BC hydro
FOR GENERATIONS

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January 8, 2013

Ms. Erica Hamilton
Commission Secretary
British Columbia Utilities Commission
Sixth Floor – 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Ms. Hamilton:

RE: British Columbia Utilities Commission (BCUC)
British Columbia Hydro and Power Authority (BC Hydro)
2004/05 and 2005/06 Revenue Requirements Application
BCUC Decision: Order No. G-96-04 October 29, 2004, Directive 66 (page 197)

BC Hydro writes to submit its F2012 Demand Side Management Milestone Evaluation Summary Report (**the Report**), dated December 2012 in compliance with Directive 66 (page 197) of the BCUC Decision dated October 29, 2004. Directive 66 directs BC Hydro to file the executive summaries of its milestone evaluation reports and full final evaluation reports for all its Power Smart programs. The Report summarizes the milestone evaluations completed during F2012 for the following:

1. Appliance Program F2008 – F2010
2. Low Income Housing - Energy Conservation Assistance Program (ECAP) F2010 - F2011
3. Residential Lighting Program F2011
4. Power Smart Partners – Commercial Program F2010
5. Power Smart Partners – Distribution Program F2009 - F2010
6. Power Smart Partners – Transmission Program F2010 - F2011
7. New Plant Design Program F2010 - F2011
8. Transmission Service Rate F2011
9. Residential Building Code F2011

BC Hydro notes that the Report has been prepared for the purpose of this compliance filing.

For further information, please contact Geoff Higgins at 604-623-4121 or by email at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

Janet Fraser
Chief Regulatory Officer

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Enclosure (1)

BC hydro
powersmart

F2012 Demand Side Management Milestone Evaluation Summary Report

December 2012

ABSTRACT

This report provides a summary of Milestone Demand Side Management (**DSM**) Evaluations completed by Power Smart Evaluation during F2012.

ACKNOWLEDGEMENTS

The Power Smart Evaluation team wishes to thank the members of the Evaluation Oversight Committee and the external DSM evaluation advisors for their assistance and support.

Table of Contents

List of Figures

List of Tables

Glossary

Adjusted R-squared - The adjusted R-squared is the proportion of the variance explained by the model in a least squares regression.

Auto-correlation - Auto-correlation refers to a situation where the error terms are correlated over time, rather than being uncorrelated as is typically assumed for a least squares regression.

Customer Baseline Load - The Customer Baseline Load applies to a transmission service (Rate Schedule 1823) customer's historic annual energy consumption in kWh as approved by the British Columbia Utilities Commission.

Demand - Demand refers to the amount of electricity that is consumed at any instant in time, measured in multiples of watts. Peak demand savings are the reduction in amount of electricity that is consumed at system peak demand, which for BC Hydro occurs on a winter weekday between approximately 5 p.m. and 7 p.m.

End-use - The ultimate use for which something is intended or to which it is put (e.g. lighting, heating, air-conditioning).

Energy - Energy refers to the amount of electricity consumed (or produced) over a certain time period, measured in multiples of watt-hours. Energy savings are the reduction in the amount of electricity consumed over a certain time period.

Evaluation Design - An evaluation design describes the nature of the treatment group and the control/comparison group.

Experiment - In an experimental design, participants are randomly assigned to a treatment group or to a control group.

Free-Riders - Free-riders are those participants who would have made similar energy efficiency improvements in the absence of the program.

Least Squares Regression - In a least squares regression, the parameter values are selected based on the minimization of the sum of squares of the error terms.

Maximum Likelihood Regression - In a maximum likelihood regression, the parameter values are selected based on the maximum of the likelihood function.

Quasi-experiment - In a quasi-experimental design, there is no random assignment, but treatment and comparison group members are matched on some relevant characteristic(s) and selected on a probabilistic basis.

Run Rate - The rate at which a DSM program is saving electricity at any point in time. This is usually expressed as GWh per year at the end of a specific fiscal or calendar year.

Spillover - Spillover occurs when individuals are influenced or impacted by the program (either directly as program participants or indirectly as non-participants) to make additional energy efficiency improvements without any assistance from the program.

Acronyms and Abbreviations

CAMA – Canadian Appliance Manufacturers Association

CBL – Customer Baseline Load

CFL – Compact Fluorescent Lamp

DCM – Discrete Choice Model

DSM – Demand Side Management

ECAP – Energy Conservation Assistance Program

FIRE – Finance, Insurance and Real Estate

FRR – Free-Ridership Rate

KAM – Key Account Manager

LED – Light Emitting Diode

M&V – Measurement and Verification

NPD – New Plant Design Program

NTG – Net-to-Gross ratio

PSP – Power Smart Partners

RR – Realisation Rate

SEMP – Sustainable Energy Management Plan

SOR – Spillover Rate

SUCH – Schools, Universities, Colleges, and Hospitals

TSR – Transmission Service Rate (BC Hydro Electric Tariff, Rate Schedule 1823). Often also referred to as the Industrial Stepped Rate

1 Introduction

BC Hydro evaluates its demand-side management (**DSM**) initiatives to document their activities and impacts, to validate energy and peak savings and to improve the design and operation of initiatives. The objective of BC Hydro's DSM evaluation function is to provide timely, credible, actionable, and cost-effective evaluation studies. BC Hydro uses the California Evaluation Framework[1] as a guide to undertaking DSM evaluations and related activities.

1.1 Background

BC Hydro undertakes a comprehensive approach to confirm the electricity savings that result from its DSM initiatives. A key aspect of this approach is the evaluation of DSM initiatives. Evaluation activities center on three main categories, which are described below: process evaluations, market evaluations and impact evaluations. The basic objectives of evaluations are to document activities, assess impacts, and identify opportunities for improvement.

The British Columbia Utilities Commission (**BCUC**) Resource Planning Guidelines note: "Because of measurement difficulties and uncertainty about consumer behaviour, DSM programs should be evaluated before and after implementation to determine their full impacts." Further, in directive 69 of its decision on BC Hydro's F05/06 Revenue Requirements Application, the BCUC directed BC Hydro to file "executive summaries of its milestone evaluation reports and full final evaluation reports for each program".

BC Hydro determines the impact of its DSM initiatives in the following manner. First, a complete evaluation plan is prepared covering the scope, issues, timing and expected costs of the evaluation study(s). Second, evaluations are conducted at major initiative milestones and can include elements of process, market, and impact evaluations. Third, evaluations are reviewed and approved by a BC Hydro cross-functional DSM Evaluation

[1] The California Evaluation Framework provides a consistent, systemized, cyclic approach for planning and conducting evaluations of energy efficiency programs. The framework is widely used in the industry.

Oversight Committee (**EOC**), chaired by a staff member from outside the Power Smart business group. The structure of the EOC follows recommendations from the BCUC in 2004 to diversify the membership. The EOC also has two external senior advisors who provide assistance and support to the Power Smart Evaluation department to ensure that BC Hydro's DSM evaluations align with industry best practice.

1.2 DSM Evaluation Principles and Approach

BC Hydro's approach to DSM evaluation emphasizes four main principles:

- Undertaking baseline studies and periodic data collection to understand the nature and size of the pre-program market and changes in the market over time.
- Leveraging existing program, market, and customer data to minimize evaluation costs.
- Using multiple lines of evidence to increase the credibility, validity, and reliability of evaluation findings.
- Reviewing and approving completed evaluation studies by the EOC, which represents key stakeholders.

DSM evaluations are often divided into three main categories: process evaluations; market evaluations; and impact evaluations. These three types of studies can be summarized as follows:

Process Evaluations. In process evaluations, the researcher identifies and describes the program model or program logic, start-up procedures, implementation procedures and anticipated outcomes. Key issues for process evaluations may include the following:

- Are program goals clear, well defined, measurable, and achievable?
- Are the goals clearly communicated through the organization?

- Is responsibility clearly defined?
- How efficient and effective are program processes?
- How can program processes be improved?
- What is the extent of stakeholder awareness of and participation in the program?
- How satisfied are the stakeholders with the program and its components?

Market Evaluations. In market evaluations, the researcher attempts to understand the impact of the program on the demand-side and the supply-side of the market. Key issues for market evaluations include the following:

- What is the size of the market?
- How much of the market has been captured?
- What is the remaining market potential?
- What are the barriers to market transformation?
- How successfully are the market barriers being addressed?
- What are the sales of more efficient and less efficient products?
- What are the prices of more efficient and less efficient products?

Impact Evaluations. In impact evaluations, the researcher evaluates the goals and objectives of the DSM initiative with respect to the outcomes, whether intended or unintended. Key issues for impact evaluations include the following:

- What are the short-term impacts on clients or stakeholders?
- What are the long-term impacts on clients or stakeholders?

- What are the estimates of the initiative's gross and net energy and capacity savings?

1.3 Evaluation Studies

Evaluations summarized in this report include the following:

- Appliance Program F2008 – F2010
- Low Income Housing - Energy Conservation Assistance Program (**ECAP**) F2010 - F2011
- Residential Lighting Program F2011
- Power Smart Partners – Commercial Program F2010
- Power Smart Partners – Distribution Program F2009 - F2010
- Power Smart Partners – Transmission Program F2010 - F2011
- New Plant Design Program F2010 - F2011
- Transmission Service Rate F2011
- Residential Building Code F2011

2 Residential Programs

2.1 Appliance Program F2008 - F2010

2.1.1 Introduction

BC Hydro has provided support for the development and implementation of an Energy Star-focused Appliance program, which has reduced energy use and increased energy efficiency of new residential appliances in British Columbia. This study evaluates the impact of the Appliance Program for F2008 through F2010.

