500 customers, was provided with the real time monitor and 52 control customers were chosen who were not given the real-time monitor.

In order to assess the impact of the real-time monitor on electricity consumption, the electricity (kWh) usage was monitored from the date of initial installation until September, 2005. Monthly reads of the meter data were taken to enhance accuracy of the kWh monitoring once the real-time monitor was provided to the customer. Usage data was also collected for all pilot participants prior to the real-time monitor being made available for a period of up to 18 months.

Customer usage was tracked over two and a half years including the pre-experiment period. All the key variables such as weather, demographic factors and appliance installations or changes in the residence were accounted for and controlled in the model analysis. In addition, three customer questionnaires were administered, one at the beginning of the pilot, one at the midpoint and one at the end to capture information on qualitative factors such as ease of use, changes to dwelling characteristics (such as square footage, age of dwelling) or appliances.

Results

The results indicate a significant positive impact on customer usage. An important observation from the study is that the behavioural response remained persistent and did not decrease over time during the study period.

Overall, the aggregate reduction in electricity consumption (kWh) across the study sample was 6.5% at a high level of statistical accuracy.

- For households with non-electric space heating, the aggregate reduction in energy consumption was 8.2%. Within this sample a reduction of 5.1% is observed for a house that has non-electric water heating house and non-electric space heating. However, a large reduction of 16.7% is observed for a non electric house but with electric water heating.
- For households with electric space heating, the impact of real time feedback is low showing a reduction of about 1.2%. However, we observe for Lincoln (our southern most region of the sample) a conservation impact of 3.4% for households with electric pace heating compared to 6.7% for non-electric space heating.
- A lesson learned is that separating out the feedback from the electric heating load and the rest of the load would be required to encourage conservation in this sector.
- Consistent with previous studies, income and demographic factors had no impact on the responsiveness to the monitor.

No other price or conservation incentives were given to participants in the study. Therefore, the conservation results observed in the pilot are interpreted as the minimum to be garnered in the absence of other possible conservation incentives. Thus, if a real time feedback monitor is used in conjunction with the provision of additional literature and tips on conservation or price measures, an overall average reduction of between 7% and 10% is feasible.

Customer Satisfaction

Our findings show a very high level of satisfaction with the real-time monitor. According to questionnaire statistics, 60.5% of the participants felt the monitor made a difference in their homes. The majority of the participants, 65.1%, reported that they planned to continue using the monitor after the pilot was complete. When asked how useful they found the monitor in helping them conserve energy, 63% of the participants ranked the monitor 3 or greater on a scale of 0 to 5.

Conclusions

1) A primary finding of the pilot study is that real-time feedback of energy consumption is effective in promoting conservation. The results are statistically significant and support the hypothesis that real-time feedback of consumption and cost encourage conservation.
2) Overall, the average aggregate reduction in energy consumption across the whole study sample was 6.5%.
    i) Within this sample, non-electric heating households are showing a significant conservation impact or reduction in energy consumption of 8.2%. Within the non-electric heating group, the range in reduction is from 5.1% (for a non-electric water heating house) to 16.7% (for an electric water heating house).
    ii) The aggregate reduction for households with electric space heating was low at a level of 1%.
3) The results indicate a sustained response over the study time period and this finding is important for larger deployment of such a device. No reduction in conservation response was detected through the duration of the pilot.
4) Qualitative feedback from participants was positive: over 60% of the participants were generally very pleased with the performance and usefulness of the real-time monitor in helping them reduce energy consumption and manage their costs. Even the participants in homes with electric space heating, showing a low level of reduction, considered the monitor useful.
5) An overall average reduction of between 7% and 10% is feasible if the real time monitor is used in conjunction with additional information and tips for energy conservation, financial incentives or price measures.
    i) The overall reduction of 6.5% observed in the study corresponds only to the impacts of real-time feedback. In this pilot study, no other price incentives or information on conservation was provided to the participants who were provided with the real-time monitoring device. Thus, these results are interpreted as the bare minimum impacts.
    ii) If the real-time monitoring is used in conjunction with other price and/or conservation measures, the conservation impact will be larger.