

Conservation Effect of Immediate Electricity Cost Feedback on Residential Consumption Behaviour

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Introduction

Demand management and conservation is actively promoted in most electric utility companies in Canada, the United States and other industrialized countries in the world. Over the past decade, concern for the environment and the finite nature of non-renewable energy resources has dictated increased emphasis in this partial solution for meeting future electricity demand.

Most demand management programs have focused on more efficient hardware to provide a similar level of service to the customer with no associated sacrifices. Efforts to change customer consumption behaviour have been largely based on providing conservation information.

Ontario Hydro has undertaken customer behaviour studies to determine the conservation potential of giving customers feedback which might assist them in reducing their electricity consumption. The first phase of this research started in 1991 with the development and testing of the Residential Electricity Cost Speedometer (RECS), which was developed as a research instrument for the

project. The RECS combines a sophisticated electronics and interactive software package with colour graphics. It measures household electricity consumption and provides cost/energy displays for various loads, such as: Range, Fridge, Dishwasher, Heating/Air Conditioning, Water Heating, Washer, Dryer, Lights & Plugs and Total. It provides feedback on an hourly, daily, monthly and annual basis: some of these are illustrated in Figures 1 - 3. The RECS was installed in 25 homes in order to measure the effect of immediate consumption and cost feedback of electricity end-use on customer behaviour.

The RECS is based on a personal computer equipped with a colour monitor and an analog-to-digital input system. The inputs are taken from voltage sensors and current transformers mounted on the circuits supplying the various loads being monitored. The instantaneous power is computed approximately every 3 milliseconds, averaged, and used to update the present-usage displays every 0.6 seconds.

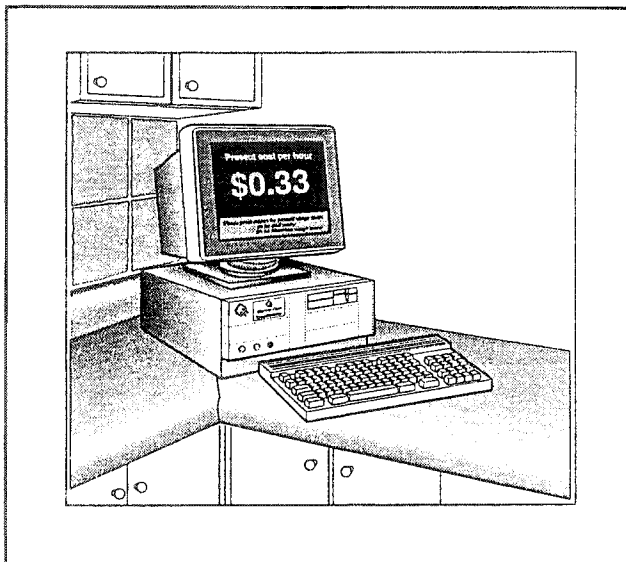


Figure 1. Residential Electricity Cost Speedometer (RECS) Indicating Present Cost Per Hour Display

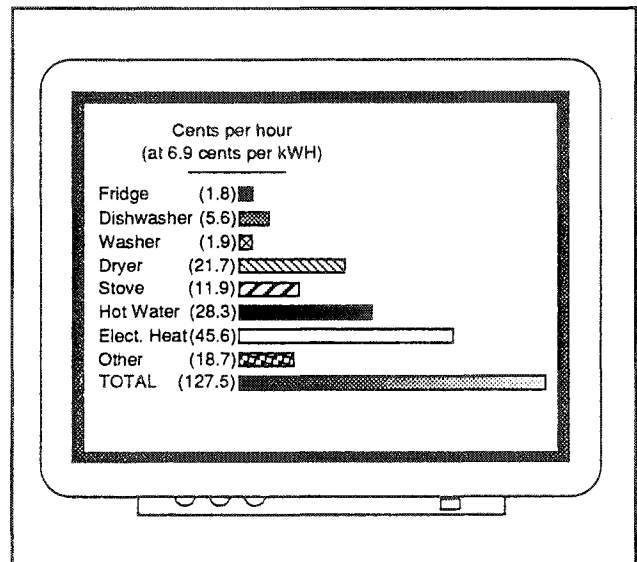


Figure 2. RECS Display of Present Electrical Usage (\$) by End-Use

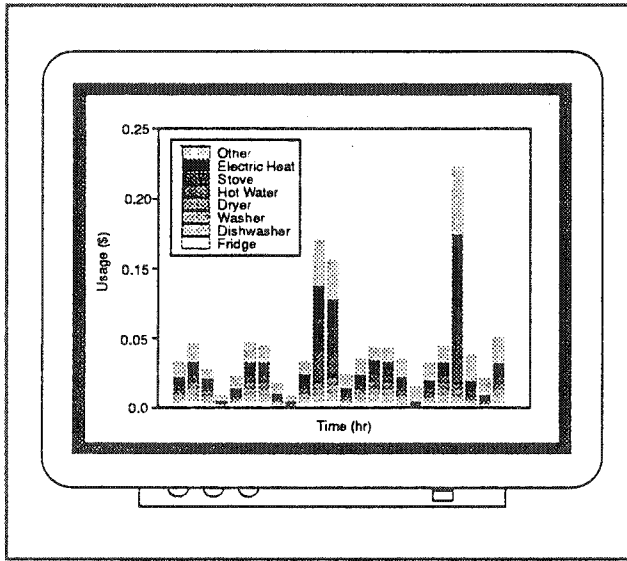


Figure 3. RECS Display of Daily Cost by End-Use

Methodology

In order to conduct this research, 100 all-electric households were qualified from a random sample drawn from a population of approximately 8800 such houses in the Newmarket, Ontario area. These 100 houses were randomly assigned to one of three groups: the RECS Group, who received the feedback device; the Contact Control (CC) Group, who were aware that their electricity consumption was being studied, but did not get the RECS and the No Contact Control (NCC) Group, who were not aware that their electricity consumption was being studied.