From January 2008 to May 2010, the Appliance Program provided rebates on Energy Star labelled appliances (clothes washers, refrigerators and freezers but excluded dishwashers because of high Energy Star market share). Analysis of this first phase of the Appliance Program indicated that it had experienced considerable success in transforming the market, but that program design changes were appropriate to minimize free riders. During the second phase, from April 1, 2011 to the present, the incentive program has been modified to include selected Energy Star clothes washers, refrigerators, and dishwashers as well as all Energy Star freezers. Because the energy efficiency standard for qualifying clothes washers was raised significantly, the incentive was increased. Incentive levels are summarized in Table 2.1.1.

Table 2.1.1 Energy Star Appliance Incentive Levels

Appliance	January 1, 2008 to May 31, 2010	April 1, 2011 to March 31, 2012
Clothes washers	All Energy Star: $50	Selected Energy Star: $75
Refrigerators	All Energy Star: $50	Selected Energy Star: $50
Dishwashers	N/A	Selected Energy Star: $25
Freezers	All Energy Star: $25	All Energy Star: $25

Based on Canadian Appliance Manufacturers Association (**CAMA**) appliance shipment data, the share of Energy Star qualified appliance shipments to British Columbia. experienced fast growth - increasing from 30 per cent of total shipment in early 2008 to 71 per cent in early 2010. The rate of growth in Energy Star share varied by appliance

over the program period - for refrigerators, the Energy Star share of shipments increased from below 40 per cent (37.5 per cent) in early 2008 to over 60 per cent (63.4 per cent) in mid-2010. For clothes washers, the Energy Star share of shipments increased from just over 60 per cent (61.1 per cent) in early 2008 to over 70 per cent (73.4 per cent) in mid-2010.

2.1.2 Approach

For this evaluation, there were five main activities: (1) conduct a program review; (2) undertake a supply-side assessment; (3) undertake a demand-side assessment; (4) review price trends for Energy Star-qualifying and non-Energy Star-qualifying appliances; and (5) estimate energy and peak savings.

The following Table 2.1.2 provides a summary of the issues, data, and methods for this study. The study uses information collected from program files, program staff interviews, customer surveys, in-store surveys, CAMA data, and BC Statistics data to build a comprehensive database for the analysis. Econometric models and algorithms are used to estimate energy and peak savings.

Table 2.1.2 Evaluation Issues, Data Sources, and Methods

Issues	Data Sources	Methods
Program review	Program files Program interviews Literature review	File review
Supply-side assessment	Appliance stock survey (n = 40 stores per year)	Cross tabulations
Demand-side assessment	Energy Star Tracker (n = 750 per quarter)	Cross tabulations
Appliance prices	Appliance stock survey (n = 40 stores per year)	Cross tabulations
Energy and peak savings	CAMA data BC Statistics data Appliance stock survey (n = 40 stores per year)	Engineering algorithms Econometric models

2.1.3 Results

Program Review

At the time of program launch, there were several barriers to market transformation including low awareness of Energy Star appliances among consumers, low availability of Energy Star product in stores, and high prices for Energy Star products. BC Hydro employed a phased strategy to transform the household appliance market and acquire energy and peak savings. The program has successfully addressed these barriers through four main activities: information and promotions, support for provincial sales tax exemption,[2] financial incentives, and legislative support for more stringent Minimum Energy Performance Standards.

Supply Side Assessment

The surveyed retail stores averaged 35 refrigerator units on display. The product shares are as follows: bottom mount – 56 per cent, top mount – 26 per cent, side by side – 19 per cent. The Energy Star refrigerator share increased from 57 per cent in 2009 to 78 per cent in 2010. The surveyed retail stores averaged eight freezer units on display. The product shares are as follows: chest freezers – 61 per cent and upright freezers – 39 per cent. The Energy Star freezer share decreased from 48 per cent in 2009 to 39 per cent in 2010, but it is not yet clear why the Energy Star market share decreased. The surveyed retail stores averaged 24 clothes washer units on display. The product shares are as follows: front load – 73 per cent and top load – 27 per cent. The Energy Star clothes washer share increased from 70 per cent in 2009 to 79 per cent in 2010.

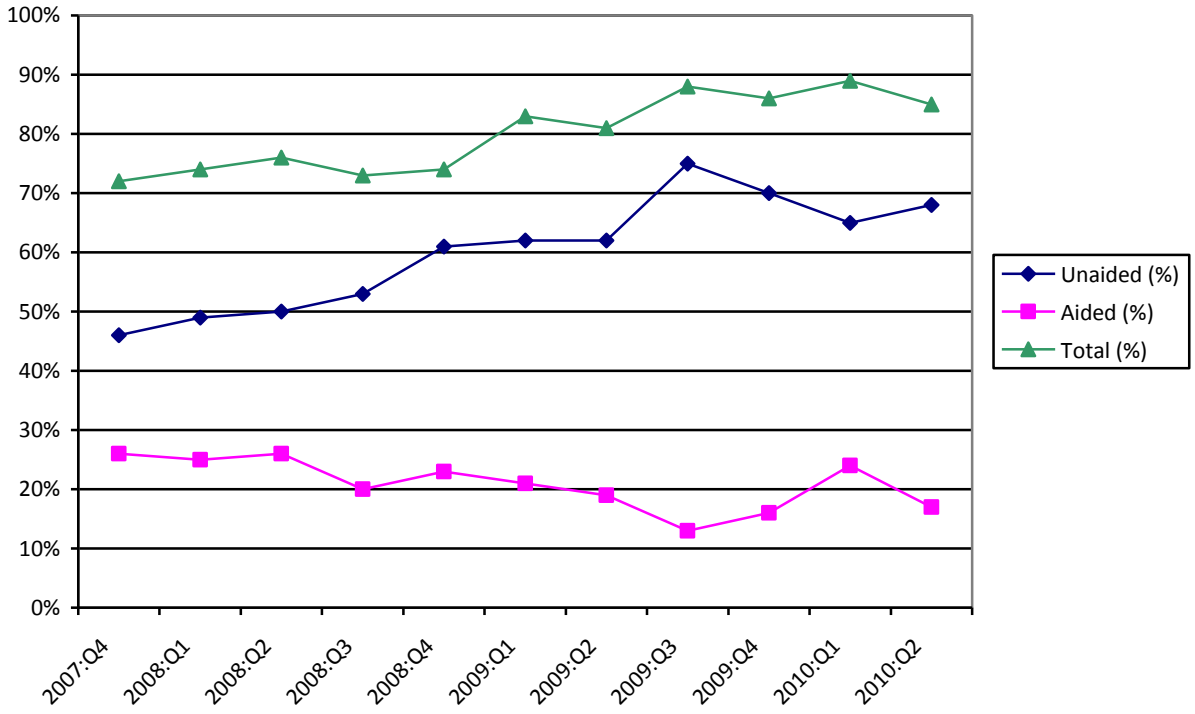
Demand Side Assessment

To determine unaided awareness of Energy Star, respondents were asked “Have you seen or heard of the Energy Star label?” Those who indicated yes were viewed as having unaided awareness of the Energy Star label. Those who responded no to this first question were asked “Please look at the Energy Star label: have you seen or heard

[2] The Energy Star exemption for residential refrigerators, freezers and clothes washers ended on March 31, 2010. All major household appliances are now subject to HST.

of this label?" Those who responded yes (aided awareness) were added to the unaided awareness to determine total awareness. Unaided awareness has increased substantially over the period surveyed, from 46 per cent in November 2007 to 68 per cent in June 2010. Total awareness has also increased, rising from 72 per cent in November 2007 to 85 per cent in June 2010.

Figure 2.1.1 Energy Star Awareness



Respondents who purchased various products over the 12 months before the survey were asked a series of questions about the label and about the product they purchased. However, it should be noted that the sample sizes were relatively small since in any given year, only a small share of customers purchase a new major appliance. For all three appliances, the share of Energy Star Label recall increased over the period covered by the surveys. Energy Star label recall increased from 51 per cent to 62 per cent for refrigerators, from 45 per cent to 54 per cent for freezers, and from 58 per cent to 65 per cent for clothes washers. Respondents who saw the Energy Star label on the products they purchased were asked questions about the importance of the

influence of the Energy Star label on their purchase decision. For all three appliances, the stated influence of the Energy Star label is quite high, but there is no well-defined trend in the share of respondents saying that the Energy Star label is very or somewhat important in the purchase decision.

Appliance Prices

Appliance price comparisons are complicated because prices are driven by a number of factors including volume, features, materials used as well as whether or not they are Energy Star compliant. The prices for major appliances by Energy Star status were compared using the 2009 in-store survey, and this study suggests that the price difference between Energy Star and non-Energy Star appliances may be substantial. The 2010 study suggests that the price difference between Energy Star and non-Energy Star appliances may have widened for clothes washers and refrigerators but narrowed substantially for upright freezers and for chest freezers.

Energy and Peak Savings

To estimate net energy savings by appliance type, unit energy savings were multiplied by the number of units attributable to the program (estimated using an econometric model based on program impacts on shipments). To estimate net peak savings by appliance type, a peak-to-energy ratio was applied. Evaluated energy savings were 7.8 GWh per year compared to reported energy savings of 11.6 GWh per year, while evaluated peak savings were 1.0 MW.

