Understanding Behavioral Savings in the Commercial Sector

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Power Smart Evaluation
Overview

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- Literature Summary
- Program Description
- Approach
- Results
- Key Learning’s
Introduction

- Over the past five years, there has been a renewed interest in the potential role of energy conservation in reducing energy consumption and related harmful emissions.

- In some ways, this renewed interest in energy conservation is similar to the Integrated Resource Planning initiatives of the 1980s, which emphasized that demand-side and supply-side options should be placed on an equal footing.

- But one area where this renewed interest in energy conservation differs from the past lies in the increased awareness that technical solutions and financial subsidies are not enough to bring about appropriate market transformation.
Introduction

- BC Hydro intends to meet 50% of the expected growth in electricity demand over the next 20 years through energy conservation.

- BC Hydro recognizes that traditional energy conservation activities need to be supplemented in such areas as energy codes & standards, conservation rates & behavioral change activities.

- This presentation reviews BC Hydro’s e.Points Bonus program which was a major initiative aimed at encouraging behavioral, operations & maintenance (BOM) savings in the commercial & industrial sectors.
Past research on energy conservation has been dominated by an **engineering economics** paradigm, in which agents adopt technologies & practices which are cost effective.

Analysis of opportunities typically proceeds by estimating life cycle costs & assuming that the technologies & practices with the best **life cycle costs** will be the ones adopted.

The rich **behavioral literature** on how customers actually make decisions on choice of technologies has had, until recently, relatively little impact on conservation policies.
Increasing evidence indicates that customers do not automatically adopt technologies with the lowest life cycle costs – this has led to a useful literature on market barriers & social marketing.

This suggests the need to re-examine the role of energy users in securing conservation benefits & to build a model to understand why some customers adopt energy conserving technologies & practices while others do not adopt them.
Program Description

- **e.Points Bonus** was a **five-year Power Smart initiative** launched in 2002 to recognize & reward large commercial & industrial customers who achieved a 5% reduction in electricity across all their eligible accounts.

- Customers who **reduced their overall electricity intensity by 5%** were awarded e.Points dollars which could be used to fund additional hard-wired savings.

- The program thus had **two types of savings**: (1) savings associated with energy efficiency activities to meet the 5% target such as behavioral, operations & maintenance (BOM), and (2) hard-wired savings associated with the expenditures of the e.Points dollars.
Program Description

- **BOM savings** are associated with customer activities such as turning off computers lights (behavioral), re-commissioning existing control systems (operational), & cleaning heat exchangers (maintenance).

- Customer’s **energy intensity** was measured as the total kWh associated with its accounts divided by relevant base metric (building square footage).

- **Consumption was tracked** on the program website, & if the goal was met in a given year, the e.Points were rewarded & the baseline reset, but if the goal was not met, additional time was allowed to meet the goal.

- The **formula** for determining e.Points was as follows:
  \[
  \text{e.Points awarded} = \text{baseline (kWh/year)} \times 0.05 \times \$0.04/\text{kWh}
  \]

  Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Approach

- The study is based on a random survey of program participants & non-participants.
- Participants were defined as Power Smart Partners who joined e.Points Bonus, while non-participants were Power Smart Partners who did not join e.Points Bonus.
- Survey asked detailed firmagraphic, behavioral & attitudinal questions.
- This information was used to conduct a participation & impact evaluation, which is not reviewed here, as well as the present behaviour-focused study.
### Approach

Population frames were 151 participant customers and 160 non-participant customers.

Analysis was based primarily on **z-tests for differences in sample proportions** between the participant group and the non-participant group.

<table>
<thead>
<tr>
<th>Frame</th>
<th>Sample</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>151</td>
<td>64</td>
</tr>
<tr>
<td>Non-part</td>
<td>160</td>
<td>51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>Share</th>
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<tbody>
<tr>
<td>64</td>
<td>42%</td>
</tr>
<tr>
<td>51</td>
<td>32%</td>
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</table>
Results

- Results are presented separately for 5 aggregated end-uses: lighting; cooling & heating; refrigeration; fans, pumps & equipment; domestic hot water (DHW) & cooking; as well as the total.

- Consumption per end-use is presented for 13 sectors: large grocery; hotel/motel; health care; high rise office; low rise office; library; recreation center; large retail; restaurant; elementary school; secondary school; wholesale; & miscellaneous.

- Energy efficiency improvements for each end-use are divided into: (1) hard-wired, technology actions and (2) behavior, operations & maintenance (BOM) actions.
Lighting Consumption

- Large Grocery
- Hotel/Motel
- Health Care
- Highrise Office
- Lowrise Office
- Library
- Recreation
- Large Retail
- Restaurant
- Elem School
- Second School
- Wholesale
- Miscellaneous

kWh/ft²/year

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
For lighting, the rate at which hard-wired technology installations occur is **substantially higher** than the rate at which behavioral, operations & maintenance actions occur.

For both technology & BOM actions, the difference in participant & non-participant percentage action rates are **statistically significant** at the 10% level (one-tailed test).

<table>
<thead>
<tr>
<th></th>
<th>Participant</th>
<th>Non-part</th>
<th>Difference</th>
<th>z-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>94%</td>
<td>84%</td>
<td>10%</td>
<td>1.67*</td>
</tr>
<tr>
<td>BOM</td>
<td>56%</td>
<td>43%</td>
<td>13%</td>
<td>1.40*</td>
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</tbody>
</table>
Cooling & Heating Consumption

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.

PS Evaluation
For cooling & heating, the rate at which hard-wired technology installations occur is **somewhat higher** than the rate at which behavioral, operations & maintenance actions occur.

