

A New Residential Opportunity: Variable Speed Furnace Motors

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Power Smart

British Columbia Hydro

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BChydro 
powersmart

British Columbia



British Columbia Hydro

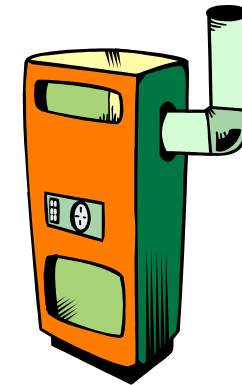
- 54,000 gigawatt hours of electricity annually
 - ▶ 92% large hydro
 - ▶ 2,500 GWh Power Smart annually
- 18,400 kilometres of transmission lines
- 55,700 kilometres of distribution line
- 95% of the province's population
 - ▶ 1.7 million customers



The Program

- **Collaborative Venture**

- ▶ Terasen Gas (investor owned)
 - furnace upgrade
- ▶ BC Hydro & Natural Resources Canada
 - furnace motor upgrade
 - \$150 2003
 - \$100 2005 – 2007
- ▶ Trade Allies and Suppliers
 - furnace dealers, heating contractors & gas fitters



The Technology

- Shaded Pole Motor – 10% to 25% efficiency
- Capacitor Start Motor
- Permanent Split Capacitor Motors
 - ▶ Single speed
- Direct Current Permanent Magnet Motors or Variable Speed Motors (VSMs)
 - ▶ Two speeds
 - 55% - 67% high speed mode efficiency
 - 34% - 39% low speed mode efficiency
 - ▶ Four speeds
 - 74% - 78% high speed mode efficiency
 - > 70% low speed mode efficiency



Program Logic Model



	Marketing	Motor Replacement	Furnace Replacement	Assumptions
Inputs	Customers and trade allies are aware of the advantages of variable speed motors	Financial incentives for furnace motor replacement	Financial incentives for furnace replacement	Offer is attractive to customers
Outputs	Expected number of residential customers participate in program	Variable speed furnace motor fans installed	High efficiency condensing furnaces installed	Level of take back is not significant
Purpose	Reduce energy use Increase customer satisfaction			Level of energy savings is significant
Goal	Reduce long-term energy acquisition costs Increase long-term system reliability			

Approach

Evaluation Issue	Main Data Sources	Method
Program review	Program stakeholder interviews Participant survey Non-participant survey	z-tests
Supply side assessment	Trade ally Survey Literature review	Cross tabulations
Demand side assessment	Participant survey Non-participant survey	z-tests
Market model	Trade ally surveys Official data	Multiple regression analysis
Energy and peak savings	Participant survey Non-participant survey	Engineering algorithms

Participant vs Non-Participant, Post Only, Quasi-Experimental Design

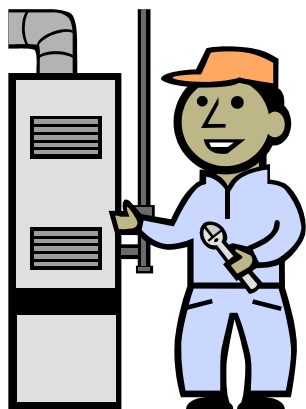
Consumer Surveys



Characteristics	Participants (n = 100)	Non-Participants (n = 100)	Difference	z-value
Share 55 or older	54%	63%	-9%	-1.29
Share married/common law	81%	71%	10%	1.66
Share completed university/college	39%	33%	6%	0.88

Consumer Awareness (before installation)	Participants (n = 100)	Non-Participants (n = 100)	Difference	z-value
Aware of the VSM	21%	17%	4%	0.72
Considering purchase of VSM	12%	6%	6%	1.48

Trade Ally Surveys



Trade Ally	Number	Percent
Furnace dealer and heating contractor	9	18%
Independent heating contractor	13	26%
Gas fitter	2	4%
All of the above	23	46%
Other	3	6%
Total	50	100%

Satisfaction with Program Components



Percent (%) Very or Extremely Satisfied

Satisfaction With:	Participants (n = 100)	Trade Allies (n = 40)	Difference	z-value
Information on the rebate	75%	66%	9%	1.40
Furnace types available for rebate	66%	74%	-8%	1.23
Procedures to obtain rebate	74%	72%	2%	0.32
Amount of rebate	62%	56%	6%	0.86

Supply Side Assessment



Retrofit Furnace Sales, 2003 and 2007

Year	Mid Efficiency Furnace	High Efficiency Furnace	Total
2003	5,485	5,704	11,189
2007	4,405	8,181	12,586

Retrofit Furnace Motor Sales, 2003 and 2007

Year	Permanent Split Capacitor	Variable Speed	Total
2003	4,923	6,266	11,189
2007	5,538	7,048	12,586