Table 2.1.3 Appliance Program Energy and Peak Savings Estimates

Period	Reported energy savings (GWh/year)	Evaluated energy savings (GWh/year)	Reported peak savings (MW)	Evaluated peak savings (MW)
F2008-F2010	11.6	7.8	-	1.0

2.2 Low Income Program –Energy Conservation Assistance Program (ECAP) F2010 and F2011

2.2.1 Introduction

BC Hydro designed an energy savings acquisition program for low-income residential customers identified under the Statistics Canada Low-Income Cut-off. Low-income customers face significant barriers to participation in conventional DSM programs. Factors affecting participation include low disposable income and sub-optimal access to program information and financing (social marginalization). Similarly defined programs are available in other North American jurisdictions.

The primary objectives of the Low Income Program are to:

- Make energy efficiency more accessible to low-income customers.
- Provide energy savings for BC Hydro.
- Provide low-income customers with energy-efficient technologies that reduce energy consumption and lower utility bills.
- Increase knowledge and awareness of energy efficiency among low-income customers.

The Low Income Program provides some low-cost energy savings measures that are easy to install by a homeowner or tenant. These are packaged into an Energy Saving Kit,[3] which includes CFL lamps, faucet aerators, low-flow showerheads, pipe wrap, caulking, and draft proofing materials, outlet gaskets, window film, and a number of additional measures as well as tips on saving energy in the home. Over 50,000 Energy Savings Kits had been distributed free of charge to low-income customers as of February 2012.

[3] BC Hydro evaluated the Energy Saving Kit component of the Low Income Program in F2011.

Further offerings are delivered through the ECAP, which is a sub-component of the Low Income Program. The ECAP provides qualified low-income BC Hydro residential account holders with a home energy evaluation, the installation of additional energy saving products such as energy-efficient refrigerators and personalized energy efficiency advice. All services and equipment are supplied free of charge to the participant. Of eligible low-income customers, approximately 47 per cent own and inhabit electrically heated single-family dwellings eligible for further retrofits under the basic or advanced stream of the ECAP.[4] The advanced stream includes basic offerings but adds a comprehensive home insulation offer. Other low-income customers such as renters or those living in natural gas heated dwellings remain eligible for the basic program stream.

ECAP commenced in May 2009 and over its first 11 months saw 607 participants of whom 534 (88 per cent) received basic stream deliverables and 73 (12 per cent) received the advanced. The next year (F2011), the program operated for a full 12 months and totalled 1,719 participants consisting of 1,659 basic (97 per cent) and 60 advanced (3 per cent) program deliveries. The two-year total for F2010 and F2011 was 607 (26 per cent) and 1,719 (74 per cent) respectively for 2,326 program completions in all.

The purpose of this document is to present an evaluation of ECAP for F2010 and F2011.

2.2.2 Approach

The evaluation issues examined in this study were addressed by analysing program-related data consulting customers and utilizing internal BC Hydro resources such as program administrators. The four main evaluation issues were:

- **Program Review.** Program components are described and an analysis of program logic is provided.

[4] BC Hydro Residential End-use Survey (2010).

- **Consumption Analysis.** Consumption changes due to the ECAP program are analysed.

- **Customer Survey.** The survey assesses customer participation and attitudes towards the program, tabulates the number of products installed, and discusses free ridership and spillover.

- **Energy Savings.** This section presents the energy savings attributed to the program in F2010 and F2011.

The evaluation issues, data sources, and methods used in the study are listed in Table 2.2.1.

Table 2.2.1 Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Discussions with Program Managers and Administrators	Update Logic Model
End use consumption	Initial technical analysis by retrofit item; billing data	Engineering algorithms informed and affirmed by billing analysis
Participation, satisfaction, product installation, free riders, participant spillover	Customer telephone survey (n = 300 of 2,000 polled)	Cross tabulations
Energy savings	Monthly billings, program recipient data and BC Hydro Residential End-Use Study (**REUS**) 2010	A pre and post-test with participant and non-participant groups

Impact Method

Energy savings were estimated for program activity in fiscal years 2010 and 2011. Any naturally occurring conservation was accounted for in the gross savings calculations through the employment of participant and control groups. Initial gross savings estimates were calculated using a pre and post experimental design. The assumption is that, if the participant and comparison groups are sufficiently comparable, any difference in outcome between the two groups may be attributed to the program.

2.2.3 Results

Program Rationale

As of March 31 2011, ECAP installed energy-efficient products in the homes of approximately 2,300 low-income residential customers and provided them with personalized energy efficiency advice. The program rationale was expressed through a program logic model, which describes the linkages between inputs, outputs, purpose and goal for each activity. The review of the logic model supports a claim of program validity for the following reasons: (1) program linkages had face validity and were plausible; (2) key outputs were based on reasonable assumptions and, therefore, were likely to be met; and (3) key model components had performance indicators that could be measured against objectives.

Customer Survey

A detailed telephone survey of program participants conducted in June 2011 resulted in 300 interview completions. The response rate was 15 per cent of 2,000 participants polled and proportional representation by region and dwelling type was satisfactory. When customers were asked how they first became aware of the ECAP offering the most prevalent sources of customer awareness were building managers (25 per cent), BC Hydro billing statements (25 per cent), friends and relatives (10 per cent), and the BC Hydro Website (9 per cent). Participant satisfaction with the various program components was high with 92 per cent of respondents rating the overall quality of the work done by the program contractor as either “excellent” or “good”.

Energy Savings Estimates

The program and comparison groups were compared across selected strata such as geographic location, program stream and dwelling type. A total of 448 participating households and 119 non-participating households were used to generate the final samples. Average pre-program consumption for program participants and non-participants was comparable at 15,142 kWh and 15,011 kWh per year respectively.

The difference between these values is not statistically significant, and consumption for both groups follows similar distributions.

An original objective of this evaluation was to base free rider and spillover estimates on the relative importance customers placed on program participation when deciding to install energy-efficient products. However, the methodology chosen to estimate free riders and spillover produced results that were considered invalid because, in retrospect, the methodology was predicated on an unrealistic depiction of the customer decision process. Program participants receive a range of retrofit measures all at once, whereas the survey asked them about their decisions on individual measures in isolation of each other. The free rider rate on the full range of retrofit measures all at once is likely much lower than a weighted average of individual measures in isolation since customers would likely resist paying for an entire suite of measures at one time, but might do so in stages over a longer period of time. Given these arguments and further support from literature on other low-income programs, the free rider and spillover rates for the ECAP component were set to zero.

Gross and net energy savings were based on program activity in two fiscal years. A pre and post experimental design with participant and non-participant groups was used to compare pre-program and post-program metrics including electricity use. The gross savings were approximately 0.5 GWh per year for F2010 and 1.5 GWh per year for F2011. Since both free rider and spillover rates were assumed to be zero, gross and net savings are identical.

Table 2.2.2 Low-Income ECAP Energy Savings Estimates

Period	Reported Energy Savings (GWh/year)	Evaluated Gross Savings (GWh/year)	Evaluated Net Savings (GWh/year)
F2010	0.4	0.5	0.5
F2011	1.4	1.5	1.5

2.3 Residential Lighting Program F2011

2.3.1 Introduction

The BC Hydro Residential Lighting program is a multi-year energy savings acquisition and market transformation initiative that encourages customers to use energy-efficient lighting such as compact fluorescent and LED lamps as well as energy-efficient lighting fixtures. The specific objectives of the program are to: (1) sustain and increase the market share in advance of regulations for more efficient lighting; (2) promote efficient lighting products not covered by government regulations; (3) promote newer products such as LED lighting; (4) increase awareness and encourage customers to purchase targeted products; (5) provide customers with an accessible and simple program; and (6) collaborate with utilities, government and industry in pursuit of market transformation and raising awareness levels of impending regulations.

The purpose of this report is to present a combined process, impact, and market evaluation of the Compact Fluorescent Lamp (**CFL**) and Energy Star Fixtures components of the BC Hydro Residential Lighting Program.

2.3.2 Approach

This evaluation employs a post-only, quasi-experimental design with treatment and comparison groups to identify the market impact of BC Hydro's residential Energy Star lighting program. The treatment group consists of 603 randomly selected residential BC Hydro customers, while the comparison group is made up of 600 randomly selected residential electricity customers in a demographically similar (but differently located) region. North and South Dakota were chosen for comparison because they are considered demographically similar to British Columbia but without significant exposure to residential lighting DSM programs. Direct energy savings attributed to the program were estimated from program participation data. Table 2.3.1 summarizes the evaluation issues, data sources and methods pertaining to this study.

Table 2.3.1 Evaluation Issues, Data Sources and Methods

Issues	Main data sources	Method
Program review	Discussions with Program Managers and Administrators	Update Logic Model
Supply side assessment	Retail shelf space study (n = 41) Literature review	Cross-tabulation
Demand side assessment	BC Hydro Participant Survey (n = 603) Comparison Group Survey (n = 600)	Descriptive statistics
CFL and Fixture prices	Retail shelf space study (n = 41)	Cross-tabulation
Energy and peak savings	BC Hydro Participant Survey (n = 603) Comparison Group Survey (n = 600) Program participation data	Discrete Choice Model; Engineering algorithms

2.3.3 Results

Program Review

BC Hydro has employed a phased strategy to transform the residential lighting market and acquire energy and peak savings. At program launch in 2001, there was low customer and retailer awareness of compact fluorescent lighting and Energy Star fixtures. This was due to the limited availability of energy-efficient products in stores and substantially lower prices for conventional lighting. However, the program has now successfully addressed these issues. Program rationale was examined using a program logic model and a comprehensive literature review. Both review and analysis confirm that the program logic is valid with strong linkages among inputs, outputs, purposes and goal statements. Key components of the model are also clear, well defined and measurable.