For technology actions, the difference in participant & non-participant percentage action rates is **statistically significant** at the 10% level, while for BOM actions this difference is **statistically significant** at the 5% level.

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<thead>
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<th>z-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>73%</td>
<td>59%</td>
<td>14%</td>
<td>1.65*</td>
</tr>
<tr>
<td>BOM</td>
<td>63%</td>
<td>41%</td>
<td>22%</td>
<td>2.28**</td>
</tr>
</tbody>
</table>

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
Refrigeration Consumption

- Large Grocery
- Hotel/Motel
- Health Care
- Highrise Office
- Lowrise Office
- Library
- Recreation
- Large Retail
- Restaurant
- Elem School
- Second School
- Wholesale
- Miscellaneous

kWh/ft²/year

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
## Refrigeration Actions

<table>
<thead>
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<th>z-test</th>
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</thead>
<tbody>
<tr>
<td>Technology</td>
<td>39%</td>
<td>35%</td>
<td>4%</td>
<td>0.41</td>
</tr>
<tr>
<td>BOM</td>
<td>34%</td>
<td>27%</td>
<td>7%</td>
<td>0.80</td>
</tr>
</tbody>
</table>

- For refrigeration, the rate at which hard-wired technology installations occur is **similar to the rate** at which behavioral, operations & maintenance actions occur.

- For both technology & BOM actions, the difference in participant & non-participant percentage action rates are **not statistically significant**.
Fans, Pumps & Equipment Consumption

- Large Grocery
- Hotel/Motel
- Health Care
- Highrise Office
- Lowrise Office
- Library
- Recreation
- Large Retail
- Restaurant
- Elem School
- Second School
- Wholesale
- Miscellaneous

kWh/ft²/year

Reliable power, at low cost, for generations.
Fans, Pumps & Equipment Actions

For fans, pumps & equipment, the rate at which hard-wired technology installations occur is **substantially higher** than the rate at which behavioral, operations & maintenance actions occur.

For both technology & BOM actions, the difference in participant & non-participant percentage action rates are **statistically significant** at the 10% level (one-tailed test).

<table>
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<th>Non-part</th>
<th>Difference</th>
<th>z-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>62%</td>
<td>50%</td>
<td>12%</td>
<td>1.45*</td>
</tr>
<tr>
<td>BOM</td>
<td>44%</td>
<td>32%</td>
<td>16%</td>
<td>1.37*</td>
</tr>
</tbody>
</table>
**DHW & Cooking Consumption**

- Large Grocery
- Hotel/Motel
- Health Care
- Highrise Office
- Lowrise Office
- Library
- Recreation
- Large Retail
- Restaurant
- Elem School
- Second School
- Wholesale
- Miscellaneous

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
For domestic hot water & cooking, the rate at which hard-wired technology installations occur is somewhat higher than the rate at which behavioral, operations & maintenance actions occur.

For both technology & BOM actions, the difference in participant & non-participant percentage action rates are not statistically significant.
Total Consumption

- Large Grocery
- Hotel/Motel
- Health Care
- Highrise Office
- Lowrise Office
- Library
- Recreation
- Large Retail
- Restaurant
- Elem School
- Second School
- Wholesale
- Miscellaneous

kWh/ft²/year

Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations. Reliable power, at low cost, for generations.
### All Actions

For all actions, the rate at which hard-wired technology installations occur is **substantially higher** than the rate at which behavioral, operations & maintenance actions occur.

For both technology & BOM actions, the difference in participant & non-participant percentage action rates are **statistically significant** at the 1% level.

<table>
<thead>
<tr>
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<th>Non-part</th>
<th>Difference</th>
<th>z-test</th>
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</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>72%</td>
<td>37%</td>
<td>35%</td>
<td>3.72***</td>
</tr>
<tr>
<td><strong>BOM</strong></td>
<td>59%</td>
<td>36%</td>
<td>23%</td>
<td>2.52***</td>
</tr>
</tbody>
</table>

- **Participant**
- **Non-part**
- **Difference**
- **z-test**
Key Learning’s

- BC Hydro’s e.Points Bonus program encouraged business customers to examine & to change behavioral, operations & maintenance actions to save electricity.

- We examined the hard-wired, technology and the behavioral, operations & maintenance (BOM) actions of samples of participants & non-participants.

- Technology actions were substantially to somewhat more common than BOM actions for the:
  - lighting; cooling & heating; fans, pumps & equipment; and DHW & cooking areas,
  - but about the same for refrigeration.

- Participants were undertaking hard-wired actions at a significantly higher rate than non-participants for:
  - lighting; cooling & heating; and fans, pumps & equipment,
  - but not for refrigeration and DHW & cooking.
Key Learning’s

- Participants were also undertaking BOM actions at a significantly higher rate than non-participants for:
  - lighting; cooling & heating; and fans, pumps & equipment,
  - but not for refrigeration and DHW & cooking

- Although BOM savings will be in many cases the low-cost, no-cost options, some firms appear not to realize the significance of non-hard wired savings

- Additional utility activities in promotion, training & education with respect to behavioral, operations & maintenance savings appear warranted

- Case studies & manuals aimed at building owners & operators may be particularly useful in this regard
Key Learning’s: Potential Impacts of Conservation Change

- Present research suggests that there may be substantial opportunities for low cost-no cost measures to reduce consumption if current conservation practices are applied more broadly.

- Less is known about how to motivate agents to perform the desired conservation practices, & this will be the subject of future research.

- This research should be thought of as the beginning of a process to identify where opportunities lie as opposed to a comprehensive assessment.

- Specifically, we have been working with the Consortium for Energy Efficiency to understand how social marketing can be used to define the relevant behavioral problems, identify means of changing behavior & implement programs aimed at behavioral change.
References


References


References


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