

Billing Analysis & Environment that “Re-Sets” Savings for Programmable Thermostats in New Homes

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Introduction

- Hydro-Québec introduced energy efficiency program for electronic thermostat in 2003
- In 2007, Hydro-Québec hired Econoler to evaluate the program
- Obtaining reliable evaluated savings estimates for programmable thermostats is challenging
 - Program design created opportunity for comparative billing analysis



Concerns and Quebec's Unique Situation

- Past evaluations have found little to no energy savings from programmable thermostat programs in North America
- But different for Quebec!
 - 90% of homes use electricity for heating
 - Most homes have a thermostat for every room



Program overview

- Designed for residential new construction
- Offers incentives for electronic thermostat – programmable and non-programmable
- Very effective with a penetration of 80% of the market
- Information kept for each participant in program database



Methodology

- Focus on single family houses (25,703 customers)
- Analysis focussed on winter consumption (less noise in comparative billing analysis)
- Collection of electricity consumption for the last 3 years, totalling 206,861 observations (bi-monthly billing period)
- Collection of daily heating degree days for each period and each region



Methodology

-Outliers-

- Outliers criteria:
 - Billing periods which cover more than 80 days
 - Customers with average daily electric consumption smaller than 15 kWh
 - Customers whom own more than 30 electronic thermostats
 - Customers whom own more than 10 programmable thermostats
- After removing outliers, dataset totaled 178,354 observations



Methodology

-Analysis of Covariance-

- ANCOVA method was selected in order to correct for the non-random error that would be present in the billing analysis
- Will also reduce noise, making it easier to find program effects
- Model framework was:

- $E_{it} = B_1S_{it} + B_2W_{it} + C_{it}$

E: Average daily consumption

S: Dummy variable

W: Average HDD

C: Constant representing baseload



Analysis and Findings

- Compare single family dwelling with programmable thermostats and those with only non-programmable thermostats
- Test whether the presence of at least one programmable thermostat had an influence on electricity consumption



Analysis and Findings

- The coefficient for presence of programmable thermostats was negative (savings found) and its t-statistic was well over 2 at 12.97

<u>R-Square</u>		0.4226
<u>Variable</u>	<u>Coefficient</u>	<u>t-Statistic</u>
Presence of programmable thermostat	-1.74	-12.97
Average HDD	3.03	360.90
Baseload	29.98	204.82



Weather & Heating in a Cold Climate

- Extent of cold climate in Québec
 - Could be expected to create non-linear relationship between usage & HDD
 - Simple, common, non-linear (HDD) specification did not produce reasonable model
 - Both theory & data inspection suggested non-linear relationship



Analysis and Findings

Final billing analysis based upon models by 6 weather categories

Subgroups (HDD)	Subgroup weight based on weather database	Savings (kWh)	Weighted savings (kWh)	Cumulative savings (kWh)
0-5	7.48 %	64	5	5
5-10	16.69 %	136	23	28
10-17	31.34 %	562	176	204
17-22	18.06 %	705	127	331
22-27	14.12 %	597	84	415
27-35	12.31 %	156	19	434



Research Findings

- Maximum savings is reached for the 17-20 HDD subgroup (7 to -2°C)
- However, saving were shown to drop afterward
 - Hypothesis for non-linear relationship: Trade off between maintaining comfort & cost of energy bill was assumed to explain this pattern



Research Findings

- Annual savings for a single family home with at least one programmable thermostat was estimated to be 434 kWh
- Represents a reduction of 3.6% of the heating load
- Savings level per thermostat was then used to estimate expected savings within multifamily dwellings



Conclusion

- Model specification can made significant differences in program savings estimates
- Alternative model specification should be tested as indicated by program theory, past literature, thermal performance and behavioural theory