Supply Side Assessment

The supply side assessment consists of a shelf-space study of 41 retail establishments with product information collected on eight main product categories of CFL. The annual trend in the shelf space allotment of CFL product by store type is shown in Table 2.3.2 below. Product share has increased from 14 per cent in recent years to about 25 per cent and has remained at this level for the past three years. The increase in shelf

space devoted to CFLs has been most pronounced in retail/pharmacy and grocery stores.

Table 2.3.2 CFL Shelf Space by Store Type (%)

	Fiscal Year			
Store Type	**2008**	**2009**	**2010**	**2011**
General merchandise	31	36	25	25
Home improvement/hardware	20	21	18	19
Retail/pharmacy	12	40	49	41
Grocery	5	15	19	27
Total	14	25	23	24

Product information was also collected for eight types of Energy Star fixtures. The annual trend in shelf-space allotment of Energy Star fixtures by fixture type is shown in Table 2.3.3. Shelf-space share increased dramatically to about 8 per cent and has remained at about this level for the past three years.

Table 2.3.3 Energy Star Fixture Shelf Space by Fixture Type (%)

	Fiscal Year			
Fixture Type	**2008**	**2009**	**2010**	**2011**
Ceiling fan	3	4	7	2
Flush mounted ceiling fixture	4	19	10	7
Other ceiling lights	0	1	4	2
Floor lamp	3	4	1	11
Outdoor fixtures	7	15	13	20
Table lamps	3	6	4	11
Torchières	12	40	30	19
Wall fixture	2	3	3	4
All fixture average	3	9	6	8

Demand-Side Assessment

The demand-side assessment is based on November 2010 customer surveys of 603 treatment and 600 comparison group customers.

Table 2.3.4 compares treatment and comparison group responses on questions addressing the awareness and purchase of CFL products. The awareness and advertising recall of CFL products are higher for the BC Hydro customers (treatment group) than for the Dakotas (comparison group) but purchase rates[5] for these products in British Columbia dropped from 70 per cent in F2010 to 54 per cent in F2011. This last development erased any meaningful difference in purchase rates between the two groups. This anomaly may be a by-product of combined high awareness and purchase rates in British Columbia over the past several years coupled with the much longer service life of CFL bulbs. This could lead to lower replacement (and hence purchase) rates and a consequent drop off in current purchase rates for the BC Hydro group.

Table 2.3.4 CFL Awareness and Purchase Behaviour

Dimension	Treatment (B.C.) n = 603 (%)	Comparison (Dakotas) n = 600 (%)	Difference (%)	z-value
Aware of CFL Technology	90.2	86.7	3.5	1.93*
Customer first became aware in the last year	5.2	9.4	-4.2	-2.64*
First aware 1 to 5 years ago	56.8	68.9	-12.1	-4.09*
First aware > 5 years ago	38.0	21.6	16.4	5.79*
Customers recalling CFL Information, Advertising or Promotion	58.3	43.8	14.5	5.10*
Customer purchased at least one CFL in the last year	54.3	55.9	-1.6	-0.55

* Statistically significant at 90 per cent confidence level.

Table 2.3.5 compares treatment and comparison group responses on questions relating to Energy Star fixture awareness and purchase behaviour. Compared to customers in the Dakotas, awareness, purchasing intention, and recall of advertising regarding Energy Star fixtures remained significantly higher among residents in British Columbia in F2011.

[5] *Purchase Rate* is defined as the percentage of customers who purchased a CFL in the past year.

Table 2.3.5 Awareness and Purchase of Energy Star Fixtures

Dimension	Treatment (B.C.) n = 603 (%)	Comparison (Dakotas) n = 600 (%)	Difference (%)	z-value
Aware of Energy Star fixtures	44.6	31.3	13.3	4.49*
Intend to purchase ES fixture in future	67.0	51.1	15.9	5.73*
Recall any advertising, etc.	22.7	11.5	11.2	5.22*
Purchased Energy Star fixture in last year	7.6	5.5	2.1	1.46

* Statistically significant at 90 per cent confidence level.

Prices

A reduction in price for energy-efficient products is a key objective of a market transformation program and successive BC Hydro shelf-space studies have collected detailed price information on compact fluorescent and incandescent lighting to ascertain such reductions. Eight CFL product categories were analysed with annual price fluctuation by style and shape summarized in Table 2.3.6 below. In general, prices of globes, A-shapes and bullets have dropped in recent years while other products have not experienced this decline.

Table 2.3.6 Annual Average CFL Prices in Nominal Dollars

	Fiscal Year				
Lamp Type	2007 ($)	2008 ($)	2009 ($)	2010 ($)	2011 ($)
Spiral	4.24	5.59	3.90	4.21	4.29
Globe	8.42	7.23	6.85	7.42	7.51
Tube	3.79	n/a	6.94	7.83	10.16
A-shape	9.97	8.15	6.73	8.06	6.67
Bullet	9.45	8.99	8.72	8.12	6.96
Post-pin	n/a	7.30	7.81	8.88	7.99
Circular	10.36	n/a	11.81	9.52	10.41
Reflector/PAR	9.36	11.37	11.70	10.86	10.29

Price information was also collected for several types of Energy Star fixtures and is presented in Table 2.3.7. The prices of Energy Star qualifying flush-mounted ceiling

lamps, suspended ceiling lights, floor lamps, table lamps, torchières and wall fixtures have all dropped since F2007. Prices are not adjusted for inflation.

Table 2.3.7 Average Energy Star Fixture Prices in Nominal Dollars

	Fiscal Year				
Lamp Type	**2007 ($)**	**2008 ($)**	**2009 ($)**	**2010 ($)**	**2011 ($)**
Ceiling fan with lamps	104.32	116.54	118.78	111.41	118.51
Flush mounted ceiling fixture	66.86	53.00	33.47	28.91	32.44
Suspended ceiling lights	176.14	53.00	59.99	20.40	35.77
Floor lamp	107.70	61.99	73.51	54.88	55.69
Outdoor fixtures	35.03	31.81	35.97	40.20	44.63
Table lamps	49.89	30.91	37.70	33.28	22.96
Torchières	65.62	63.31	64.15	79.61	56.68
Wall fixture	77.21	34.82	40.09	39.02	50.49

Energy and Peak Savings Estimates

Data from both treatment and comparison surveys were used in a Discrete Choice Model (**DCM**) to look for potential indirect (market) impacts of the program. As only a very small difference in purchasing rates was detected between the groups, no measurable impact of this kind was discernible. Since no statistically significant market effect existed in F2011, only direct program effects were realisable. These latter results are based on program participation data for CFL and Energy Star fixtures after adjustment for free rider and spillover rates.

Table 2.3.8 Direct Savings Analysis for CFL Bulbs

Component	Value
CFL Product Purchased through the Program	290,869
Free rider Rate (%)	20.0
Incremental CFL Bulbs Purchased	202,009
Installation Rate Net of Replacements CFL Bulbs (%)	71.0
Net Count of CFL Bulbs Installed	143,426
Demand Saving per CFL Unit (watts)	53

Component	Value
Total Demand Savings Run-rate (MW)	7.60
Coincidence Factor for Peak (%)	27.3
Total Peak Demand savings (MW)	2.3
Annual Hours of Use	888
Annual energy savings per CFL (kWh)	47.1
Annual Total Energy Savings Run- rate (GWh)	7.8
Cross-effects for Energy Consumed (%)	16
Cross Effects for Peak (%)	16
Annual Energy Savings Run-rate less Cross-effects (GWh)	6.5
Annual Peak Demand Savings less Cross-effects (MW)	1.9

Table 2.3.9 Energy and Demand Savings for Energy Star Fixtures

Component	Value
Total program Sales Fiscal Year 2011	56,852
Installation Rate %)	94
Coincident Factor (Peak) (%)	38.3
Unit Savings Per Fixture	varies by type
Annual Hours of Use	1,232
Free rider Rate (%)	7
Cross Effects for Energy (%)	18
Cross Effects for Peak (%)	18
Annual Energy Savings Run-rate less Cross-effects (GWh)	5.5
Annual Peak Demand Savings less Cross-effects (MW)	1.7

Hours of use and peak coincidence factors were obtained from a load measurement study conducted for BC Hydro (Sampson, 2004) and applied to estimate total energy and peak coincident demand impacts. All direct impacts attributable to BC Hydro's residential lighting program for F2011 are reported in Table 2.3.10.

Table 2.3.10 Residential Lighting Program Energy and Peak Savings Estimates

	Energy savings (GWh/year)		Peak savings (MW)	
Fiscal Year	Reported	Evaluated	Reported	Evaluated
2011	15.2	12.0	n/a	3.6

3 Commercial Programs

3.1 Power Smart Partner Program F2010

3.1.1 Introduction

The BC Hydro Power Smart Partner (**PSP**) Program was launched in November 2002. The PSP program targets three distinct types of commercial accounts: (1) Commercial businesses; (2) Schools, Universities, Colleges and Hospitals (**SUCH**); and (3) Government. The program uses financial incentives to encourage business and institutional customers to undertake an energy-efficient retrofit. The program also provides a wide range of supporting activities including energy studies, energy managers, energy management assessments, education and training, recognition and tools for operational and behavioural actions.

The main objectives of the program are (a) to acquire electricity savings and (b) lay the groundwork for additional future energy savings by promoting an energy conservation business culture. Participants must be BC Hydro Tier 1 customers and purchase at least $200,000 in electricity per year from BC Hydro. Eligible customers gain access to technical assistance for the identification and implementation of energy efficiency projects as well as financial assistance to reduce initial retrofit costs.

The purpose of this report is to provide an impact evaluation of the PSP Commercial program for F2010.