Supply Side Assessment



Retrofit Furnace Prices, 2003 and 2007

Year	Mid Efficiency Furnace	High Efficiency Furnace	Difference
2003	\$ 2,300	\$ 3,350	\$ 1,050
2007	\$ 2,738	\$ 3,493	\$ 755

Retrofit Furnace Motor Prices, 2003 and 2007

Year	Permanent Split Capacitor	Variable Speed	Difference
2003	\$ 256	\$ 769	\$ 513
2007	\$ 205	\$ 631	\$ 426

Demand Side Assessment



Importance of Factors Influencing Furnace System Choice (Percent (%) Extremely / Very Important)

Factor	Participants (n = 100)	Non-Participants (n = 100)	Difference	z-value
Comfort in your home	82%	82%	0%	0.00
Indoor air quality	67%	81%	-14%	2.26 *
Energy efficiency	85%	75%	10%	1.77
Initial cost	63%	67%	-4%	0.60
Operating cost	64%	71%	-7%	1.06

* indicates significance at the 10% level.

Consumer Satisfaction



Satisfaction with Furnace Attributes (Percent (%) Extremely / Very Satisfied)

Attribute	Participants (n = 100)	Non-Participants (n = 100)	Difference	z-value
Choice of furnace	86%	80%	6%	1.13
Price of your furnace	66%	66%	0%	0.00
Reliability of your furnace	90%	90%	0%	0.00
Ease of installation	76%	75%	1%	0.16
After sales service	56%	66%	-10%	1.45
Natural gas bill after installation	52%	60%	-8%	1.14
Electricity bill after installation	51%	61%	-10%	1.42

Free Rider Analysis



How important was the financial incentive in your decision to purchase a variable speed furnace motor?

	Very Important (5)	(4)	(3)	(2)	Not at all important (1)	Don't Know	Total	Free rider rate
Responses (n = 100)	26%	27%	17%	10%	13%	7%	100%	-
Weight	1.00	0.75	0.50	0.25	0	0	-	-
Product	0.26	0.20	0.09	0.03	0	0	0.57	0.43

APPROACH

- Objective is to estimate demand & supply model for variable speed furnace motors (VSMs)
- Both ordinary least squares & maximum likelihood methods were used
- Price for product i is determined by the presence of the program & year (perfectly elastic supply curve)
- Quantity of VSMs is determined by price & presence of the program (downward sloping with respect to the log of the price)

Market Model Results

- Results of the maximum likelihood are preferred
 - ▶ reduced auto-correlation & statistically significant at 5% level
- Presence of the program
 - ▶ increases variable speed furnace motor sales by 1,620/yr
 - ▶ reduces price of variable speed furnace motors by \$ 93
 - \$ 30/yr without program
- Presence of the program
 - ▶ Increases high efficiency furnace sales by 1,492/yr
 - ▶ Reduces price of high efficiency furnace by \$ 240
 - \$ 27/yr without the program



APPROACH

➤ Net Savings₂₀₀₇

= Average Annual Unit Saving₂₀₀₇ * Net Number of Units Installed₂₀₀₇

➤ Realization Rate₂₀₀₇

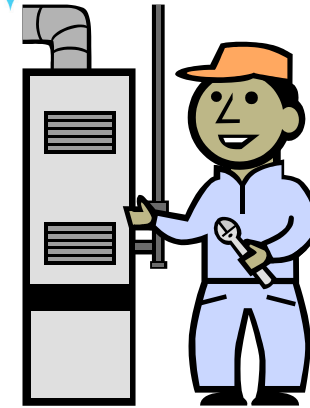
= Net Savings₂₀₀₇ / Program Reported Savings₂₀₀₇

➤ Program Net Savings₂₀₀₃₋₀₇

= Realization Rate₂₀₀₇ * Program Reported Savings₂₀₀₃₋₀₇

➤ Average Annual Unit Savings were estimated from survey data, engineering data on kW load & weighted average consumption in various motor modes

Energy & Peak Savings



Variable Speed Furnace Motor Program F2003 – F2008

Reported Evaluated

Energy Savings GWh/yr	5.0	7.2
Peak Savings MW	1.5	1.4

Conclusions

- Variable speed furnace motors can substantially reduce energy consumption & peak demand
 - ▶ VSMS can increase comfort as part of a home ventilation strategy
- The program achieved high levels of participation & consumer satisfaction
 - ▶ Less successful at achieving high levels of awareness & interest
- Financial incentives have a significant effect on the consumer decision to install a variable speed furnace motor
- Evaluated energy savings are 7.2 GWh/yr & peak demand savings are 1.4 MW
 - ▶ Compared to reported savings of 5.0 GWh/yr & 1.5 MW
- Incremental costs for VSMS fell from \$ 513 in 2003 to \$ 426 in 2007

Invitation to Attend



International Energy Program Evaluation Conference

August 11 – 14, 2009

Portland, Oregon USA

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International Energy Program Evaluation Conference

Europe - June 2010