The hypothesis being tested was that immediate and specific electricity end-use feedback would result in conservation behaviour (>3%). The research plan called for measuring the total electricity consumption for a 60 day interval from January - April, 1992 for each group and comparing it with consumption for a similar 60 day interval from the previous year. In all cases, the data would be adjusted for degree day variations, since over 50% of electricity in the average all-electric home is used in space heating during this period of the year.

Results

The research findings displayed in Figure 4 show the average daily consumption for the RECS Group was 12.9% less than that of the combined control groups (the mean consumption for the NCC & CC were not found to be significantly different). The combined Control Group exhibits a constant pattern of consumption in both 1991 and 1992 in contrast to the reduced consumption of the

RECS Group after they receive continuous feedback. The amount of customer conservation behaviour elicited by the presence of the RECS was far greater than that anticipated by the researchers and supports the hypothesis.

All electricity consumption data was recorded in kilowatt hours, normalized to 100% in 1991 and temperature corrected for degree day variation for 1991 and 1992 using the temperature data for the study area provided by Environment Canada.

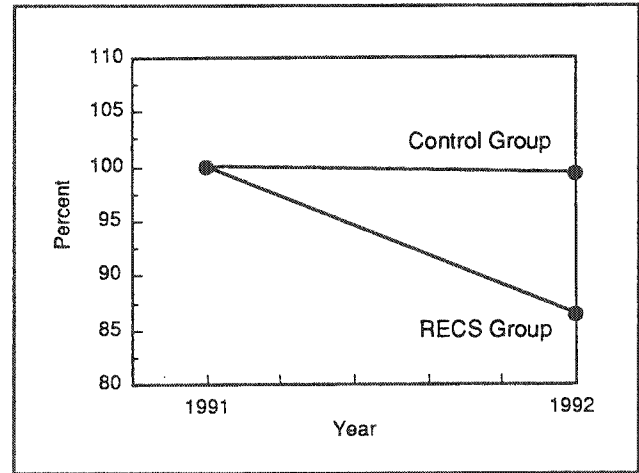


Figure 4. 1992 Temperature Corrected Average Usage (\$) as a Percent of 1991

The reduced consumption of the RECS group relative to the control group was statistically significant at the 95% confidence level, as reported in Table 1.

Table 1. Estimated 1992 Usages as a Percent of 1991 Consumption (see Figure 5)

| Control | RECS | Difference | Std. Error | Confidence |
|---------|------|------------|------------|------------|
| 99.3 | 86.4 | 12.9 | 6.46 | .954 |

The qualitative data gathered through customer contact and a post test interview indicate that the RECS Group was conditioned by RECS and began thinking about their electricity usage in ways not possible without specific feedback. For example, two RECS households contacted Ontario Hydro for information on replacing their resistance heating systems with heat pumps. The RECS Group also reported increasing their use of RECS over the 60 day test and found it useful in helping them save

electricity. The consumption data displayed in Figure 5 are consistent with the interview data. This figure also indicates a persistence of conservation behaviour over the 60 days with electrical consumption declining by approximately 5% over the 60 days.

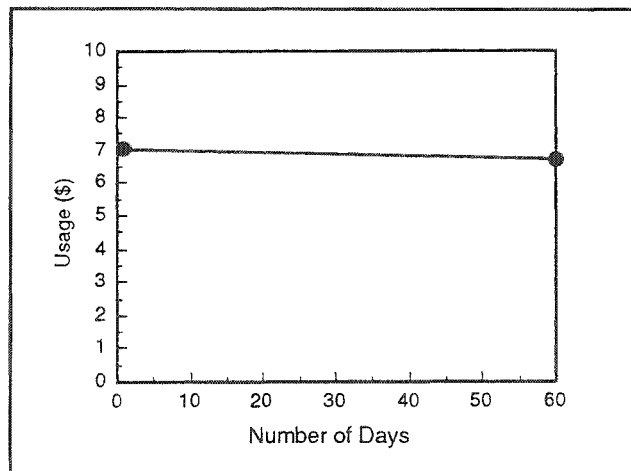


Figure 5. Temperature Corrected Average Usage (\$) for the RECS Group in 1992

Discussion

In the future, social and behavioural change may play an ever-increasing role in demand management and utilization of energy resources. This research focused on feedback of electricity consumption and cost to the customer in real time and measured the spontaneous behavioural response that occurred and the large associated reduction of electricity consumed. Immediate feedback may become one of the central components in promoting conservation behaviour.

The next phase of this research will pair RECS feedback with conservation information after which electricity consumption will be measured. In further research, the feedback and information pairing will be examined in terms of the conditioning effect on customer choice in their future purchasing decisions of electricity-consuming hardware. The customer interview data suggest a pattern of large step change reductions in consumption might be expected as customers replace standard efficiency heating and electrical appliances with highly efficient replacements

and undertake other conservation upgrades to the thermal barriers of their homes.

In this study, the reduction in electricity consumption over a 60 day period was substantial; however, further research is required over a 2-3 year period to determine whether this level of conservation can be replicated and maintained. Ontario Hydro will be developing research plans in this area and would entertain enquiries/proposals for joint research from utilities, institutions or organizations.

Acknowledgements

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