3.1.2 Approach

The main data sources for the impact evaluation included project level data from the program database, metered hours-of-use data from Power Smart Measurement and Verification (**M&V**), and surveys of participant and non-participant customers.

The program database provided comprehensive project data for the 388 PSP Commercial participant sites. The data extract included a variety of information on project dates, application status, types and quantities of products installed, engineering

estimates of gross energy savings and metered gross energy savings. The information is based on on-site metering of 117 sites comprising 40 per cent of total reported PSP F2010 energy savings estimates.

A telephone survey of program participants was conducted in May 2011 to investigate elements of customer satisfaction and program experience, customer knowledge and attitudes concerning energy conservation, facility characteristics, free rider, and spillover behaviour. Survey respondents were queried only once about no more than two sites to minimize the customer response burden. Of 388 sites that participated in the program during Fiscal Year 2010, a total of 78 site-level survey responses were returned.

Three hundred ninety-five (395) customers with profiles comparable to the 388 program participants were initially selected for a non-participant telephone survey. Although the non-participant sample was statistically matched to the participant set by their business types and baseline annual consumption, attrition reduced the total number of non-participant responses to 64 sites as opposed to the 78 completing the participant survey.[6] The non-participant survey collected information on non-participant program awareness, barriers to program participation, counts of energy saving retrofits installed, facility characteristics as well as customer knowledge and attitudes concerning energy conservation.

Savings Estimate Method

A bottom-up approach was undertaken that used metered and survey data to estimate gross and net evaluated energy savings. Initially, the sample of 117 metered retrofits was used to calculate a gross realisation rate for the 388 participating sites that adjusted engineering estimates of gross energy savings based on actual (on-site) metered energy savings. Secondly, a survey-based approach was utilised to estimate free rider and spillover rates. Finally, net evaluated energy savings were calculated with

[6] The original sample of 395 sites was culled to 190 to prevent excessive (multiple) surveying of customers. The 2010 participant population of 388 was similarly reduced to 127. These culls restricted the potential number of survey completions, but still provided statistically significant confidence levels in the results.

a net-to-gross ratio based on survey-based estimates of participant free rider and spillover rates.

The estimated gross realisation rate (**RR**) was derived by applying a stratified ratio estimation method to compare engineering estimates of gross energy savings (388) to the sample (117) of metered energy savings. Projects were first stratified by energy savings to reduce the variation of actual savings within each stratum, thereby improving the precision of the estimated realisation rate.

The estimated gross realisation rate was applied to engineering estimates of gross energy savings to produce evaluated gross energy savings. The survey-based net-to-gross ratio was then applied to evaluated gross energy savings to obtain evaluated net energy savings. Peak savings were estimated by applying appropriate load factors.[7]

3.1.3 Results

The Power Smart Partners Commercial program addresses both market transformation and resource acquisition opportunities. The program successfully addressed the following three main economic barriers to energy efficiency in its market segment.[8]

(1) **Affordability:** customers had both a real and perceived lack of investment capital.

(2) **Acceptance:** energy was often a small component of a commercial customer's costs, so that there was a lack of interest in energy efficiency and conservation.

(3) **Adoption:** customers faced capital rationing and available capital for new projects was directed towards initiatives that provided a higher return on investment than energy efficiency initiatives.

[7] This is an annual estimate of the ratio of average to peak usage available from BC Hydro's Load Research Department.

[8] Awareness, acceptance and other non-economic barriers also exist but have diminished in importance over the 8 years since program inception. For example, program acceptance has improved in recent years by streamlining the application and approval process.

A breakdown of survey responses from participating customers by business segment at the corporate level (one corporation may include two sites) is shown in Table 3.1.1. The categories consist of the retail and wholesale trades, finance, insurance and real estate (**FIRE**), SUCH, government, and other unclassified customers. Participant counts from F2009 are included for reference. Responses from the finance, insurance and real estate segments has fallen in proportion with the rise in the number of participating schools, universities, colleges and hospitals.[9]

Table 3.1.1 Participants by Main Business Segment (%)

Segments	Fiscal Year 2009 (n = 45)	Fiscal Year 2010 (n = 58)
Retail/Wholesale Trade	29	35
Finance, Insurance and Real Estate	20	9
Schools, Universities, Colleges and Hospitals	9	22
Government	4	17
Other	38	17
Total	100	100

A participant survey collected additional qualitative and quantitative information. Table 3.1.2 summarizes selected results from survey items related to customer satisfaction. Customers were asked: “How satisfied are you with the following aspects of the Power Smart Partners program”? A 5-point scale was used where 1 means not at all satisfied and 5 means very satisfied. Table 3.1.2 tabulates the proportions for the top two box scores (a “4” or a “5”). Satisfaction with the program as a whole dropped significantly. However, this decline does not reflect changes to the program that have occurred since March 2010.[10]

[9] BC Hydro Power Smart does not generally survey the same customers more than once during a calendar year. This restricts the sampling frame and explains some of the shift in participant representation by business segment.

[10] While the evaluation surveys ask respondents to consider only their involvement with the program during the timeframe evaluated, it is unclear if respondents may factor in older or more recent program experience in their response. Subsequent to the timeframe of this evaluation, a streamlined application process for simple retrofit projects (PSP-Express) was introduced based on customer feedback that application processing time took too long. This new process could reasonably expect to improve overall program satisfaction through reduced application processing time.

Table 3.1.2 Customer Satisfaction with Program and its Components - 4 or 5 out of 5 (%)

Factor	F2009	F2010
Technical advice on opportunities	63	61
Level of incentives	87	77
Application process	71	69
Energy measures installed	93	89
Overall PSP program	95	82

The non-participant survey used to support the discrete choice model also collected some qualitative information. Results show that the program approval process is not as attractive to non-participants and that this lack of appeal is compounded by a somewhat weaker knowledge of the suite of available energy efficient products that are supported by the program. This finding stands despite the fact that about 92 per cent of non-participants are aware of the program. That the incentive structure was the same in both fiscal years in tandem with a deteriorating economic outlook might also provide clues for falling satisfaction levels and some lack of engagement on the part of non-participating customers.

Energy and Peak Savings Estimates

Table 3.1.3 shows reported and evaluated net savings attributed to the program in the current and immediately preceding year.

Table 3.1.3 PSP Commercial Energy and Peak Saving Estimates

Fiscal Year	Energy Savings					Peak Savings (MW)	
	Expected Gross Savings (GWh/year)	Gross Realization Rate	Evaluated Gross Savings (GWh/year)	Net-to-Gross Ratio	Evaluated Net Savings (GWh/year)	Reported	Evaluated
2009	48.6	0.97	47.1	0.96	45.2	N/A	7.3
2010	53.7	1.14	61.2	0.92	56.3	N/A	9.1

4 Industrial Programs

4.1 New Plant Design Program F2010-F2011

4.1.1 Introduction

BC Hydro's New Plant Design (**NPD**) program offers funding and design expertise to support energy efficiency in new industrial plants. The key objective of NPD is to provide resources and incentives to encourage all new industrial facilities constructed in BC Hydro's service area to be as energy efficient as possible. There are two basic requirements for potential participants: first, the customer is planning either a new green-field facility or an expansion to an existing facility which will increase the power load by at least five percent; and, second, the facility has a bill savings potential of more than $9,000 per year.

The key concept is that early engagement by BC Hydro in the investment cycle will establish a foundation for energy efficient design that will have the following benefits:

- Load impact. Minimize load added to the BC Hydro system.
- Equipment selection. Influence equipment selection based on life-cycle analysis rather than lowest first cost.
- Self-generation. Encourage customer opportunities for self-generation.

4.1.2 Approach

The objective of this study is to conduct a process and market evaluation of the NPD program. Table 4.1.1 provides a summary of the issues, data, and methods for this study. The study uses information collected from program files, program staff interviews, and a customer survey. Cross tabulations have been used to analyze knowledge of energy efficiency, investment criteria and program components. Standard algorithms have been used to estimate free riders and spillover. The key data collection effort was a customer survey conducted in June and July of 2011.

Table 4.1.1 Evaluation Issues and Methods

Issues	Data sources	Methods
Program rationale	Program documents Staff interviews	Logic model
Market analysis	BC Statistics	Regression models
Knowledge of energy efficiency	Customer survey (n = 32)	Cross tabulations
Investment criteria	Customer survey (n = 32)	Cross tabulations
Program components	Program documents Customer survey (n = 32)	Cross tabulations
Free riders and spillover	Customer survey (n = 32)	Algorithms

4.1.3 Results

Program Rationale

Based on a review of project documents and discussions with program staff, a program logic model was built which summarizes the input-output-purpose-goal linkages for each of the seven key program components. For each component, the input-output-purpose-goal chain appears to be valid, realistic, and achievable. It is therefore concluded that the program rationale underlying NPD is sound.

Market Analysis

The purpose of the market analysis is to understand recent developments in the industrial new construction market in British Columbia, and is focussed on two issues: trends in industrial construction in British Columbia; and the determinants of industrial construction. B.C. Statistics information has been used to examine trends in industrial construction in British Columbia and Canada for the period 1998-2010. For both British Columbia and Canada, the value of industrial construction (with industrial building permits used as a proxy for industrial construction) shows no obvious trend over time, and British Columbia's share of industrial construction in Canada has averaged 7 per cent. Regression models were used to analyze the relationship between industrial

construction, output (**GDP**) and the cost of capital (real interest rate). The models produced results that are consistent with economic theory, which suggests that industrial construction is quite sensitive and positively related to GDP and less sensitive and inversely related to the cost of capital.

Knowledge of Energy Efficiency

Participating and non-participating customers were asked a series of scaled questions to gauge their organization's knowledge of various energy efficient technologies. The top-two box scores (very knowledgeable and somewhat knowledgeable) for participants and non-participants were compared. For lighting, HVAC, controls/software, sub-meter/monitoring, material transport and process optimization, the difference between participants and non-participants is less than 10 per cent. For motor drives, fans, pumps, compression, and other machine drives, there is a 10 per cent or greater difference in reported knowledge in favour of participants. These results suggest that program participants generally have a higher level of knowledge of energy efficient technologies than non-participants.

Investment Criteria

Customers were asked "what best describes typical replacement circumstances assuming that capital funding requirements are in place?" For participants, the key equipment replacement circumstances are when a piece of equipment or end-use is nearing the end of its useful life, when a piece of equipment or end-use needs replacement due to complete failure, and when a piece of equipment or end-use can be replaced by one that is more energy efficient. For non-participants, the key equipment replacement circumstances are when a piece of equipment or end-use is nearing the end of useful life, when a piece of equipment or end-use can be replaced by one that yields greater production, and when a piece of equipment or end-use needs replacement due to complete failure. In order to make informed replacement decisions, this suggests that customers need to understand their options in terms of energy efficient equipment or end-uses well before a replacement decision is made. If

customers lack knowledge of energy efficient alternatives, it is likely that replacement decisions made under time constraints will limit the range of options considered, with inadequate attention paid to the energy efficiency of replacement alternatives.

Program Components

For each of the major program components, a series of questions were asked in an attempt to determine customer awareness of the component, understanding of the component, the extent to which the component was easy to work with or use, and the respondents' overall rating of the component. For the analysis, emphasis was placed on comparisons of top-two box score percentages between program participants and program non-participants. Most respondents displayed a high level of awareness of the NPD program components, and typically, participants were more aware of each of the components than non-participants. Understanding of each program component was good or excellent for most participants, while a much smaller share of non-participants typically reported a good understanding of the components. Respondent ranking of the program components being easy to work with varied greatly. Monitoring, Targeting and Reporting, Energy Managers and Key Account managers all received excellent scores, while Energy Studies, Program Literature and Capital Incentives received lower scores. When asked "Overall, how would you rate the NPD program?", all participants rated NPD as excellent or good, while 57 per cent of non-participants rated it the same.

Free Riders and Spillover

Respondents were asked several preliminary questions as part of the analysis of free ridership and spillover. Those who confirmed their site's participation in NPD were asked "How influential was the program on your organization's decision to implement the energy efficiency measures and/or install the technologies at this facility." Responses from the participant survey were assessed to produce a free rider rate of 0 per cent. Spillover was calculated based on responses to questions about additional energy efficiency measures installed at the facility that were not covered by the program financial incentives, and how influential was participation in and learnings from the NPD

program on their organization's decision to do more on their own. Only savings estimated as being at least as large as program savings were counted, and responses were assessed to compare non-program and program savings. The resulting spillover rate was 1.7 per cent.

4.2 Power Smart Partner – Transmission Program F2010 and F2011

4.2.1 Introduction

BC Hydro's Power Smart Partners – Transmission (**PSP-T**) program is a multi-year energy acquisition and market transformation initiative that encourages its largest industrial customers to undertake energy efficient investments. The key program objectives are to support customers in implementing effective and sustainable energy management programs while continuing to support the Transmission Service Rate and obtaining cost effective energy savings. The purpose of this study is to conduct a process and market evaluation of the PSP-T program.

4.2.2 Approach

For this study, there were six main activities: (1) program review; (2) estimate end use consumption; (3) assess customer knowledge of energy efficiency; (4) describe customer investment criteria; (5) review program components; and (6) estimate free riders and spill over. The study uses information collected from program files, program staff interviews, a customer survey, and site audits for the analysis. Econometric models were used to estimate end use consumption. The key data collection effort was conducted in June and July of 2011.Cross tabulations were used to analyze knowledge of energy efficiency, investment criteria and program components. Standard algorithms were used to estimate free riders and spill over.

4.2.3 Results

Program Review

PSP-T offered two funding streams: the Enabler Approach and the Incentive Approach. Customers could participate under both streams, and some customers start with the enablers and then move to incentives if and when attractive investment opportunities are found. Under the Enabler Approach customers were offered a comprehensive package of tools including (1) Sustainable Energy Management Plan (**SEMP**), (2) Monitoring, Targeting and Reporting (**MT&R**), (3) Energy Manager, (4) Key Account Managers, (5) Energy Audits and Studies, and (6) Program Literature. Under the Incentive Approach: Customers were offered (7) Capital Incentives up to 4.5 cents per kWh levelized with 100 per cent of project cost up to $1 million and 75 per cent of project cost at or above $1 million. A logic model for PSP-T was built which summarizes the input-output-purpose-goal linkages for each of the seven key program components. Analysis of the logic model suggests that the program logic is sound because there are well defined and cogent linkages among the input-output-purpose-goal chains for each activity.

End Use Consumption

To better understand how large industrial customers use electricity, a statistically adjusted engineering (**SAE**) model was used to produce end use consumption estimates for nine end uses (lighting, refrigeration and freezing, process heat, pumps, fans and blowers, compressors, processes, materials handling and other) using SAE estimates. Data came from 198 site audits. The site audits included both transmission voltage and larger distribution voltage industrial customers and produced modeled estimates of electricity consumption by end use. Table 4.2.1 summarizes the end use estimates for the whole sample and for the three divisions: primary industry (agriculture, forestry, fisheries, mining), secondary industry (manufacturing), and tertiary industry (service industry sector).

Table 4.2.1 Electricity Consumption by End-Use and Industry Type (MWh per site per year)

	All industry (n = 198)	Primary (n = 20)	Secondary (n = 136)	Tertiary (n = 42)
Lighting	1,430	374	1,407	2,003
Refrigeration/freezing	885	187	915	1,124
Process heat	432	112	518	301
Pumps	2,685	804	3,378	1,335
Fans	1,510	482	1,851	895
Compression	1,859	625	2,340	330
Other process	3,289	762	4,259	1,347
Materials handling	1,104	398	1,356	623
Other	757	308	919	437
Total	13,951	4,052	16,943	8,395

Knowledge of Energy Efficiency

Participating and non-participating customers were asked a series of scaled questions to gauge their organization's knowledge of various energy efficient technologies. The top-two box scores (very knowledgeable and somewhat knowledgeable) for participants and non-participants were compared. For lighting, HVAC, motor drives, sub-metering/monitoring, fans, compression, and other machine drives the difference between participants and non-participants is less than 10 per cent. For controls/software, pumps, and process optimization there is a 10 per cent or greater difference in reported knowledge in favour of participants. For material transport, there is a 10 per cent or greater difference in reported knowledge in favour of non-participants.

Investment Criteria

Customers were asked "What best describes typical equipment replacement circumstances assuming that capital funding requirements are in place?" For participants, the most common responses were when a piece of equipment or end use is nearing the end of its useful life; and when a piece of equipment or end use needs

replacement due to complete failure. For non-participants, the most common responses were when a piece of equipment or end use is nearing the end of useful life; when a piece of equipment or end use can be replaced by one that is more energy efficient; and when a piece of equipment or end use can be replaced by one that yields greater production. These responses suggest that customers need to understand their options in terms of energy efficient equipment well before a replacement decision is made. If customers lack knowledge of energy efficient alternatives, it is likely that replacement decisions made under time constraints will limit the range of options considered, with inadequate attention paid to the energy efficiency of replacement alternatives.

Program Components

For each of the major program components, a series of questions were asked in an attempt to determine customer awareness of the component, understanding of the component, the extent to which the component was easy to work with or use, and the respondents' overall rating of the component. For the analysis, emphasis was placed on comparisons of top-two box score percentages between program participants and non-participants. Most respondents displayed a high level of awareness of the PSP-T program components, and typically, participants were more aware of each of the components than non-participants. Understanding of each program component was good or excellent for most participants, while a much smaller share of non-participants typically reported a good understanding of the components. Respondent ranking of the program components being easy to work with varied between participants and non-participants, with participants rating many of the components lower on being easy to work with – notably Capital Incentives, Monitoring, Targeting and Reporting (**MT&R**), and SEMP. When asked "Overall, how would you rate the PSP-T program?" no respondent rated PSP-T as poor, 69 per cent of participants and 50 per cent of non-participants rated PSP-T as excellent or good.

Free Riders and Spillover

Respondents were asked several preliminary questions as part of the analysis of free ridership and spillover. Those who confirmed their site's participation in PSP-T were asked "How influential was the program on your organization's decision to implement the energy efficiency measures and/or install the technologies at this facility." Responses from the participant survey were assessed to produce a free rider rate of 8 per cent. Spillover was calculated based on responses to questions about additional energy efficiency measures installed at the facility that were not covered by the program financial incentives, and how influential was participation in and learnings from the PSP-T program on their organization's decision to do more on their own. Only savings estimated as being at least as large as program savings were counted, and responses were assessed to compare non-program and program savings. The resulting spillover rate was 26 per cent, but this estimate needs to be treated with considerable caution since, upon reflection of the results, the survey question may have been misinterpreted.

Study Limitations

This study has two significant limitations. First, the sample size is small because the participant population is small. This limits the validity and usefulness of the statistical analysis of the survey data for differences between participant and non-participant respondents, although it does not affect the regression model of end-use electricity consumption estimates that was based on a robust sample. Second, the survey was administered as an internet survey, so there was no opportunity to ask respondents about the reasons for their responses. It might be useful to modify this approach in future process evaluations.

4.3 Power Smart Partner – Distribution Program F2009 and F2010

4.3.1 Introduction

The Power Smart Partners – Distribution (**PSP-D**) program was introduced in December 2008 to provide support for small and medium-sized industrial firms for the

retrofit and energy-efficient operation of industrial technologies and systems. Its chief objective is to encourage these customers to implement an integrated energy management program into their on-going business practices.

The PSP-D program was designed for the approximately 1,000 industrial customers serviced at distribution voltage (< 69 kV) with electricity bills greater than $50,000 per year (approximately 1 GWh of consumption). During F2009 and F2010, PSP-D focused primarily on the 200 customers with bills greater than $250,000 (approximately 4 GWh of consumption).

Three industry sectors comprise over 60 per cent of the total energy consumption across all PSP-D eligible customers, and therefore PSP-D primarily targets these largest sectors: Wood Products, Manufacturing, and Food and Beverage. Secondary industry sectors include Agriculture, Oil and Gas, Warehousing and Storage, and Transportation. In each sector, PSP-D targets three key barriers identified to securing energy efficiency projects: (1) Lack of investment capital; (2) Lack of time and resources; and (3) Lack of interest. PSP-D seeks to overcome these barriers by implementing a pro-active, targeted strategy.

The purpose of this study is to conduct a process and impact evaluation of the PSP-D program for F2009 and F2010.

4.3.2 Approach

For this study, there were six main activities: (1) program review; (2) determine market awareness of the program, assess customer satisfaction and barriers to participation; (3) estimate program gross savings; (4) estimate program net savings; and (5) determine perceptions of customer needs and marketplace trends through interviews with trade allies. The study uses information collected from program files, M&V results, program staff interviews, interviews with trade allies, customer surveys and customer site visits. Gross savings were estimated using ratio estimation based on a sample of projects with M&V results and information collected in site visits. Cross

tabulations were used to analyze knowledge of energy efficiency, investment criteria and program components. For net savings, standard algorithms were used to estimate free riders and spill over. Table 4.3.1 provides a summary of the issues, data, and methods for this study.

Table 4.3.1 Evaluation Issues, Data Sources and Methods

Issues	Data sources	Methods
Program review	Documents review Staff interviews	Program logic model
Market Awareness, Customer Satisfaction, Investment Criteria	Participant Survey (n = 40) Partial-Participant[11] Survey (n = 16) Non-Participant Survey (n = 13)	Cross tabulations
Customer needs and marketplace trends	Trade Ally Interviews (n = 24)	Qualitative analysis
Gross Impacts	M&V results (n = 11) Site audits (n = 33)	Ratio estimation
Net Impacts	Participant Survey (n = 40) Partial-Participant Survey (n = 16)	Algorithms

4.3.3 Results

Program Review

PSP-D encompasses multiple initiatives that are intended to take customers through the sequential stages of energy efficiency projects. Over-arching initiatives are offered to assist the integration of energy management into the customer's existing business, including funding assistance to develop a SEMP, for an Energy Manager and for an Energy Management Assessment (**EMA**). Other offers, such as Energy Audits, Customer Site Investigation (**CSI**), Scoping Studies, and End-Use Training Workshops provide customers with funding and technical assistance to help build a solid business case for efficiency upgrades. PSP-D also offers financial incentives for energy efficiency measures or for supporting significant process or operational changes within customers'

[11] Defined as decision makers at facilities who conducted an energy study with program support but who did not complete any energy efficiency retrofit projects with program support during F2009-F2010.

facilities. Other offers such as MT&R and Employee Energy Awareness are designed for continuously improving energy performance through ongoing monitoring, target setting and employee feedback and behaviour change.

A logic model for PSP-D was built which summarized the input-output-purpose-goal linkages for each of the seven key program components. Analysis of the program elements and logic model suggests that the program logic is sound because there are well defined and plausible links among the input-output-purpose-goal chains for each activity.

Customer Decision Making and Satisfaction

Surveys of participants and non-participants were conducted to collect information on their energy management practices and awareness and opinion of PSP-D. Some of the key findings include:

(1) BC Hydro information sources are very important to many customers, but decision-makers stay current with energy efficiency by relying on multiple sources of information.

(2) Most respondents indicated that they use simple payback to assess energy efficiency projects, but many respondents indicated that they also employ more than one method.

(3) Participants who went on to complete energy saving projects were much more likely to have been contacted directly by contractors (vendors) over any other source.

Ninety-five per cent of participants indicated that they were either likely or very likely to implement another project under the PSP-D program, and 87 per cent were likely or very likely to recommend the program to colleagues or other firms.

Responses from non-participants indicated that the primary reasons for non-participation related to circumstances internal to the customer rather than the PSP-D program. When asked to elaborate on what would make them more likely to participate, most respondents indicated higher incentives.

Energy Savings Estimates

Analysis of gross savings was based on a review of savings for a sample of sites chosen from among the participants in the program. The evaluated gross energy savings estimates were derived by site-by-site analyses, using project documentation and data collected through site visits. The gross realization rate was near 100 per cent for the program as a whole based on M&V results for the larger projects and due to a large proportion of savings coming from lighting measures which typically have more accurate ex-ante energy savings estimates than other measures. Participant surveys were used to estimate free ridership of 26 per cent and spillover of 13 per cent which combine into a net-to-gross ratio of 87 per cent. The net-to-gross ratio was applied to evaluated gross savings to estimate evaluated net savings. Table 4.3.2 shows reported and evaluated net savings.

Table 4.3.2 PSP-D Energy Savings Estimates

Fiscal Year	Expected Gross Savings (GWh/year)	Evaluated Gross Savings	Net-to-Gross-Ratio	Evaluated Net Savings (GWh/year)
2009	6.5	6.5	0.87	5.7
2010	19.5	19.5	0.87	17.0

Trade Ally and Energy Manager Interviews

Trade allies are consultants, contractors and equipment distributors that sell energy efficiency products and services to BC Hydro customers. All trade allies interviewed had either positive or very positive views of the PSP-D program. Though every respondent had suggestions for program refinements and improvements, all respondents encouraged the continuation and/or expansion of the program. Allies indicated that one

of the most positive aspects of the PSP-D program was the array of incentive offers. Similarly, they expressed appreciation for BC Hydro continually improving program offers and administration. While some did not report any problems in dealing with the programs, other allies found it difficult to keep up with the constant changes.

Energy managers were quite complimentary of the level of assistance that they had received from BC Hydro, but they did indicate some areas where increased assistance would be helpful.

5 Conservation Rates

5.1 Transmission Service Rate F2011

5.1.1 Introduction

BC Hydro provides electricity to approximately 130 customer sites at transmission voltage. This group, the transmission rate class, is dominated by industrial facilities in the forest products pulp and paper, mining, electrochemical, oil and gas processing, and transportation sectors, and it makes up more than one-third of BC Hydro's domestic load. Before April 1, 2006, the rate charged to these customers was a flat energy rate (1821) coupled with a demand charge.

Following a 2003 BCUC hearing and extensive consultations, BC Hydro filed the Transmission Service Rate Application (**TSR**) with the BCUC on March 25, 2005 including four components: (1) Stepped Rates; (2) Time of Use Rates; (3) Market Access; and (4) Program Enablers. Stepped Rates and Time of Use Rates for former 1821 rate customers became effective on April 1, 2006. The rate established an initial Customer Baseline Load (**CBL**) at 2005 historical consumption adjusted for various factors such as DSM, force majeure and plant capacity increases. The Tier 1 price applies to consumption up to and including 90 per cent of the CBL and the Tier 2 price applies to consumption in excess of 90 per cent of the CBL. On February 22, 2008, BC Hydro applied for interim and final orders on the re-pricing of the TSR to reflect the cost of new supply in its F2006 Call for Tender process. On March 10, 2008, the Commission provided interim approval for the new rates with effect on April 1, 2008. The Commission order of June 17, 2008 confirmed the new Tier 2 rate, and set out procedures for the calculation of the revised Tier 1 rate.

The purpose of this study is to provide a retrospective process and impact evaluation of the TSR in F2011. The impact evaluation attempts to estimate the additional impact of the TSR on energy consumption and peak demand. This is also referred to as unreported DSM, which are residual energy savings from energy conservation and efficiency and self-generation actions that were funded and installed by the customer

without BC Hydro assistance. Unreported DSM is assumed to occur in response to the TSR and Power Smart enabling activities working in combination, but are not reported to BC Hydro by customers. Conversely, reported DSM is typically claimed as Power Smart energy savings and evaluated through the PSP – Transmission program evaluation.

5.1.2 Approach

This study leverages a detailed online survey of 34 TSR customers to explore several process evaluation questions and an econometric model to estimate impact. The basic method for the impact analysis is interrupted time-series regression modeling combined with engineering algorithms. Table 5.1.1 summarizes the issues, data sources and methods for this study.

Table 5.1.1 Evaluation Issues, Data Sources and Methods

Issues	Data sources	Methods
TSR review	File and documents review Interviews (customer survey)	Logic framework analysis
Rate awareness and knowledge	File and documents review Interviews (customer survey)	Cross tabulations
Rate design and effectiveness	File and documents review Interviews (customer survey)	Cross tabulations
Investment criteria	File and documents review Interviews (customer survey)	Cross tabulations
Support for and Role of the TSR	File and documents review Interviews (customer survey)	Cross tabulations
Energy demand and impact	BC Hydro data BC Statistics data	Econometric models Engineering algorithms

5.1.3 Results

TSR Review

The review has three major findings. First, over the four fiscal years F2007 through F2010, Tier 1 sales averaged 97.1 per cent of total TSR sales, Tier-2 sales averaged

2.9 per cent of total sales, and the Tier 2 share of sales fell from 5.4 per cent of total TSR sales in F2007 to 2.4 per cent of total TSR sales for F2010. The second point is that the aggregate CBL load has fallen from 15,964 GWh per year in F2007 to 13,117 GWh in F2010. Third, the rationale for the TSR is that customers will rationally respond to the higher marginal price of Tier 2 energy by seeking ways to reduce energy purchases. This rationale for the TSR has been examined by developing a logic model which shows strong and valid linkages among inputs, outputs, purposes and goal statements, so that it is reasonable to expect that transmission customers will respond to the price signal given by the Tier 2 price and reduce their consumption of electricity accordingly.

Rate Awareness and Knowledge

To measure customer awareness and knowledge of their rate structure, respondents were asked a series of increasingly specific questions on the rate structure. First, 83 per cent of responding customers correctly understood on an unaided basis that they faced an inclining block rate, while 17 per cent of respondents incorrectly believed that they faced a flat energy charge. Second, 88 per cent of surveyed customers had heard of the TSR, 9 per cent had not heard of the TSR, and 3 per cent did not know one way or the other. Third, among all responding customers, 80 per cent confirmed knowing, on an aided basis, that their main account is billed on the TSR, while 8 per cent of customers were not previously aware of this, and 12 per cent were not aware of the TSR even in concept.

Rate Design, Awareness, Understanding and Use

Survey data has been used to examine customer awareness, customer understanding, and customer views of ease of use for each of the main rate components. Among those aware of the TSR, 100 per cent of respondents were aware of the stepped rate component of the TSR. In terms of understanding, 88 per cent of customer respondents rated their understanding of the stepped rate component of the TSR as excellent or good.

Among customer respondents aware of the TSR and its stepped rate component, 33 per cent rated this particular component as excellent or good in terms of being easy to work with and act upon.

Investment Criteria

To understand the context of energy-related investment, customers were asked several questions about the factors driving capital investment decisions. Ninety five per cent of customers report that incentive payments received from BC Hydro or other utilities are an important consideration in this regard. This top-two box importance score declines marginally to measure 90 per cent in regards to advice and/or recommendations from engineering consultants, 84 per cent in regards to the cost of energy, 80 per cent in regards to advice and/or recommendations from equipment vendors, and declines to 70 per cent in regards to advice and/or recommendations from BC Hydro or other utilities.

When asked about typical circumstances leading to new capital investment, 44 per cent of respondents stated that the typical circumstance was when a piece of equipment or end-use is nearing the end of its useful life with far few responding when a piece of equipment or end-use needs replacement due to complete failure (18 per cent), when a piece of equipment or end-use can be replaced by one that yields greater production (18 per cent), when a piece of equipment or end-use can be replaced by one that is more energy efficient (16 percent) and fewer still when a piece of equipment or end-use can be replaced by one that yields better output quality (4 per cent).

Support for and Role of the TSR

Respondents were also asked about whether or not their organization supported the TSR. A total of 60 per cent of responding customers said that they support the TSR, including 32 per cent who strongly support it. The balance of customers reported that they were indifferent (21 per cent) towards the rate rather than opposed to it (7 per cent). Based on a further line of questioning, a large majority of respondents

(78 per cent) indicated that the TSR encouraged the installation of additional energy efficiency investments.

Energy and Peak Savings Estimates

Load impacts, defined as the residual effects of the TSR on consumption net of energy saving projects reported to BC Hydro (or unreported DSM), are estimated using a log linear regression model. The statistical results are generally good, and the equation has a high level of explanatory power. The incremental energy savings of the TSR is calculated using the Tier 2 price elasticity multiplied by the relative change in the Tier 2 price from the base year multiplied by the Tier 2 consumption lagged one year. For F2011, the estimated unreported DSM was 81.0 GWh per year compared with evaluated results of 79.8 GWh per year. For F2011, the program did not report peak savings and the evaluated savings were 7.5 MW.

Table 5.1.2 TSR Unreported DSM Energy and Peak Savings Estimates

	Energy (GWh/year)		Peak (MW)	
Fiscal Year	**Estimated**	**Evaluated**	**Program reported**	**Evaluated**
F2011	81.0	79.8	N/A	7.5

6 Codes and Standards

6.1 Residential Building Code F2011

6.1.1 Introduction

BC Hydro has provided support for the development and implementation of residential energy codes and related energy efficiency standards, which have affected energy use and energy efficiency in new residential construction in British Columbia. The purpose of this study was to evaluate the impact of the September 2008 changes to the B.C. Building Code on energy use in residential dwellings for F2011.

6.1.2 Approach

For this study, there were five main issues as follows: (1) document and assess logic model, (2) characterize the new residential construction market in British Columbia; (3) describe relevant energy use-related features of the code; (4) estimate unit energy savings by dwelling type and main space heating fuel; and (5) estimate energy and peak savings by dwelling type and main space heating fuel for F2011.

A summary of the study issues, data and methods for this study is shown in the following table. The study uses information collected from site audits, developer interviews, and customer surveys to build a database for the analysis. Whole dwelling energy modelling is then used to estimate energy and peak savings.

Table 6.1.1 Evaluation Issues, Data Sources and Methods

Issues	Data	Method
1. Document and assess logic model	Documents review Interviews	Logic framework
2. Characterize new residential construction market	Canada Mortgage and Housing Corporation (**CMHC**) information	Survey analysis
3. Characterize key residential building code requirements	B.C. official documents	Documents review
4. Estimate unit energy savings	On-site visits Billing data	HOT-2000 models
5. Estimate energy and peak savings	Baseline study CMHC data	Algorithms

6.1.3 Results

Logic Model

BC Hydro has supported code research, code adoption and code compliance. The initiative rationale has been examined using this logic model, which was developed from interviews with staff, a documents review and a literature review. This review and analysis confirms that the basic initiative logic is valid. There are strong linkages among inputs, outputs, purposes and goal statements. Indicators for key components of the logic model are clear, well defined and measurable.

New Residential Construction Market

Comparing the British Columbia and Canadian housing markets for the period 2006 - 2010 provides a useful benchmark. Key housing market variables include housing starts, resale housing units, resale housing prices, employment and gross domestic product. Table 6.1.2 summarizes year-over-year changes in percentage terms for these variables for both British Columbia and Canada.

Table 6.1.2 Housing Market Indicators for British Columbia and Canada

Fiscal Year	Housing start (% change)		Resale housing (% change)		Resale prices (% change)		Employment (% change)		GDP (% change)	
	B.C.	Can	B.C.	Can	B.C.	Can	B.C.	Can	B.C.	Can
2006	5.1	0.8	-9.1	-0.1	17.7	11.2	3.1	1.9	4.1	2.8
2007	7.6	0.4	6.3	7.9	12.3	10.8	3.2	2.3	3.0	2.2
2008	-12.4	-7.6	-33.0	-17.1	3.5	-0.7	2.1	1.5	0.2	0.5
2009	-53.2	-29.4	23.4	7.7	2.4	5.1	-2.4	-1.6	-1.8	-2.5
2010	64.7	27.4	-12.2	-3.9	8.5	5.8	2.0	1.6	3.3	2.9

Source: CMHC, Housing Market Outlook, First Quarter 2011.

Energy Code

In the early to mid-1990s, a number of changes were made to the British Columbia Building Code (**BCBC**) and to the City of Vancouver Building By-law (**VBBL**). These changes included the following: (1) adoption of the minimum insulation table 9.25.2.A in the BCBC in 1994; (2) adoption of the minimum insulation table 9.25.2.A for single-family dwellings in the VBBL in 1995; and (3) adoption of the minimum insulation table 9.26.2.A for multi-family dwellings in the VBBL in 1991. Additional requirements in new residential housing included installation of an air barrier, installation of a dedicated ventilation system, and installation of, as a minimum, double-glazed windows. As of September 8, 2008, the BCBC required an improvement in energy and water efficiency in British Columbia, and the code applied to all new construction and renovation.

Unit Energy Savings

To estimate unit energy savings by fuel (electricity in kWh and natural gas in GJ), defined as the difference between pre-code and post-code unit consumption, sixteen prototype dwellings were built using HOT 2000. The sixteen prototypes were two composite dwelling types (single family/duplex and row house/apartment) times two space heating fuels (electricity and natural gas) times four regions (Lower Mainland, Vancouver Island, Southern Interior and North), and were based on data from 800 on-site audits in British Columbia sponsored by BC Hydro and by the federal government's Office of Energy Efficiency. This information was used to build a set of

detailed models; a series of model runs was undertaken, until the models tracked actual consumption of electricity and natural gas appropriately. The archetypes were first modeled as representative of typical new construction pre-September 2008 code change, and were subsequently modeled to just bring them up to the post-code change requirements.

Energy and Peak Savings Estimates

To estimate gross energy savings by segment, unit energy savings were multiplied by the number of starts lagged one quarter for that segment. Information on housing starts by dwelling type came from CMHC data. To estimate net savings, gross savings of 6.3 GWh were multiplied by the average compliance rate of 63 per cent, based on measure compliance for a number of prescriptive measures for a sample of the audited and modeled buildings. To estimate gross peak savings by segment, a peak-to-energy ratio of 0.20 MW/GWh was applied. Estimated gross natural gas savings were 31.7 TJ for F2011.

Table 6.1.3 Residential Energy Code Energy and Peak Savings Estimates

Fiscal Year	Energy Savings (GWh/year)		Peak Savings (MW)	
	Gross	Net	Gross	Net
F2011	6.3	4.0	1.3	0.8